Neighbourhood and household socio-economic influences on diet and anthropometric status in urban South African adolescents

By

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A doctoral Thesis

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Abstract

Background and Aims

Many low- and middle-income countries are undergoing epidemiological and health transitions. South Africa has one of the highest prevalences of overweight and obesity in Sub-Saharan Africa. This research examined neighbourhood and household socio-economic influences on the risk of overweight and obesity in terms of anthropometric status and dietary intake among urban South African adolescents. A further aim was to conduct a qualitative study on the potential for religious groups such as Churches to be used as community-based organisations for obesity intervention.

Methods

A secondary analysis of neighbourhood and household socio-economic status (SES), anthropometric and dietary data was carried out on adolescents aged 17-19 years from the Birth to Twenty Plus cohort study in Johannesburg-Soweto. Qualitative data were collected through focus groups discussions and a community readiness survey with church leaders.

Results

No significant associations were observed between SES (household and neighbourhood) and energy, protein, fat, or carbohydrate intakes in males. Some significant associations were found between SES and dietary intake in females. Females had a higher prevalence of overweight and obesity than males (26.2% vs. 8.2%, $p<0.0001$). In males, poor household SES was associated with lower odds of overweight, fatness and high waist-to-height ratio (WHTR). For females, household SES was not significantly associated with overweight, fatness and high WHTR. The qualitative research showed that there was a very low level of community readiness among church leaders for obesity prevention programmes.

Conclusions

The dietary results suggest that the diet of these adolescents is transitioning to that seen in high income countries. It also highlights that even within the same relatively small urban area, nutrition transition does not affect different groups in uniform ways. The qualitative results indicate that programmes should focus around raising awareness of the problem of overweight/obesity in this community.

Key words

Adolescents, South Africa, socio-economic status, neighbourhood, household, sex, diet, overweight, obesity, urban

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“The greatest glory in living lies not in never falling, but in rising everytime we fall”

Nelson Mandela

Publications Arising

Published

- Pradeilles, R., Griffiths, P.L., Norris, S., Feeley, A., Rousham, E.K. (2015) (published). Socio-economic influences on anthropometric status in urban South African adolescents: sex differences in the Birth to Twenty Plus cohort. Public Health Nutrition.
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Prepared manuscripts

- Pradeilles, R., Griffiths, P.L., Rousham, E.K., Norris, S., Feeley, A. Neighbourhood and household socio-economic influences on dietary intake in urban South African adolescents: sex differences in the Birth to Twenty Plus cohort. Public Health Nutrition.
- Pradeilles, R., Rousham, E.K., Norris, S., Kesten, J., Mendenhall, E; Griffiths, P.L. An assessment of community readiness for obesity prevention interventions in adolescents through Churches in urban South Africa. BMC Public Health.
- Pradeilles, R., Griffiths, P.L., Rousham, E.K., Norris, S., Mendenhall, E. Perceptions of body image among urban South African religious leaders. Social Science and Medicine.
- Pradeilles, R., Griffiths, P.L., Norris, S., Said-Mohamed, R. Neighbourhood socio-economic disparities within Soweto. South African Journal.

Conference contributions

Conference oral presentations from my PhD

- The Researchers in Development PhD Network (RiDNet), November 2013, Leeds. *Title: Quantifying dietary intakes of adolescents in Johannesburg and Soweto, South Africa: issues of time, data cleaning, data management and validity*
- British Society for Population Studies (BSPS), September 2013, Swansea. *Title: Community and household SES influences on dietary intake and obesity in urban South African adolescents*
- Population studies conference for postgraduate students (PopFest), July 2013, Southampton. *Title: Community and household SES influences on dietary intake in urban South African adolescents*

Research seminars from my PhD

- The Developmental Pathways for Health Research Unit (DPHRU), November 2014, University of the Witwatersrand, Johannesburg, South Africa
- Centre for Global Health and Human Development-research group seminar, November 2014, Loughborough
- Centre for Global Health and Human Development-research group seminar, December 2013, Loughborough
- Centre for Global Health and Human Development-research group seminar, April 2013, Loughborough
- The Developmental Pathways for Health Research Unit (DPHRU), March 2012, University of the Witwatersrand, Johannesburg, South Africa

Conference poster presentations from my PhD

- International Society for Behavioural Nutrition and Physical Activity (ISBNPA), June 2015, Edinburgh
- SSHB student conference, September 2014, Loughborough, UK
- European Congress on Obesity (ECO), May 2014, Sofia, Bulgaria
- School of Health and Life Sciences - Research Student Conference, February 2014, Loughborough, UK

- International Congress of Nutrition (ICN), September 2013, Granada, Spain
- School of Health and Life Sciences - Research Student Conference, May 2012, Loughborough; *poster winner*
- BSPS, September 2012, Nottingham, UK
- PopFest, May 2012, Loughborough, UK

Other contributions

- Press release Witwatersrand University

http://www.wits.ac.za/newsroom/newsitems/201411/25230/news_item_25230.html

- Press release Loughborough University

http://www.lboro.ac.uk/news-vents/news/2014/november/205apartheidstudy.html

- Radio interviews South Africa

https://archive.org/download/InterviewWithRebeccaFri21.11.2014/Interview_with_Rebecca-fri-21.11.2014.mp3

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List of abbreviations

AIDS: Acquired immunodeficiency syndrome

ANC: African National Congress

BIA: Bioelectrical impedance analysis

BIA-O: Body image assessment for obesity

BMI: Body mass index

Bt20: Birth to Twenty

CI: Confidence interval

COPD: Chronic obstructive pulmonary diseases

CRM: Community Readiness Model

CVDs: Cardiovascular diseases

DHS: Demographic and Health Survey

DXA: Dual-energy x-ray absorptiometry

FAO: Food and Agriculture Organisation

FFQ: Food frequency questionnaire

FG: Focus group

FGDs: Focus group discussions

GIS: Geographic information system

HDI: Human Development Index

HIV: Human immunodeficiency virus

IASO: International Association for the Study of Obesity

IHME: Institute of Health Metrics and Evaluation

IOTF: International Obesity Task Force

IQR: Inter quartile range

JK: Joanna Kesten

LMICs: Low- and middle-income countries

MRC: Medical Research Council

NCDs: Non-communicable diseases

NCHS: National Center for Health Statistics

NGOs: Non-Governmental Organisations

NHANES: National Health and Nutrition Examination Survey

OR: Odds ratios

PCA: Principal component analysis

RP: Rebecca Pradeilles

SA: South Africa

SANHANES: South African National Health and Nutrition Examination Survey

SD: Standard deviation

SES: Socio-economic status

STDs: Sexually transmitted diseases

UK: United Kingdom

UNDP: United Nations Development Programme

USA: United States of America

WC: Waist circumference

WHO: World Health Organisation

WHTR: Waist-to-height ratio

WOF: World Obesity Federation

Chapter 1: Introduction

1. Introduction

1.1 Rationale for the study

Many low- and middle-income countries (LMICs) are undergoing epidemiological and health transitions with rapid increases in the incidence of overweight, obesity and diet related chronic diseases being witnessed. This is particularly apparent in urban areas (Mendez et al. 2005; Ziraba et al. 2009; Mamun and Finlay 2014), and is reflected by a westernized lifestyle (diversified diet rich in saturated fat, refined carbohydrates, salt whilst low in fibres; paired with reduced physical activity and increased sedentary behaviour) (Popkin and Gordon-Larsen 2004; Popkin 2006a; Popkin et al. 2012).

South Africa has been exposed to political violence, oppression and Apartheid marginalization for 46 years (Mandela 1995). The Apartheid era led to major differences in the living conditions of the different population groups in terms of quality of life, SES and health (May and Govender 1998; Cameron 2003; Chopra et al. 2009; Richter et al. 2009). At the end of Apartheid and with a new democratic government in 1994, South Africa experienced socio-economic and political changes as well as a rapid urbanisation (Jenkins 1997; Seekings 2000). As a consequence, South Africa is undergoing the nutrition transition as evidenced by changes in lifestyle behaviours (diet and physical activity) and the increasing prevalence of overweight and obesity (Bourne et al. 2002; Feeley et al. 2009; Abrahams et al. 2011b; Feeley et al. 2012; Steyn and McHiza 2014). Recent data show that South Africa has one of the highest prevalences of overweight and obesity in Sub-Saharan Africa, with 30.7% of men and 64.0% of women being overweight or obese (Shisana O 2014; WOF 2014). Numerous studies amongst women of reproductive age in LMICs have shown a positive socio-economic gradient in overweight (Griffiths and Bentley 2001; Monteiro et al. 2004a; Mendez et al. 2005; Subramanian and Smith 2006; Subramanian et al. 2009; Jones-Smith et al. 2011a; Jones-Smith et al. 2011b; Subramanian et al. 2011). The limited evidence on men in LMICs has revealed a similar pattern (Monteiro et al. 2004b; Subramanian et al. 2009; Alaba and Chola 2014). Fewer studies have been conducted in men in LMICs due to the lack of data available in this group. The direction of the association between SES and overweight is dependent upon a country's level of economic development and urbanization (Popkin et al. 2012). It has been observed that the burden of overweight shifts from high to low SES groups as the gross domestic product of a country improves (Monteiro et al. 2004b; Mendez et al. 2005; Jones-Smith et al. 2011a; Jones-Smith et al. 2011b; Popkin et al. 2012; Goryakin and Suhrcke 2014; Mamun and Finlay 2014). The transition patterning differs between sexes, with overweight in women shifting from wealthy to poor groups at an earlier point of economic development compared to men (Monteiro et al. 2004b; Dinsa et al. 2012).

In high income societies a number of frameworks have been developed to explain the importance of ecological influences on nutritional outcomes (Swinburn et al. 1999; Davison and Birch 2001; Kok et al. 2008; Story et al. 2008; Kraak et al. 2014). These frameworks identify the importance of proximal determinants (individual factors such as dietary intake and physical activity behaviours, age, sex, etc.), the distal determinants which include the interpersonal (peers, neighbours and family interactions, etc.), organisational (school, church, etc.) and neighbourhood (SES, built environment, culture, food environment, etc.) levels as well as the fundamental determinants which include societal (national legislation, economic and political structure, etc.) and supranational (legislation, food production and distribution systems) levels. Despite growing evidence of the importance of an ecological approach to understanding nutritional outcomes in high income countries, the body of evidence regarding the mechanisms of neighbourhood social influences on youths' nutritional status is scarce in LMICs.

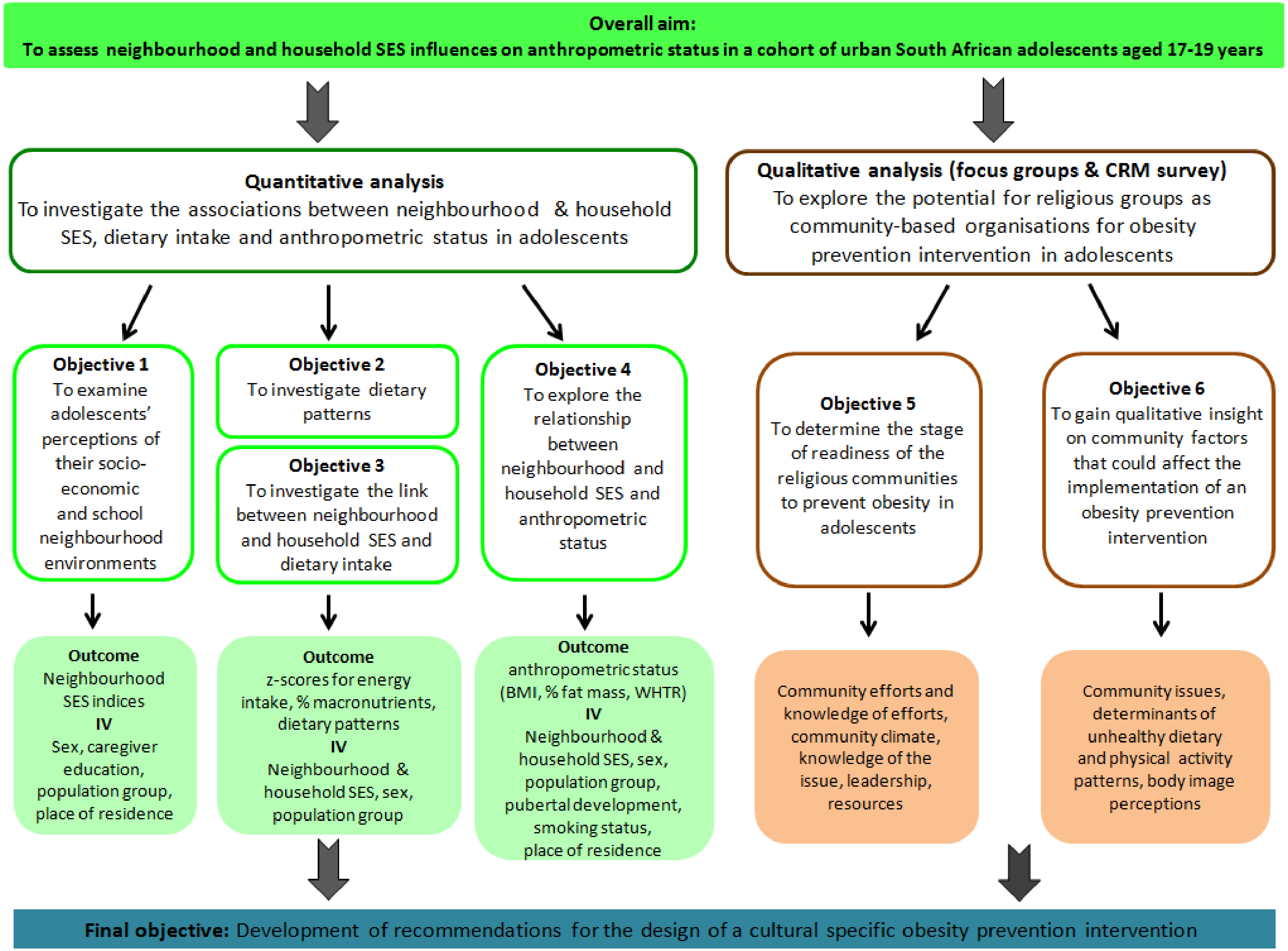
It is important to specifically study these relationships in LMICs because of the transitioning urban environments that they are experiencing. Furthermore, it is essential to identify the factors which influence poor nutritional status in adolescents as they will become the next generation of adults and risk factors for chronic diseases in adolescence may continue through to later life. It is important to study neighbourhood effects in adolescents separately from adults and children because adolescence is the point in the life course when individuals spend more time outside of the home, either in school, the community, or with friends and when they become more influenced by their environment (Jenkins and Horner 2005).

Therefore, the aim of this study is to investigate the associations between SES (at the household and neighbourhood levels), diet and anthropometric status, in a sample of urban South African adolescents aged 18 years. It is the first cohort of adolescents that have grown up in the post-Apartheid era. Therefore it is important to understand household and neighbourhood SES influences on the changing nutritional status patterns of these adolescents as they enter adulthood in this rapidly changing urban environment.

1.2 Objectives of the study

Figure 1 below gives an overview of the PhD aims and methods. The overall aim of the PhD is to examine neighbourhood and household SES influences (negative and positive) on urban South African (SA) adolescents' anthropometric status. This aim is broken down into two sub-aims, the first of which was to assess quantitatively neighbourhood and household socioeconomic influences on dietary intake and anthropometric status. For this analysis, RP was responsible for extensive data coding, cleaning and capturing as well as analysing and interpreting data. The second sub-aim was to explore the potential for religious groups as community-based social organisations for obesity prevention interventions. For this analysis, RP was responsible for developing the objectives, selecting the adequate methodology as well as organising and managing data collection, coding, analysing and interpreting data. It is intended that both the quantitative and qualitative research will be used to inform the design of an appropriate community intervention to improve adolescents' diet and thus anthropometric status in this setting in the future.

Figure 1. Summary of PhD objectives and methods



1.3 Thesis structure

The thesis structure is as follows:

- Chapter 2: This chapter introduces South Africa, the Gauteng province and the area of Johannesburg-Soweto which represents the study zone. The geographical, socio-economic and health context in South Africa will be presented.

- Chapter 3: This chapter consists of a short literature review of the field of research linking neighbourhood SES, diet and obesity in both high income and LMICs.

- Chapter 4: This chapter describes the unique nature of the Bt20+ cohort study and provides some information about the fieldwork undertaken. Furthermore, the quantitative and qualitative research methods are discussed in detail.

- Chapter 5: This chapter focusses on describing adolescents' perceptions of their socio-economic and school neighbourhood environments.

- Chapter 6: This chapter focusses on describing adolescents' dietary patterns and assesses the relationship between SES at the household and neighbourhood levels and dietary intake.

- Chapter 7: This chapter focusses on describing adolescents' anthropometric status and assesses the relationship between SES at the household and neighbourhood levels and anthropometric status.

- Chapter 8: This chapter evaluated the potential for religious groups such as Churches to be used as community-based organisations for obesity intervention. This was done by assessing the readiness of leaders from such organisations to engage in such interventions.

- Chapter 9: This chapter summarises and discusses the key findings of both the quantitative and qualitative part of this study. Following this, the strengths and limitations of the study are discussed. Future directions of research are also considered in this chapter. Finally, recommendations on how to strengthen the existing health system to deal with overweight, obesity and NCDs are also formulated.

Chapter 2: Research in South Africa

2. Research in South Africa

This chapter will introduce South Africa, the Gauteng province and the area of Johannesburg-Soweto which represents the study zone. The geographical context will be first described followed by an overview of the political context during the Apartheid legacy. Contextual information related to the demographic and socio-economic context will then be provided. It then presents information on the epidemiological and nutrition transitions in South Africa, contrasting South Africa with more or less developed countries/regions in the world.

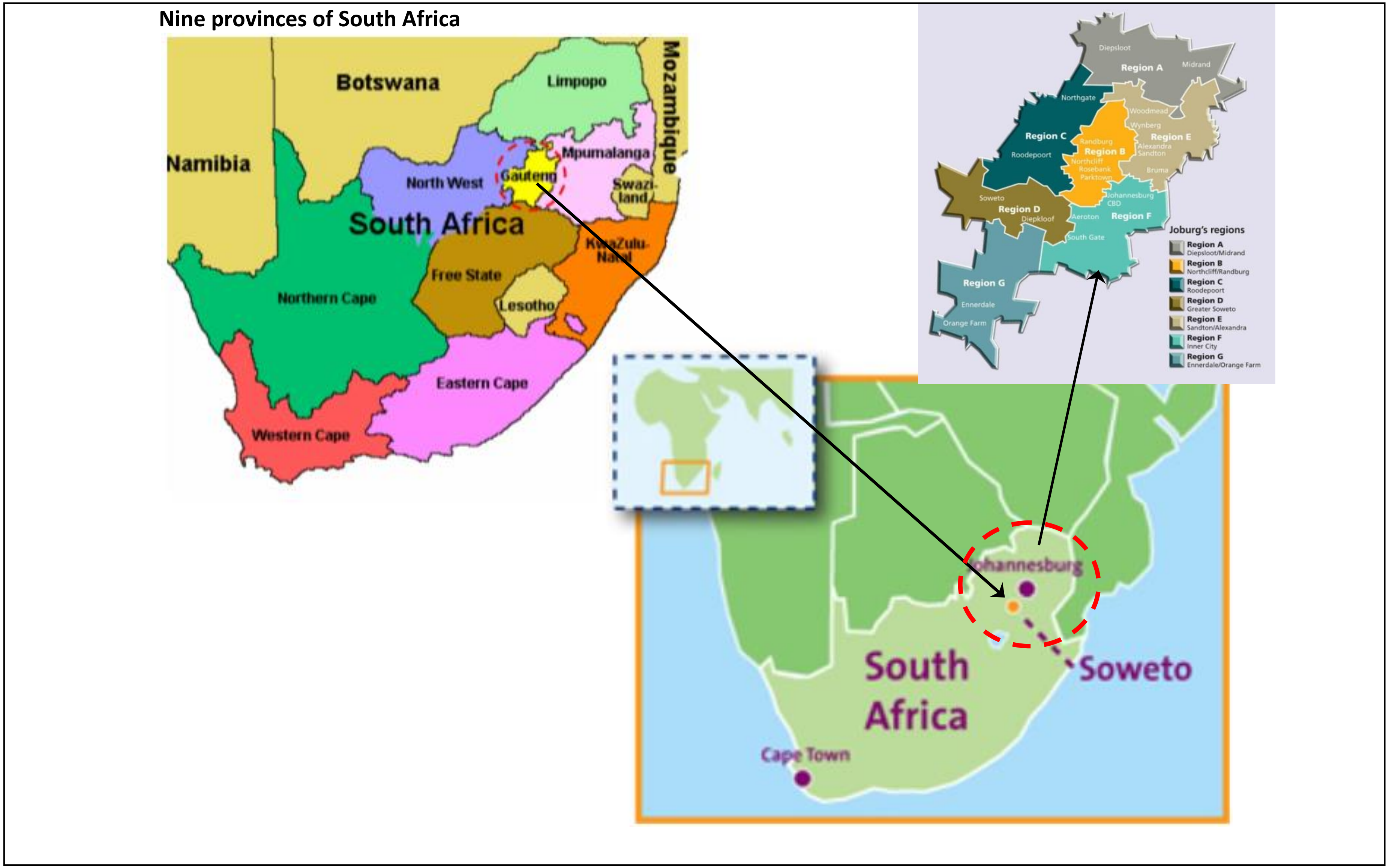
2.1 Geographical context

South Africa, a country of 1.2 million km2 is situated at the southern tip of the African continent. The neighbouring countries are Namibia, Botswana and Zimbabwe to the North and Mozambique and Swaziland to the East. Lesotho is located within the South African territory (Figure 2).

South Africa is composed of nine provinces (Figure 2). The Gauteng province comprises Soweto-Johannesburg and Pretoria. It is the smallest but the most populous and wealthiest province. The Soweto-Johannesburg city which covers 1645 km², is made up of seven administrative regions (Figure 2) and is the largest urban area in South Africa.

Soweto (South Western Township), located 15km to the South West of central Johannesburg, encompasses 32 townships. These were initially living areas for the mine workers until Soweto became a ghetto for the Black African population of Johannesburg during the Apartheid legacy.

Figure 2. Study zone: Johannesburg, Soweto (South Africa)



2.2 Political context

South Africa has been exposed to political violence, oppression and Apartheid marginalisation for 46 years (Mandela 1995). Apartheid, Afrikaans' word meaning "separateness" was a segregation system based on race (Oxford dictionary). It was adopted in 1948 by the Afrikaner National Party as a means to enhance White socio-economic domination and power whilst extending and institutionalising pre-existing racial separation (Christopher 1994; Lester et al. 2000). The racial segregation was implemented at three different levels: "petty Apartheid"; urban segregation and "grand Apartheid" (Christopher 1994).

The "petty Apartheid" sought to separate socially people of different population groups, meaning that specific facilities, transport, churches, hospitals, schools and sections of public services were reserved for whites and non-whites. The primary aim was to protect the White group from any contact with the other population groups.

The urban Apartheid aimed at separating place of residence and business areas of the cities. Indeed, non-whites were forced to leave the urban centres reserved for whites.

The "grand Apartheid", was used as a means of preventing the majority of the South African population from being involved in any political process, forced the relocation of non-White Africans to new homelands and ensured territorial separation.

The map of South African towns and cities was redefined on racial grounds and thus considerable population movements were seen in both the rural and urban areas in order to force people to fit the new spatial distribution. This process was long and took over two decades to be fully implemented. Under the Apartheid era, race and residential area were the principal components used to define people's rights (Christopher 1994; Lester et al. 2000).

A wide range of restrictive laws were enforced at the beginning of the Apartheid legacy in 1948 (Christopher 1994; Lester et al. 2000; Roberts 2001). These sought to widen inequalities and advantage the White minority. The pillars of the Apartheid legacy are presented and discussed below in Table 1.

Table 1. Pillars of the Apartheid legacy

The prohibition of mixed marriages act, 1949
Prohibited marriages between whites and members of other groups to promote racial purity.
The immorality amendment act, 1950
Prohibited extra-marital relations between whites and members of other groups.
The population registration act, 1950
Required South African's to be classified into a distinct population group (White, Black, Mixed Ancestry or Indian/Asian). The classification was based on appearance (e.g. skin colour, curliness of hair), social acceptance, descent and linguistic ability. This classification determined people's residential area, discriminatory measures against them and in turn their identities and livelihoods.
The Group Areas Act, 1950
Authorized the government to separate the territory into black and whites areas, forcing blacks to leave White areas.
The suppression of communism act, 1950
Banned communism and any political party that could represent a threat to the Afrikaner National Party politics.
The Bantu authorities act, 1951
Provided a legal basis for the relocation of blacks into homeland reserve areas (independent states).
The negative laws amendment act/Natives Act, 1952
Imposed severe controls on black's movement into and out of towns and cities.
The abolition of Passes act, 1952
Required all blacks to carry passbooks comprising fingerprints, photo and information on access to non-black areas.
The reservation of separate amenities act, 1953
Provided a legal basis for the separation of public and private services between whites and non-whites. Separation under this act did not mean equal.
The bantu education act, 1953
Reinforced inequalities in the education system by providing a legal basis for the separation of educational facilities between whites and non-whites. Educational facilities and resources were limited and unfavourable in black schools.
The public safety act and the criminal law amendment act, 1953
Allowed the government to declare severe states of emergency and apply penalties to any person protesting against the laws in place.
The separate representation of voters act, 1956
Prohibited the Mixed Ancestry population to vote in elections with whites.
University Education Act, 1959
Provided a legal basis for the separation of universities between whites and non-whites.
The bantu self-government act, 1959
Reinforced territorial division of the homelands.

Source : Christopher 1994; Lester et al. 2000; Roberts 2001

These pillars of apartheid inevitably led to intense acts of rebellion from the non-White population against the established government (Christopher 1994). In 1955, the African National Congress (ANC), national opposition party, adopted the freedom charter which sought equal political rights for all population groups. In response of that, and following the Sharpeville massacre in 1960 (South African police opened fire on a crowd of protestors killing 69 people), the government banned all opposition groups. The leader of the ANC, Nelson Mandela, was accused of sabotage against the government and was sentenced to life imprisonment in 1964 (Mandela 1995).

As the rules in place became intolerable, violent protests, riots and strikes increased in the final quarter of the 20th century. As a result of its internal policies, the international community decided to apply economic sanctions on South Africa to pressurise the Afrikaner National Party. The combination of international ostracism on the one hand and national intense pressure on the other hand led to a re-evaluation of the situation at the end of the 1980s (Christopher 1994). The government admitted that it was no longer possible to maintain stability and therefore the Passes act of 1952 was suppressed. Following that, F.W. de Klerk was elected President on 2 February 1990 and in the course of 1991, the suppression of the different acts in place was rapidly effective. Nelson Mandela was released from prison in 1990. The Apartheid was ended and negotiations began between the interested political parties which conducted South Africa to its first democratic elections in May 1994 where Nelson Mandela was elected President.

The Apartheid era led to major differences in the living conditions of the different population groups in terms of quality of life, SES and health (May and Govender 1998; Cameron 2003; Chopra et al. 2009; Richter et al. 2009). Poor areas were lacking services and infrastructure (Beall et al. 2000; Beall et al. 2003). After the implementation of the new democratic government, South Africa experienced socio-economic and political changes as well as a rapid urbanisation (Jenkins 1997; Seekings 2000). Socio-economic and education reforms targeting the disadvantaged population (mainly Black African and Mixed Ancestry) have been implemented in order to alleviate poverty and reduce inequalities. These policies included fiscal redistribution towards specific areas of need, social policies directed towards the poor, old-age pensions, child support grants, public health care and education (May 2000; Leibbrandt et al. 2011). These programmes aimed to address issues such as lack of schools and school-related facilities and resources, and to improve health service facilities and access, water and sanitation, job creation, economic empowerment, housing conditions, welfare of children, and adult education (May 2000; Cameron 2003).

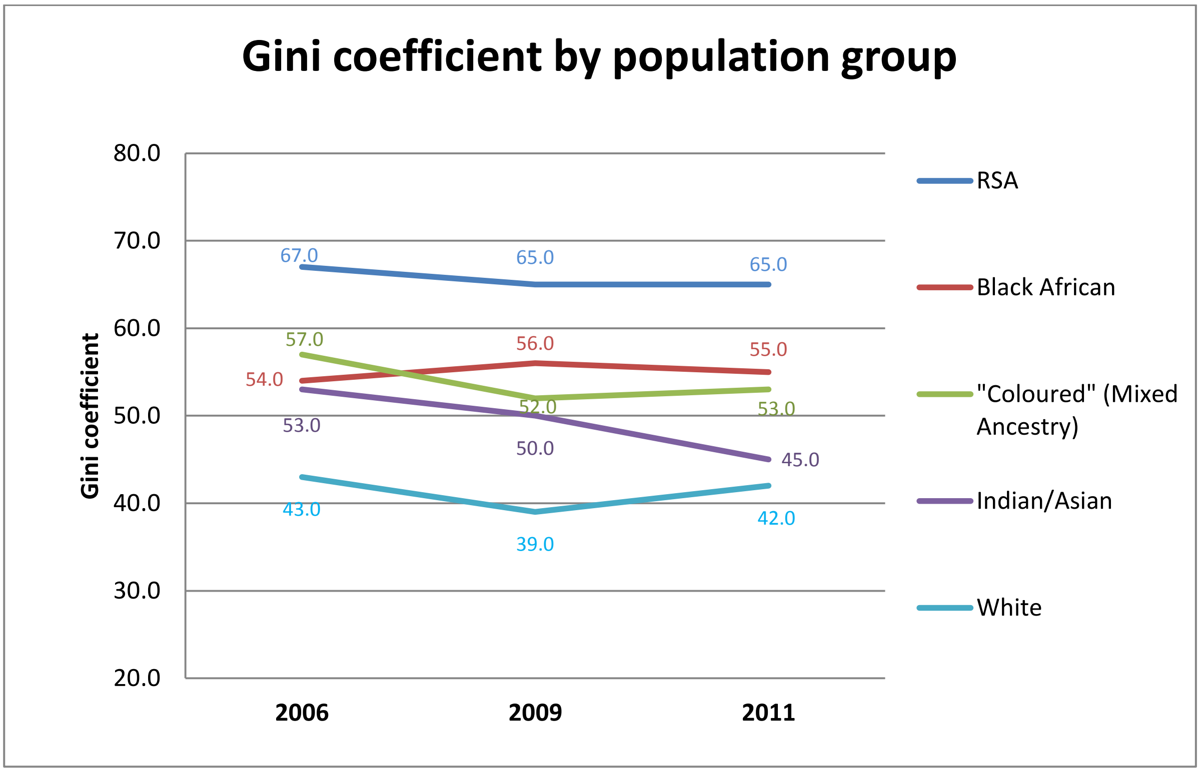
2.3 Demographic and socio-economic context

2.3.1 National level

The Human Development Index (HDI), a measure of both social and economic development, combines indicators of life expectancy, educational attainment and income. In South Africa, the HDI remained quite stable since 1990 evolving from 0.615 to 0.629 in 2012. It gives the country a rank of 118 out of 187 countries (UNDP 2013b). In comparison, the HDI for the United States of America (USA) was 0.937 (3rd), 0.878 for the United Kingdom (UK) (26th), 0.73 for Brazil (85th) and 0.558 for Ghana (135th) (UNDP 2013a).

South Africa is an upper-middle-income country (UNDP 2013a) in which extremes of wealth and poverty exist (World Bank 2014a). Evidence shows that extreme poverty and inequality have increased between 1994 and 2000 (Meth and Dias 2004; Bhorat and Kanbur 2005; Özler 2007). More importantly, the within-population group inequality has increased, especially among the Black African population (Bhorat and Kanbur 2005; Leibbrandt et al. 2011). The Gini index is a measure of inequality in the distribution of income amongst individuals or households measured from 0 to 100 (a Gini index of 0 means perfect equality whilst an index of 100 represents perfect inequality) (World Bank 2014a). In 2000, the Gini coefficient in South Africa was 57.8 and 61.0 in Brazil (World Bank 2014a). In 2009, South Africa (63.1) has overtaken Brazil (54.9) as the world's most unequal society (World Bank 2014a). The high level of inequality seen in South Africa today is mainly due to its past history of Apartheid which led to a skewed distribution of wealth, income and employment of the Black African (Barbarin and Richter 2001a). Figure 3 below shows the Gini coefficient by population group. The Black African group displays the higher level of inequality with a Gini coefficient at 55.0 in 2011 compared to 53.0, 45.0 and 42.0 in "Coloured" (Mixed Ancestry), Indian/Asian and White respectively.

Figure 3. Gini coefficient by population group



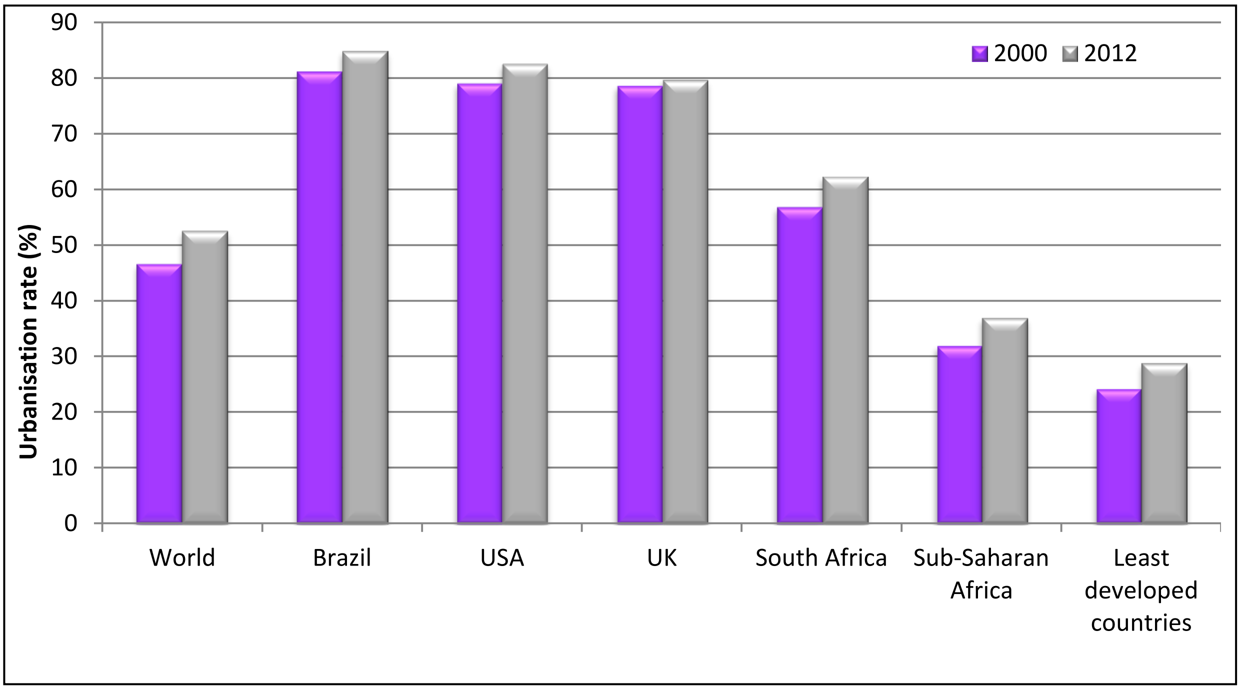
Source: Statistics South Africa 2014 (poverty trends in South Africa)

The poverty results are mixed and this is mainly due to the variety of indicators used to measure poverty (headcount poverty measures, income, expenditure, and multidimensional poverty index). Headcount poverty measures showed that, after increasing between 1995 and 2000, the proportion of the population living with less than 1$/day significantly decreased from 2000 to 2011, despite a plateau from 2006 to 2009 (Özler 2007; UNDP 2013c). However, these measures do not capture the depth and intensity of poverty for those living below the poverty line.

In 1950, the urbanisation rate in the world was estimated at 30%, increasing to 47% in 2000 and to more than 50% in 2008. The projections for 2030 are that more than 60% of the world population will live in urban areas and that 80% of the world's urban population will live in cities and towns in the developing world (UN-Habitat 2006). This underlines the rapid rate of urbanisation in the developing world. It is estimated that three out of four poor people in the world live in urban areas with inadequate shelter and access to basic services. Urbanisation leads to an increase in size of towns and cities but also in complexity of living conditions and insecurity.

Figure 4 below shows the evolution of urbanisation between 2000 and 2012 in the world, South Africa and more or less developed countries. In the least developed countries, less than three out of ten people live in urban areas as opposed to approximately eight out of ten people in high and very high income countries (e.g. Brazil, USA and the UK). South Africa is a highly urbanised country with 62.9% of its 51.8 million citizens residing in urban areas (UNDP 2013b). The urbanisation rate is higher than in the sub-Saharan region and increased steadily from 1980 to 2013 from 48% to 62%.

Figure 4. Evolution of urbanisation between 2000 and 2012 in South Africa and the world



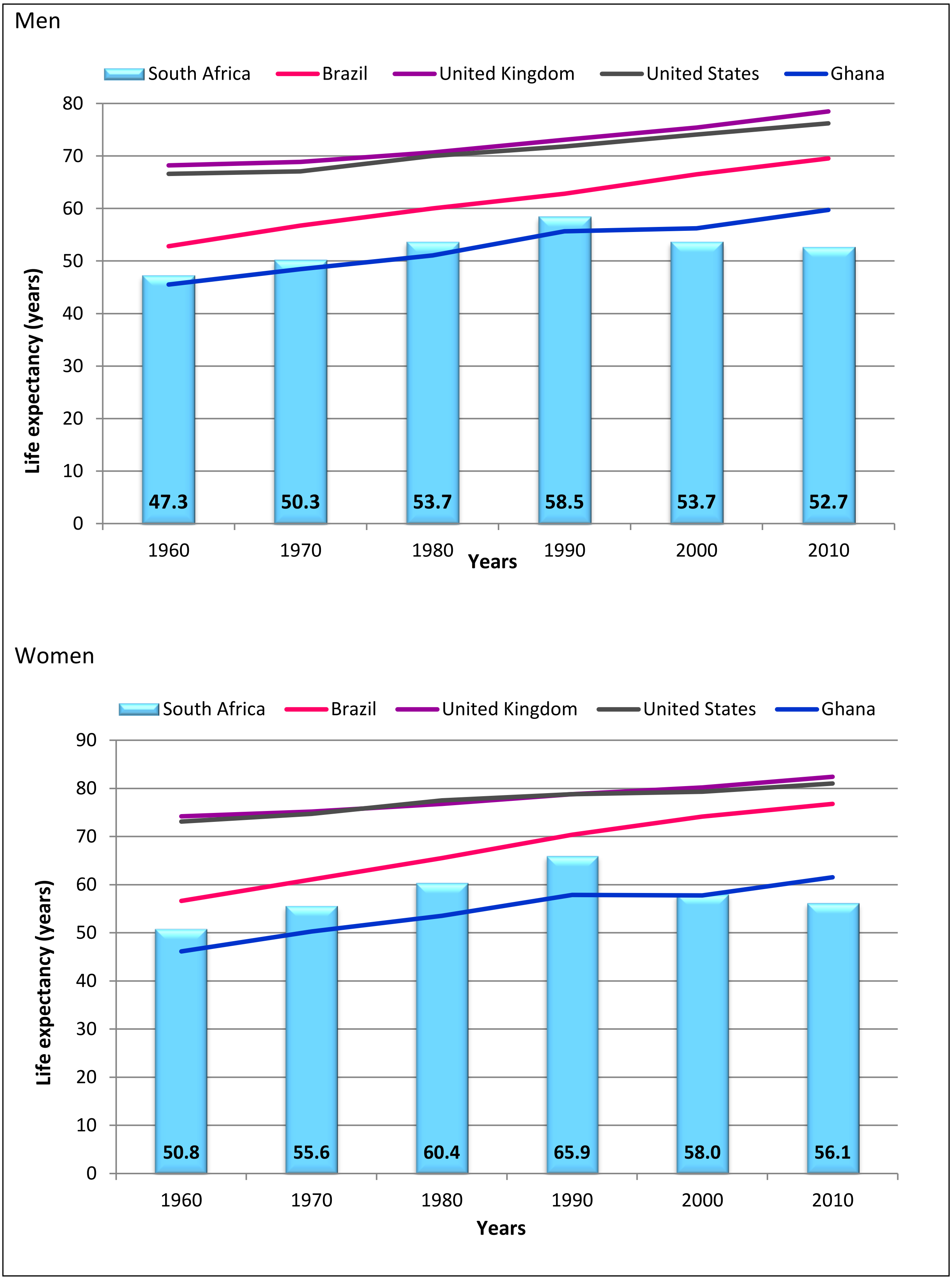
Source: United Nations, Department of Economic and Social Affairs, Population Division (2012)

Black Africans make up the majority of the South African population (79.5%), with White and “Coloured” (Mixed Ancestry) each composing 9% of the population. The remaining 2.5% are of Indian/Asian origin (Statistics SA 2012). South Africa is a multi-ethnic country known as the rainbow nation of Africa (Statistics SA 2012) comprising a wide range of cultures, languages and religions.

The literacy rate (i.e. proportion of adults aged 15 and over who can, with understanding, read or write a short, simple statement about their everyday life) was 93% in 2011 (World Bank 2014b). The access to education has been considerably facilitated after the abolition of Apartheid.

The life expectancy at birth (i.e. average number of years that a person at age zero will live if age-specific death rates remain constant) is very low, at 54.4 years in 2010 (52.7 for men and 56.1 for women) which is lower than that of some least developed countries in the world (World Bank 2014b). This can mainly be explained by the high prevalence of human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) (Karim et al. 2009). In 2013, the prevalence of HIV in South Africa (i.e. percentage of people aged 15-49 years who are infected with HIV) was 19.1% (World Bank 2014b). Within the 15-24 years old group, the prevalence of HIV slightly decreased from 9.3% in 2002 to 7.3% in 2012 (UNDP 2013c). Figure 5 displays the changes in life expectancy for both males and females over time. Data are shown for South Africa and more or less developed countries. In South African men, life expectancy increased steadily from 1960 to 1990 from 47.3 to 58.5 and then decreased until 2010. This decrease is mainly attributable to the rise in HIV-related mortality. The same tendency is seen in women. Ghana, an upper middle-income country like South Africa saw a steady rise in life expectancy from 1960 to 2010.

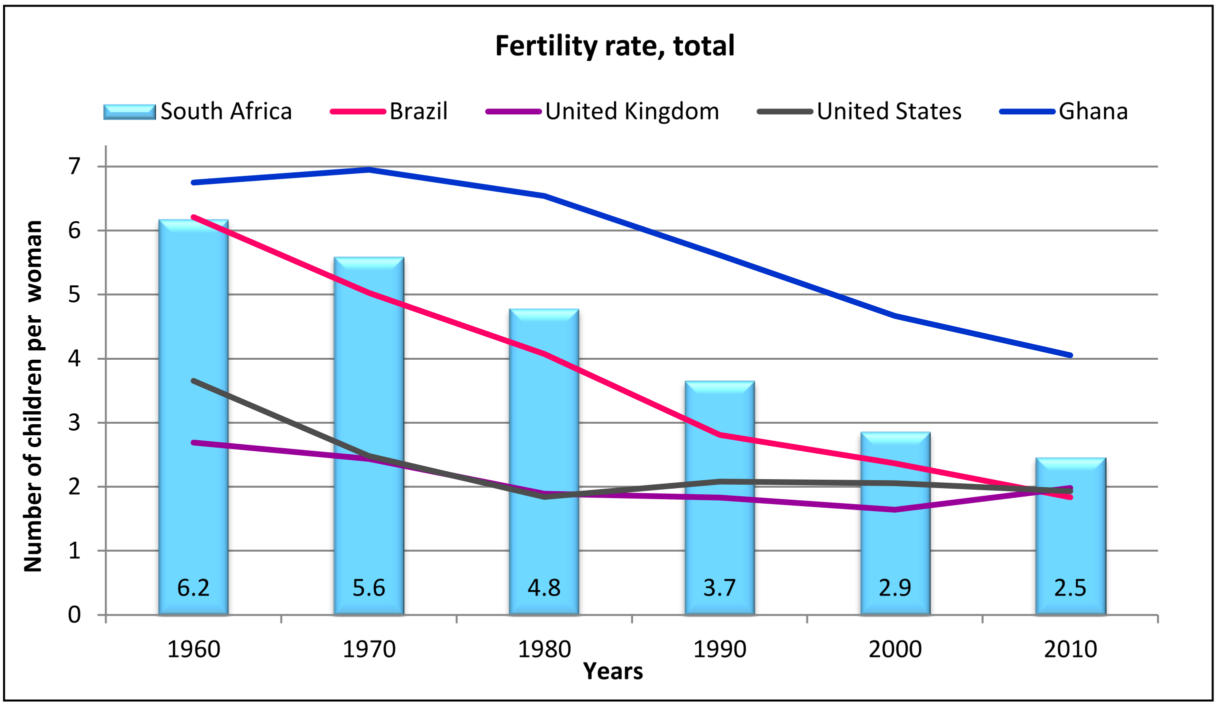
Figure 5. Evolution of life expectancy from 1960 to 2000, in South Africa and the world



Source: World Bank Databank 2014

South Africa's fertility rate (i.e. number of children that would be born to a woman if she were to live to the end of her childbearing years at the currently observed rates) decreased rapidly from 6.2 in 1960 to 2.5 in 2010. Brazil followed a similar pattern to South Africa though the decrease was faster. Overall, the 2010 fertility rate in South Africa was slightly higher than the ones observed in high and very high income countries (Figure 6).

Figure 6. Evolution of fertility rate in South Africa and the World



Source: World Bank Databank 2014

Although access to public health and social services has improved, there has been a rise in unemployment against a background of economic decline since 1994 (Meth and Dias 2004; Bhorat and Kanbur 2005; OECD 2013). The last 2011 Census in South Africa showed the unemployment rates to be at 25.6% and 34.6% amongst men and women respectively. When stratifying the results by population group, it was shown that White men display the lowest unemployment rates (5.0%) whilst Black African women display the highest one (41.2%). Unemployment rates in youth were revealed to be higher than in the older age groups (Statistics SA 2012).

Table 2 presents the evolution of socio-economic indicators over time for the whole South Africa. From 1996 to 2011, the proportion of people living in a formal dwelling increased whilst a decrease was observed in the proportion of people living in traditional and informal dwellings. However, it is important to mention that the proportion of South Africans living in informal settlements remains high (13.6%) (Statistics SA 2012). The 2001 Census showed that 20.4% of Black African lived in informal dwellings compared to 7.4% in "Coloured" (Mixed Ancestry), 1.1% in Indian/Asian and 0.5% in Whites (Statistics SA 2003). Improvements were seen in relation to access to piped water and toilet facilities. Indeed, the proportion of households who had access to piped water inside the dwelling or yard increased from 60.8 to reach 73.4% in 2011 (Statistics SA 2012). The proportion of households who had access to flush toilet increased from 51.9% in 2001 to 60.1% in 2011 (Statistics SA 2012). Results from the general household survey conducted in 2012 highlighted inequalities in access to basic services between the different population groups. Indeed, only 65.8% of Black African had access to piped water either in dwelling or yard compared to 95.7% in "Coloured" (Mixed Ancestry), and around 98% in Indian/Asian and White (Statistics SA 2012). Regarding toilet facilities, only 53.7% of Black African had access to flush toilet in comparison to 93.0% in "Coloured" (Mixed Ancestry), 97.4% in Indian/Asian and 100% in the White group (Statistics SA 2012).

The proportion of refuse removed by local authority increased from 54.3% in 1996 to 63.6% in 2011. This mode of refuse removal was more frequent in the "Coloured" (Mixed Ancestry), Indian/Asian and White groups (95.2%, 98.5% and 95.7% respectively) compared to the Black African group (56.4%).

Household assets such as cellphone, computer, fridge and television saw a large increase between 2001 and 2011. However, only about 3 people out of 5 possess a fridge (Statistics SA 2012). The 2001 Census showed that Black African were the most deprived in terms of household assets. For instance, only 39.4% of Black African had a fridge compared to 73.2% in "Coloured" (Mixed Ancestry), 96.2% in Indian/Asian and 97.6% in Whites.

Results from the general household survey conducted in 2012 showed that three-quarters (75.1%) of the White group had a medical coverage compared to 41.7% in the Indian/Asian group, 20.9% in the "Coloured" (Mixed Ancestry) group. Only 10.4% of Black African had a medical coverage (Statistics SA 2012).

These results demonstrate that overall, improvements were made in the access to basic services. However, important inequalities remain between the different population groups.

Table 2. Evolution of socio-economic indicators from 1996 to 2011

Indicator	1996	2001	2007	2011
Type of housing				
Formal dwelling	65.1	68.7	70.6	77.6
Traditional dwelling	18.3	14.8	11.7	7.9
Informal dwelling	16.2	16.4	14.4	13.6
Other	0.4	0.3	3.3	0.9
Access to piped water				
Piped water inside dwelling/yard	60.8	62.3	69.4	73.4
Piped water outside the yard	19.6	22.7	19.2	17.9
No access to piped water	19.7	15	11.4	8.8
Toilet facility				
Flush toilet	*	51.9	57.8	60.1
Pit and bucket toilets	*	32.6	29.5	30.2
Chemical toilet	*	1.9	0.4	2.5
None	*	13.6	8.3	5.2
Mode of refuse removal				
Removed by local authority	54.3	57.2	61.6	63.6
Communal refuse dump	3.2	1.8	2.2	1.9
Own refuse dump	32.6	32.5	28.8	28.2
No rubbish disposal	9.7	8.5	7.1	5.4
Household assets				
Cellphone	*	31.9	72.7	88.9
Radio	*	72.1	76.5	67.5
Computer	*	8.5	15.6	21.4
Fridge	*	49.9	63.9	68.4
Television	*	52.6	65.5	74.5
Landline telephone	*	23.9	18.5	14.5

Source: Statistics SA 2012

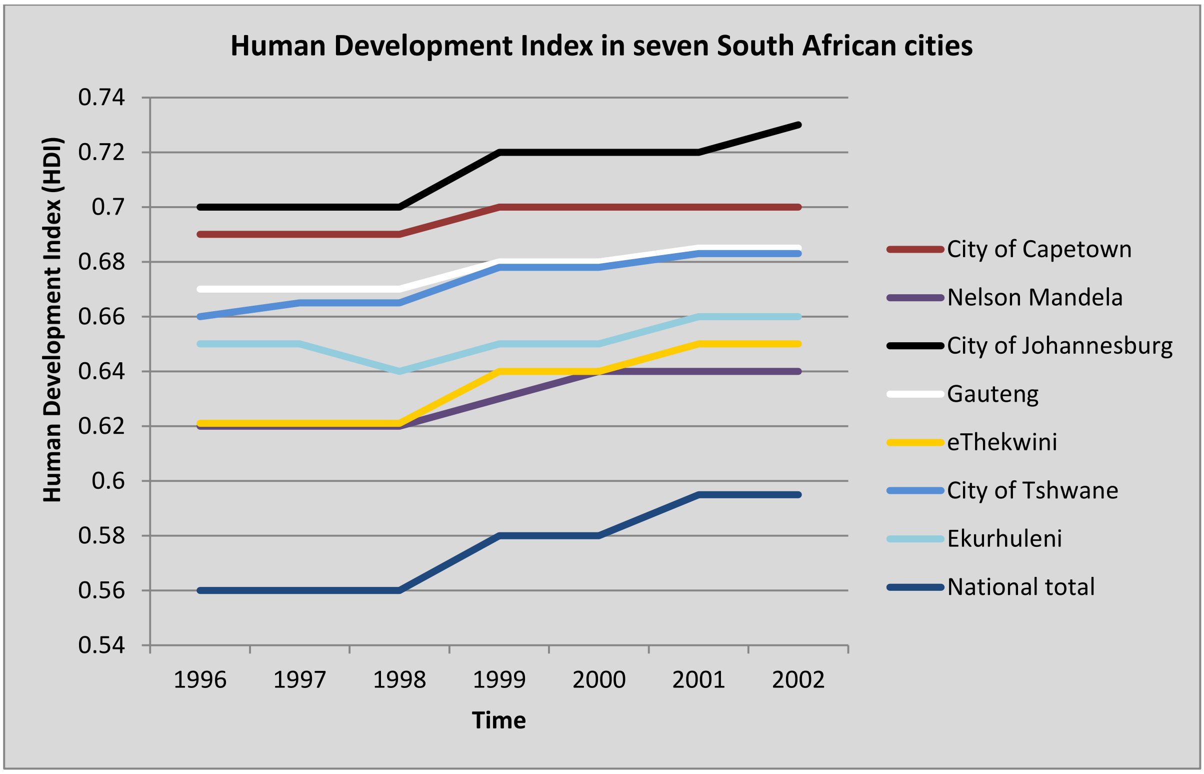
2.3.2 The area of Johannesburg and Soweto

The city of Johannesburg comprises 4.4 million inhabitants (Statistics SA 2012). The population density, at 2696 persons/km^2 is high. The population repartition is as follows: Black African (76.4%), White (12.3%), "Coloured" (Mixed Ancestry) (5.6%) and Indian/Asian (4.9%). About one third of the city's total population resides in Soweto (Statistics SA 2012).

The proportion of people aged 20 years and above who completed secondary school and matric (graduated) is 32.4% and 34.9% respectively. Only 19.2% completed higher education. The unemployment rates in the city is estimated to be around 25.0% overall and 31.5% in youth (Statistics SA 2012). In relation to sanitation conditions, around 92% of the population has access to piped water.

Though, the city of Johannesburg-Soweto presents with the highest HDI compared to six other cities in South Africa (Figure 7) (City of Johannesburg 2005), extreme inequalities and issues exist. Indeed, the inhabitants from Soweto-Johannesburg face problems such as poverty, unemployment, violence, high prevalence of HIV/AIDS, chronic diseases and food insecurity (De Wet et al. 2008).

Figure 7. Human Development Index in Seven South African cities



Source: City of Johannesburg 2005

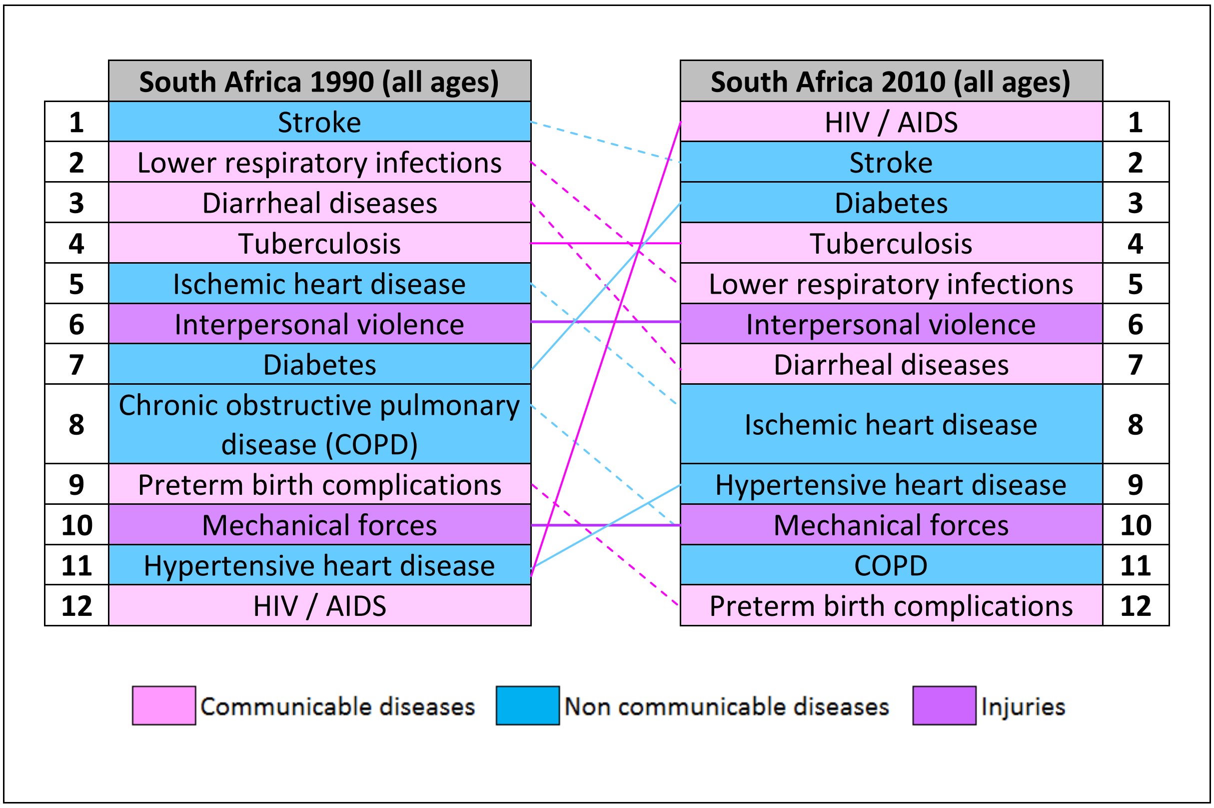
2.4 Epidemiological and nutrition transitions

2.4.1 Epidemiological transition

Figure 8 presented below shows the changes in the ranking of causes of deaths between 1990 and 2010 in South Africa in the overall population.

The main causes of death in 1990 were stroke followed by communicable diseases such as respiratory infections, diarrheal diseases and tuberculosis. In 2010, the nature of the causes shifted, with HIV/AIDS representing the first leading cause of deaths followed by stroke, diabetes and tuberculosis. When looking at the risk factors' ranking in 2010 (data not shown), high blood pressure, high body mass index (BMI), dietary risks and high fasting plasma glucose represented the main risk factors (IHME 2013).

Figure 8. Changes in the ranking of causes of deaths between 1990 and 2010 in South Africa

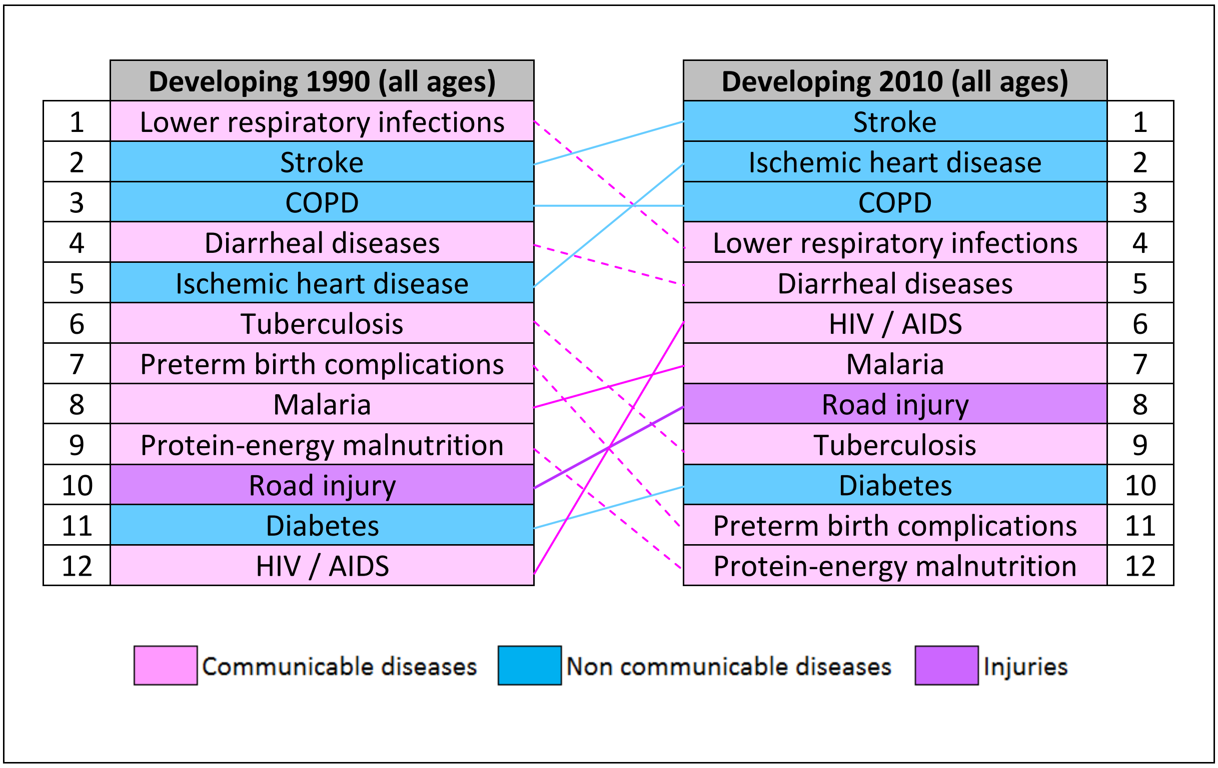


Source: Institute for Health Metrics and Evaluation 2013

Figure 9 presented below shows the changes in the ranking of causes of deaths between 1990 and 2010 in the developing world in the overall population.

In the overall population, the main causes of death in 1990 were due to communicable and non-communicable diseases such as respiratory infections, stroke and chronic obstructive pulmonary diseases (COPD). Slight changes were seen in the distribution of the causes of deaths in 2010. Stroke, ischemic heart diseases, diabetes and HIV/AIDS ranked higher as opposed to tuberculosis, preterm birth complications and protein-energy malnutrition which dropped in the ranking. When looking at the risk factors' ranking in 2010 (data not shown), dietary risks, high blood pressure and smoking were the main risk factors (IHME 2013).

Figure 9. Changes in the ranking of causes of deaths between 1990 and 2010 in the developing world

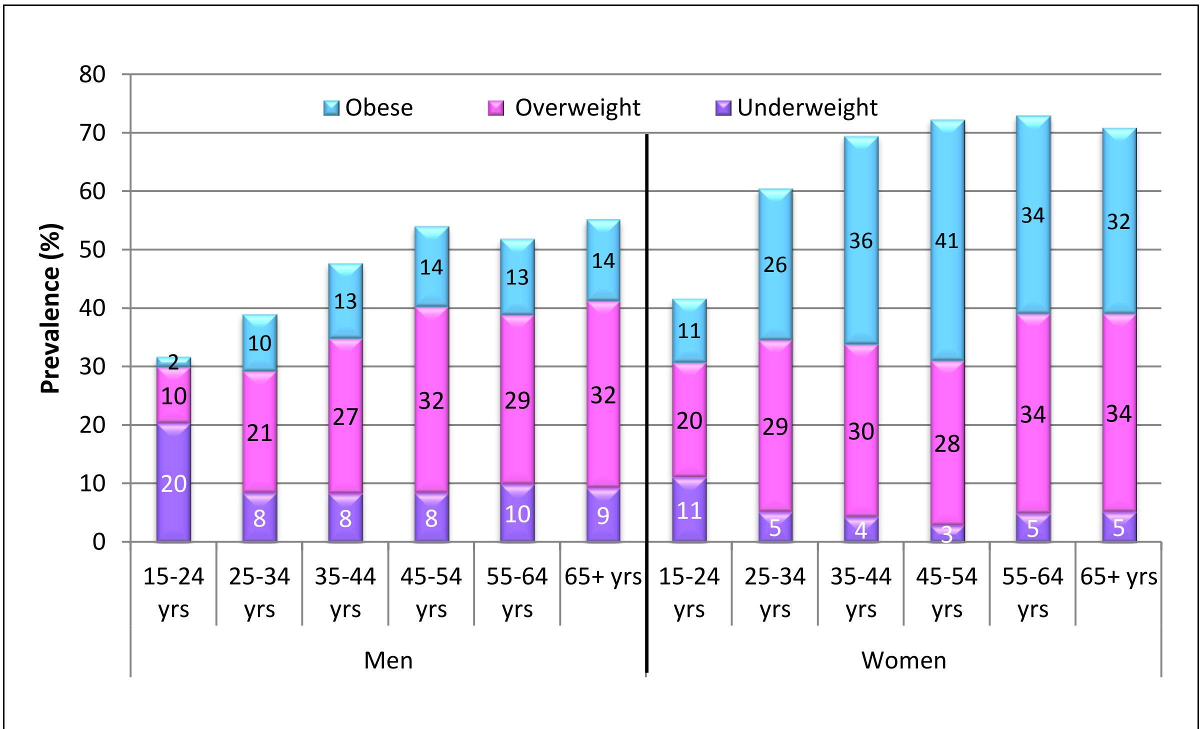


Source: Institute for Health Metrics and Evaluation 2013

These figures highlighted a rapid shift from 1990 to 2010 in the distribution of the causes of deaths in South Africa and the developing world. Communicable diseases saw a decline whilst NCDs increased. These results underline that the developing world is currently undergoing the epidemiological transition and is following the same pattern observed in the developed world (IHME 2013). The HIV/AIDS epidemic has increased in the overall population in the developing world. This suggests that the developing world is facing a double burden of diseases (communicable and NCDs) whilst the developed world is mainly affected by non-communicable diseases (IHME 2013). More specifically, in South Africa, the first cause of death was the HIV/AIDS epidemic. Diabetes was the third cause of death in the overall population whilst it was quite far in the ranking in the developed and other developing countries. The main risk factors of deaths in South Africa in 2010 were high blood pressure, high BMI and dietary risks. Given the importance of high BMI and dietary risks in this context, the epidemiology of obesity in South Africa will now be discussed. Figure 10 below displays the prevalence of underweight (BMI<18.5 kg/m²), overweight (BMI between 25-29.9 kg/m²) and obesity (BMI≥30 kg/m²) in South Africa by age groups and separately for men and women.

In men, underweight is more prevalent at younger ages (20%). The prevalence of combined overweight and obesity increases from 12% (15-24 years) to 46% (65 years +). In women, the patterns are different. The prevalence of overweight in the 15-24 years group is two times higher in women than in men. The prevalence of combined overweight and obesity increases from 31% to 68% in the 55-64 years group. Indeed, more than two women out of three are either overweight or obese. Also, the prevalence of obesity is much higher in women than in men.

Figure 10. Percentage of South African men and women aged 15 years and above by body mass index categories according to age group



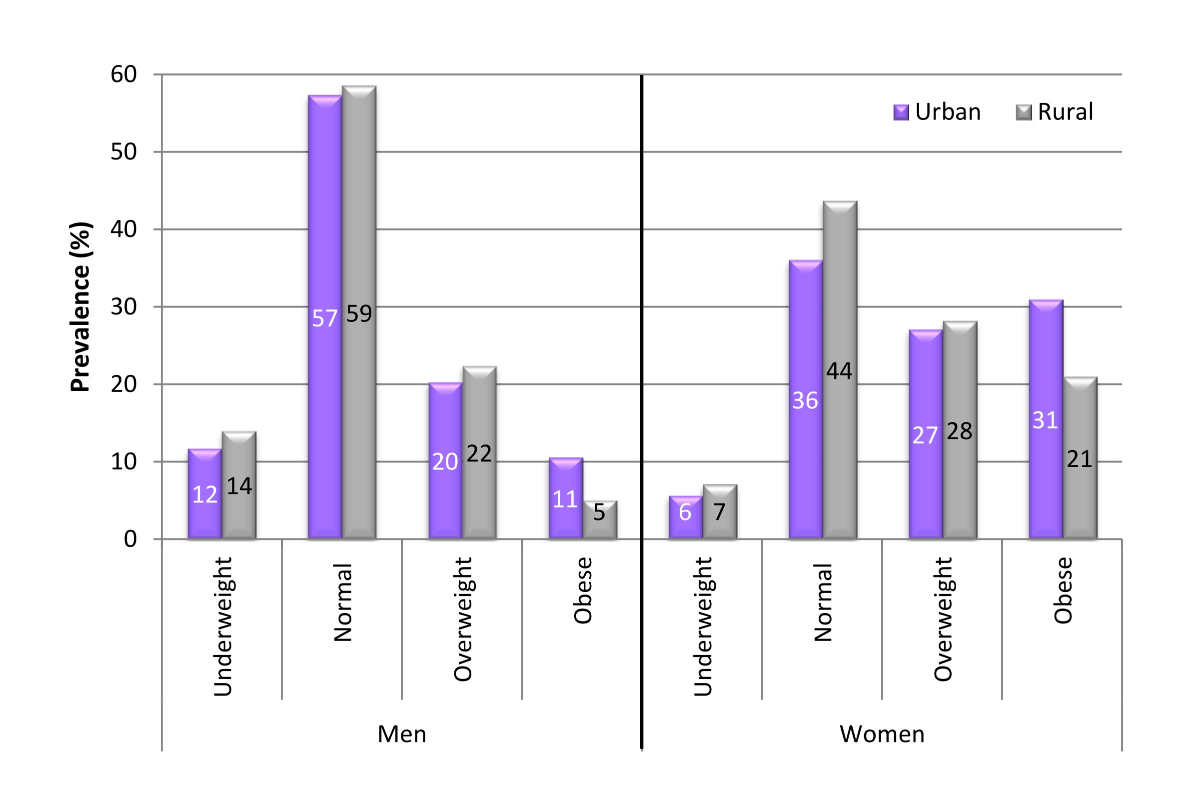
Underweight <18.5 kg/m²; Normal weight: 18.5-24.9 kg/m²; Overweight: 25-29.9 kg/m²; Obese: ≥ 30 kg/m²

Source: Department of Health, Medical Research Council. South Africa Demographic and Health Survey 2003.

Figure 11 below displays the prevalence of underweight, normal weight, overweight and obesity in South Africa by place of residence (urban vs. rural) and in women and men separately.

In men, the prevalence of underweight is higher in rural than urban areas (14.0 vs. 11.8%) whereas obesity is more prevalent in urban areas (10.6%). In women, the patterns are similar though the prevalence of obesity in urban areas is three times higher than the one observed in men (31%).

Figure 11. Percentage of South African men and women aged 15 years and above by body mass index categories according to place of residence



Underweight <18.5 kg/m²; Normal weight: 18.5-24.9 kg/m²; Overweight: 25-29.9 kg/m²; Obese: ≥ 30 kg/m²

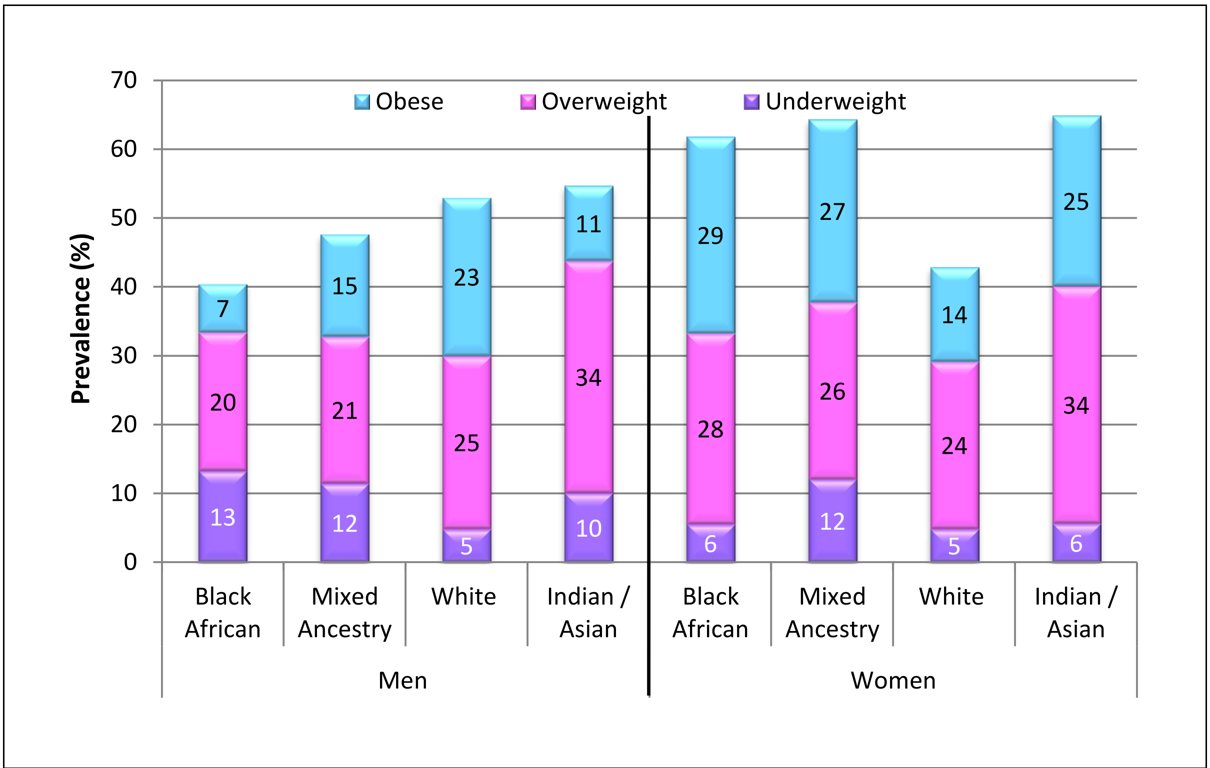
Source: Department of Health, Medical Research Council. South Africa Demographic and Health Survey 2003.

Figure 12 below displays the prevalence of underweight, overweight and obesity in South Africa by population group and in women and men separately.

In men, the prevalence of underweight is higher in Black Africans compared to Whites (13.3% vs. 4.9%). The highest prevalence of combined overweight and obesity is seen in the Indian/Asian group whilst obesity is more frequent in Whites. The prevalence of combined overweight and obesity is higher in Whites, with about one out of two men being overweight or obese. This is followed by Indian/Asian, Mixed Ancestry and Black African.

In women, the patterns are different. Underweight is more prevalent in the Mixed Ancestry group. The proportion of Black Africans and Indian/Asian who are overweight or obese is 57% and 59% respectively. About three out of five Black African and Indian/Asian women are either overweight or obese. In whites, less than two women out of five are overweight or obese.

Figure 12. Percentage of South African men and women aged 15 years and above by body mass index categories according to population group

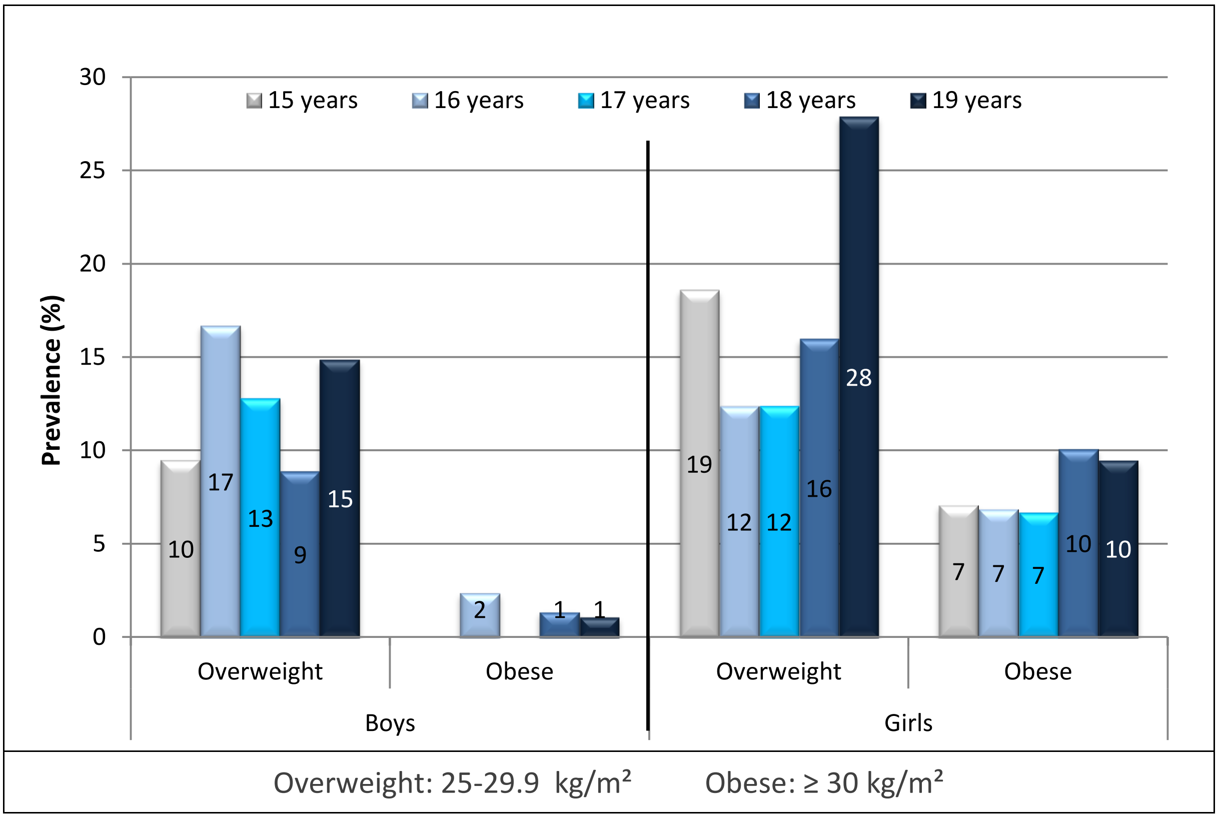


Underweight <18.5 kg/m²   Overweight: 25-29.9 kg/m²   Obese: ≥ 30 kg/m²

Source: Department of Health, Medical Research Council. South Africa Demographic and Health Survey 2003.

Figure 13 below displays the prevalence of overweight and obesity in South African adolescents by age and in boys and girls separately. Overall, the prevalence of overweight and obesity is higher in girls than in boys at all ages. In boys, the prevalence of overweight seems to be higher at 16 and 19 years with a decrease in between. In girls, the prevalence of overweight is 1.5 times higher at age 19 in comparison to age 15 years. Obesity in girls is more prevalent at later ages.

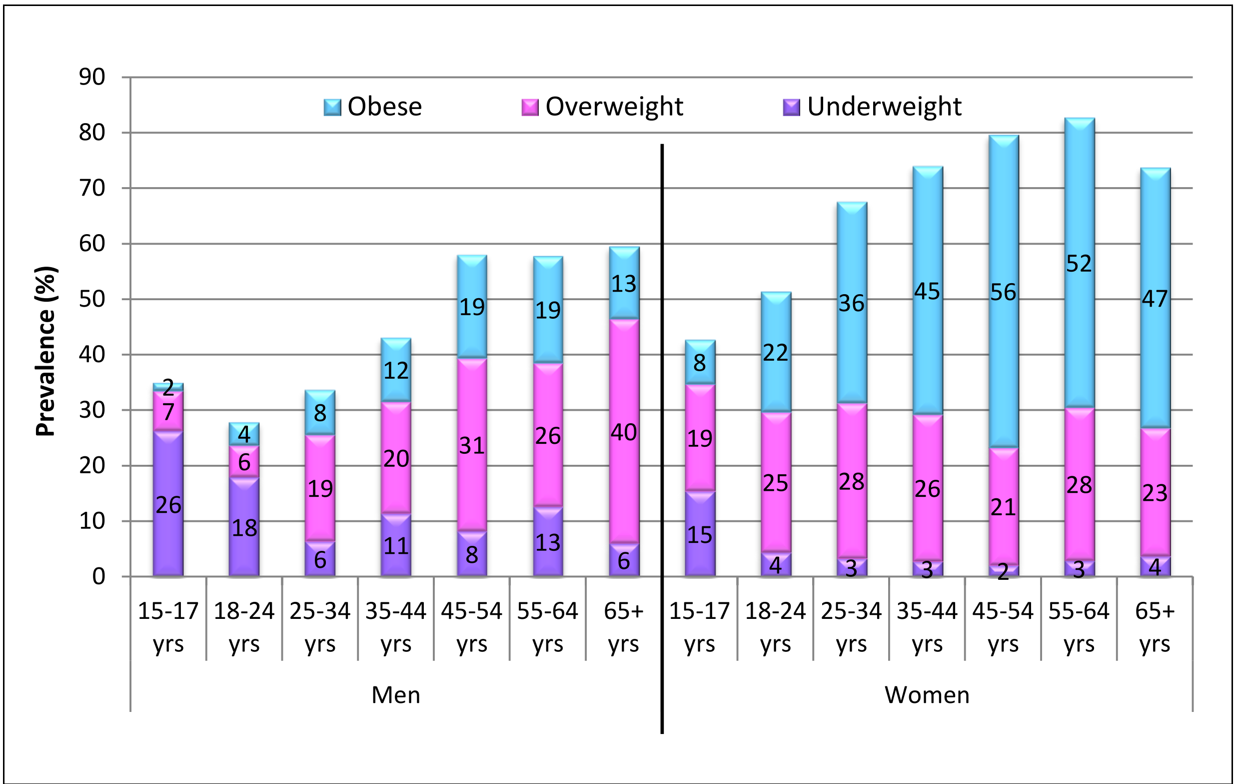
Figure 13. Percentage of South African boys and girls by body mass index categories and age



Source: Department of Health, Medical Research Council. South Africa Demographic and Health Survey 2003.

Figure 14 below displays more recent data on the prevalence of underweight, overweight and obesity in South African adolescents by age and in men and women separately. These figures come from the latest South African National Health and Nutrition Examination Survey conducted in 2012. Results are similar to the 2003 South African Demographic and Health Survey (DHS) in both men and women (Figure 12). Results in men show that the prevalence of underweight is high in the young age groups. The prevalence of combined overweight and obesity increases from 27% in the 25-34 years old group to 53% in the 65 years and above group. In women, the prevalence of underweight is not insignificant in the 15-17 years old group (15%). The prevalence of combined overweight and obesity increases by 1.7 between 15-17 years old and 18-24 years old. The prevalence of combined overweight and obesity increases from 47% in the 18-24 years old group to 80% in the 55-64 years old group. Results in females in this latest survey show an increase compared to the 2003 South African DHS results (Figure 12).

Figure 14. Percentage of South African men and women by body mass index categories and age

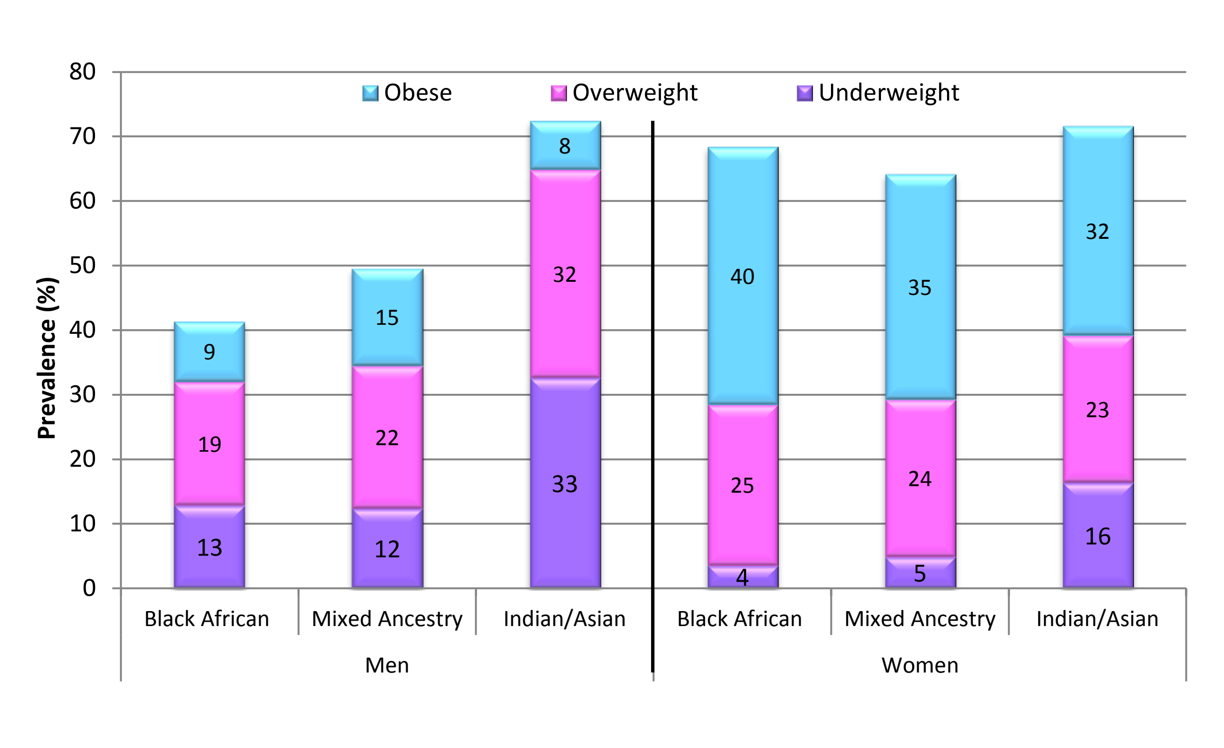


Underweight <18.5 kg/m² Overweight: 25-29.9 kg/m² Obese: ≥ 30 kg/m²

Source: Department of Health, Medical Research Council. South Africa Demographic and Health Survey 2003.

Figure 15 below displays more recent data on the prevalence of underweight, overweight and obesity in South African adolescents by population group and in men and women separately. These figures come from the latest South African National Health and Nutrition Examination Survey conducted in 2012. Results in men show that the prevalence of underweight is higher in the Indian/Asian group compared to Black African and Mixed Ancestry. The prevalence of combined overweight and obesity is also higher in the Indian/Asian group in comparison to Black African and Mixed Ancestry. In women, the prevalence of underweight is not insignificant in the Indian/Asian group (16%). The Black African group displays the highest prevalence of combined overweight and obesity (65%), followed by Mixed Ancestry (59%) and finally Indian/Asian (55%).

Figure 15. Percentage of South African men and women by body mass index categories and population group



Underweight <18.5 kg/m² Overweight: 25-29.9 kg/m² Obese: ≥ 30 kg/m²

Source: Shisana et al. 2014. South Africa National Health and Nutrition Examination Survey-NHANES I
Note: No data available for the White group

2.4.2 Food consumption patterns

Data on food availability in South Africa and other parts of the world will be presented using the Food Balance Sheets from the FAO, which give an overall understanding of the food supply pattern of a country (FAO 2012).

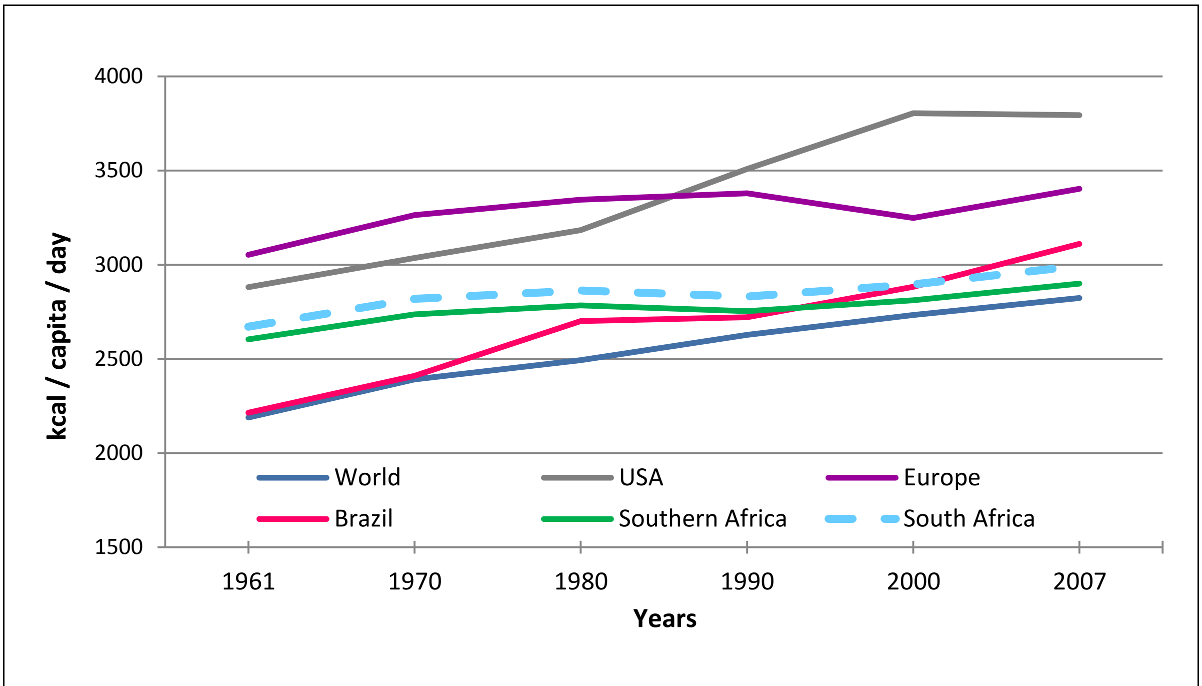
The food supply is obtained from the equation shown hereinafter: ***Food supply*** *= (total quantity of food stuffs produced + total quantity imported and adjusted to any change in stocks) – (quantities exported + fed to livestock + used for seed + losses during storage and transportation)* (FAO 2012). The per capita supply of each food item available for human consumption is obtained by dividing the respective quantity by the population size. Data on food supply per capita are expressed either in terms of quantity or energy, protein and fat intakes, by applying conversion factors (FAO 2012).

The Food Balance Sheets data are often deemed incomplete or unreliable and their quality and coverage vary significantly among countries (FAO 2001). The Food Balance Sheets are constructed using a variety of sources (e.g. ongoing national official statistics; marketing authorities and factories; farmer stock surveys; industrial/manufacturing surveys; government agencies; cost of production surveys), hence reducing the quality of this data. The accuracy of the Food Balance Sheets depends solely on the reliability of the basic statistics used to generate the tool (e.g. population size, supply and utilisation of foods and their nutritional value) (FAO 2001).

When examining food balance sheets over a period of time in a specific country, it is possible to capture changes in food supply and thus changes in dietary patterns at the national level. However, this technique does not capture within country/neighbourhood differences in terms of food availability and does not reflect seasonal variations. They also give an overall idea of how the food supply matches the nutritional requirements of the population. However, it is important to mention that food balance sheets only provide information on the food *available* for human consumption but does not reflect *actual* food consumption. In order to fully understand the food consumption patterns within a country, it is important to combine information from the food balance sheets with nutritional surveys.

Figure 16 below shows the trends in calorie availability from 1961 to 2007 in the world, Europe, USA, South Africa, Southern Africa and Brazil. The data presented are per capita and per day. In South Africa, the calories available for human consumption have slowly increased from 1961 to 2007, ranging from 2671 kcal to 2993 kcal. In Brazil, another upper middle income country, the rise has been faster. Indeed the number of calories available increased 1.5 fold (2214 kcal in 1961 vs. 3310 kcal in 2007). The calorie availability in South Africa is lower than in the USA, the UK and Brazil but higher than the availability in the world.

Figure 16. Calorie availability trends in South Africa and different parts of the world, 1961-2007



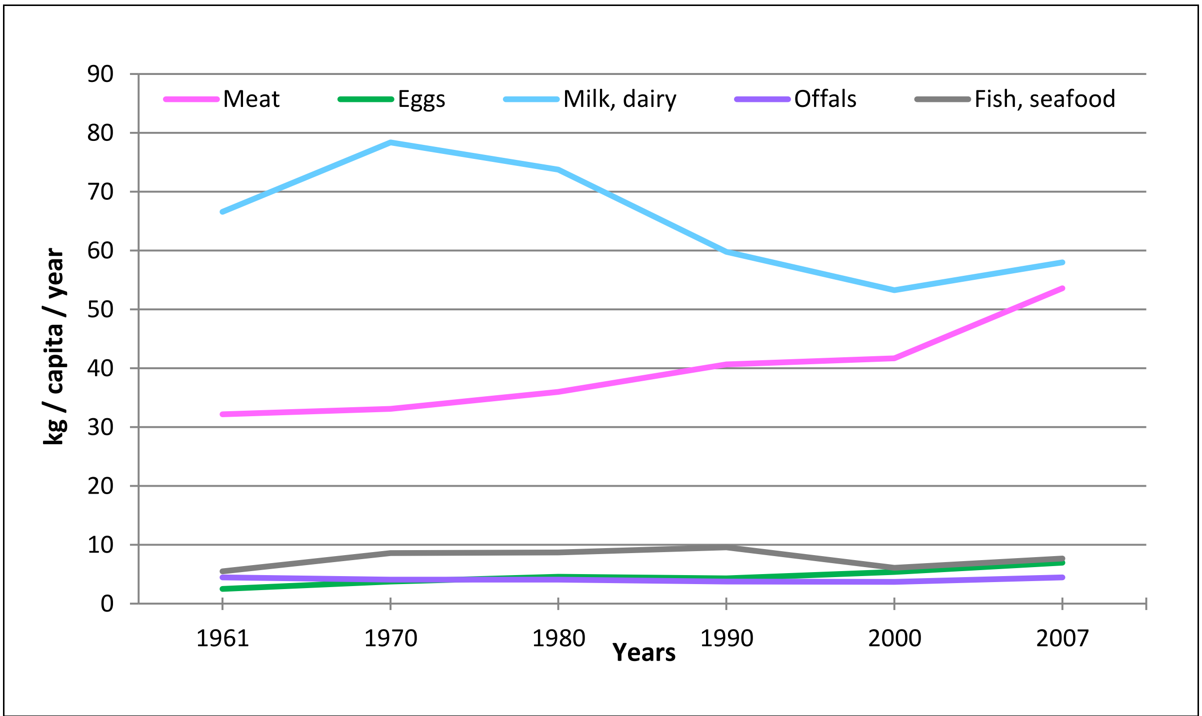
Source: FAOSTAT Food Balance Sheets 2012

Figure 17 below shows the trend in animal products availability (meat, eggs, milk and dairy, offals, fish and seafood) from 1961 to 2007 in South Africa. The data presented are in kg/capita/year. The major changes were seen for meat and milk and dairy products. Indeed, the availability of meat increased 1.7 fold, ranging from 32.2 kg to 53.6 with a fast increase between 2000 and 2007. The availability of milk and dairy products decreased rapidly from 1970 to 2007, ranging from 78.4 kg to 58 kg.

The increase in meat availability in Europe and the USA over the period was similar to the increase in South Africa (1.4 fold for the USA and 1.6 fold for Europe) though the quantities available are relatively much higher in developed countries because of the higher starting quantities (two times higher in the USA). Brazil has seen the most important and fastest increase over the period (2.9 fold) (Figure 19).

Since 1961, egg availability increased in all the countries or regions apart from the USA where it decreased. Milk and dairy products availability increased in Europe and Brazil whilst it decreased in South Africa and Sub-Saharan Africa and remained stable in the USA (Figure 19).

Figure 17. Animal products availability trends, South Africa, 1961-2007



Source: FAOSTAT Food Balance Sheets 2012

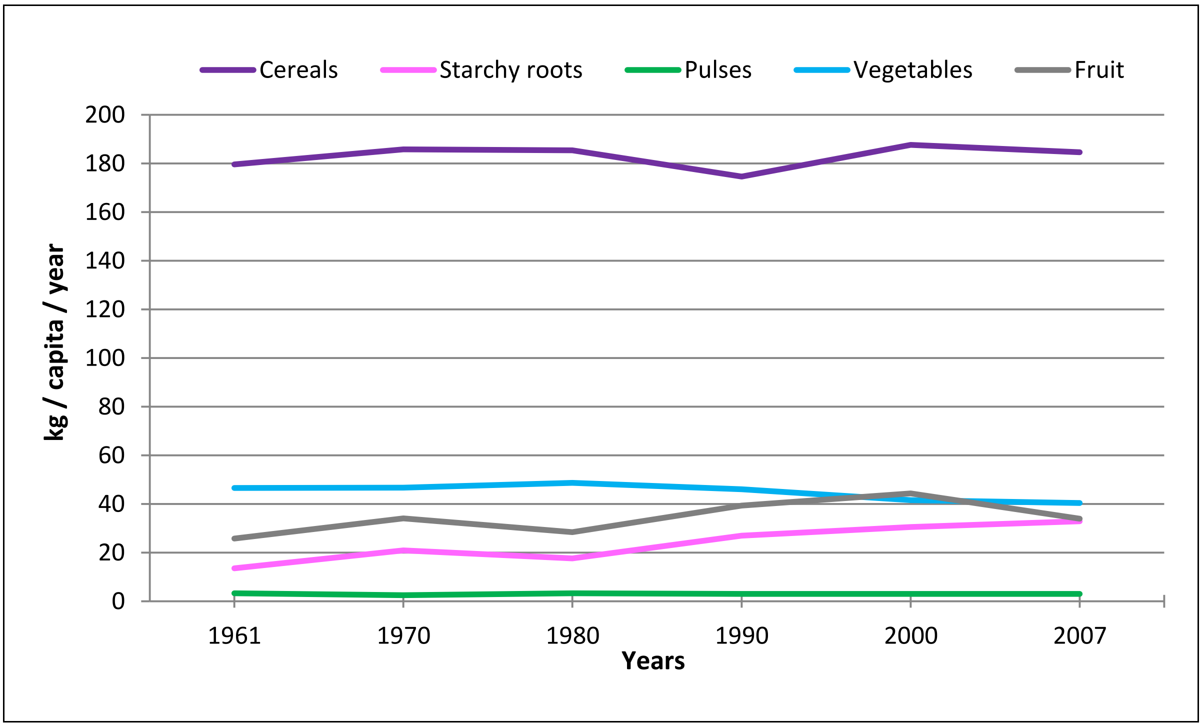
Figure 18 below shows the trends in vegetal products availability (cereals, starchy roots, pulses, vegetables and fruit) from 1961 to 2007 in South Africa. The availability of cereals, starchy roots and fruit has increased overall over time. The most important change was seen for starchy roots (2.4 fold increase) and fruit (1.3 fold increase). The availability of vegetables decreased slightly whilst availability of pulses remained unchanged.

In comparison to other countries (Figure 19), South Africa has the highest availability of cereals. The availability of cereals increased both in Brazil and the USA but decreased in Europe.

The availability of starch roots increased in South Africa, the Sub-Saharan region and the USA whilst it decreased in Europe and Brazil.

In relation to fruit and vegetables, fruit availability increased in all the different countries though it decreased since 2000 in the USA and South Africa. The same pattern was observed for vegetables except in South Africa for which the availability decreased slightly (Figure 19). From 1961 to 2007, the beans and pulses availability either decreased or remained stable in the USA, Europe, South Africa and Brazil.

Figure 18. Vegetal products availability trends, South Africa, 1961-2007

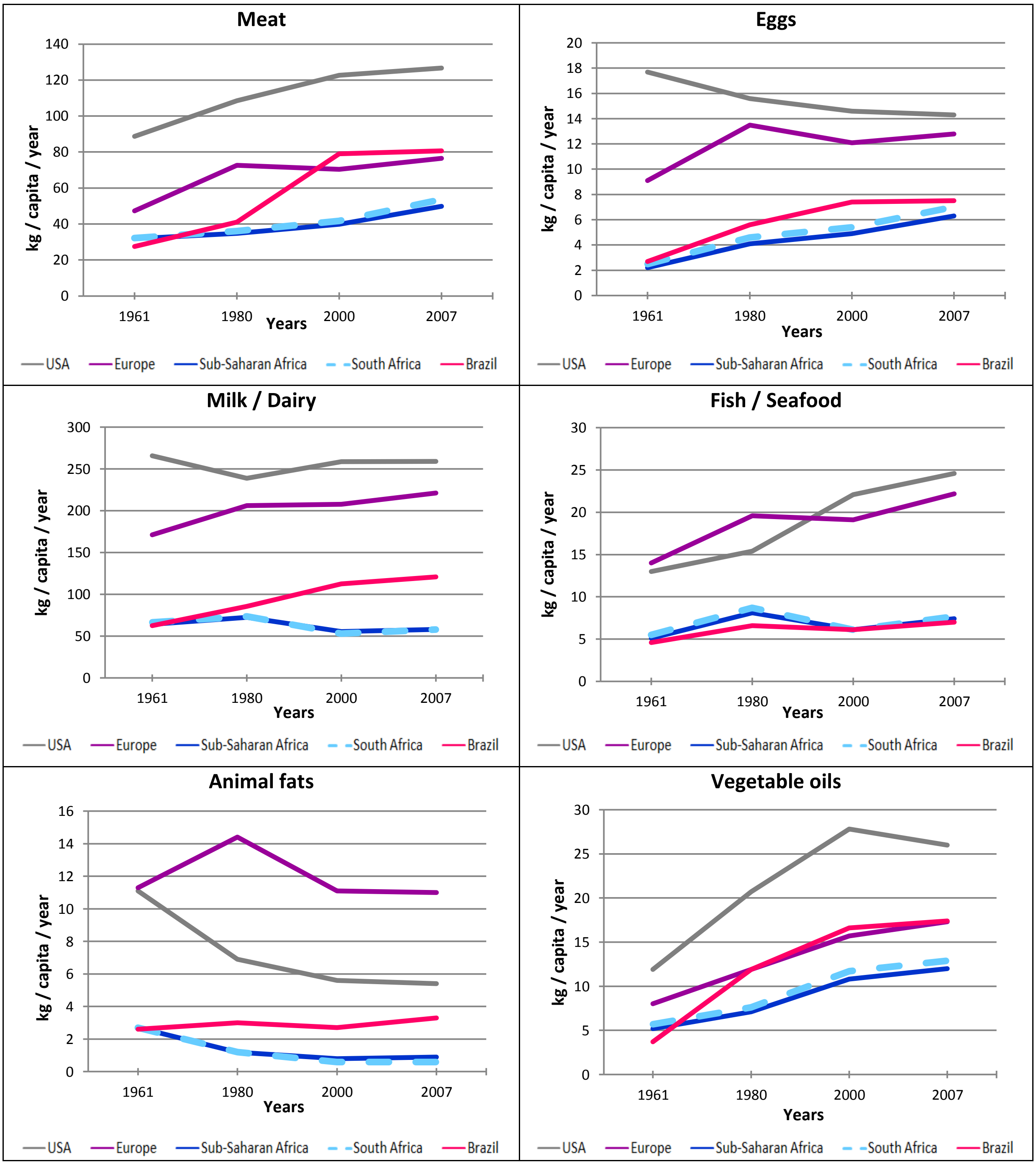


Source: FAOSTAT Food Balance Sheets 2012

The most noticeable differences were seen for animal fats and vegetable oils availability. In South Africa, Europe and the USA, the availability of animal fats decreased to an important degree whilst it increased slightly in Brazil. The most important and rapid change was seen for vegetable oil availability which increased in all the different parts of the world investigated. However, it started decreasing in 2000 in the USA (Figure 19).

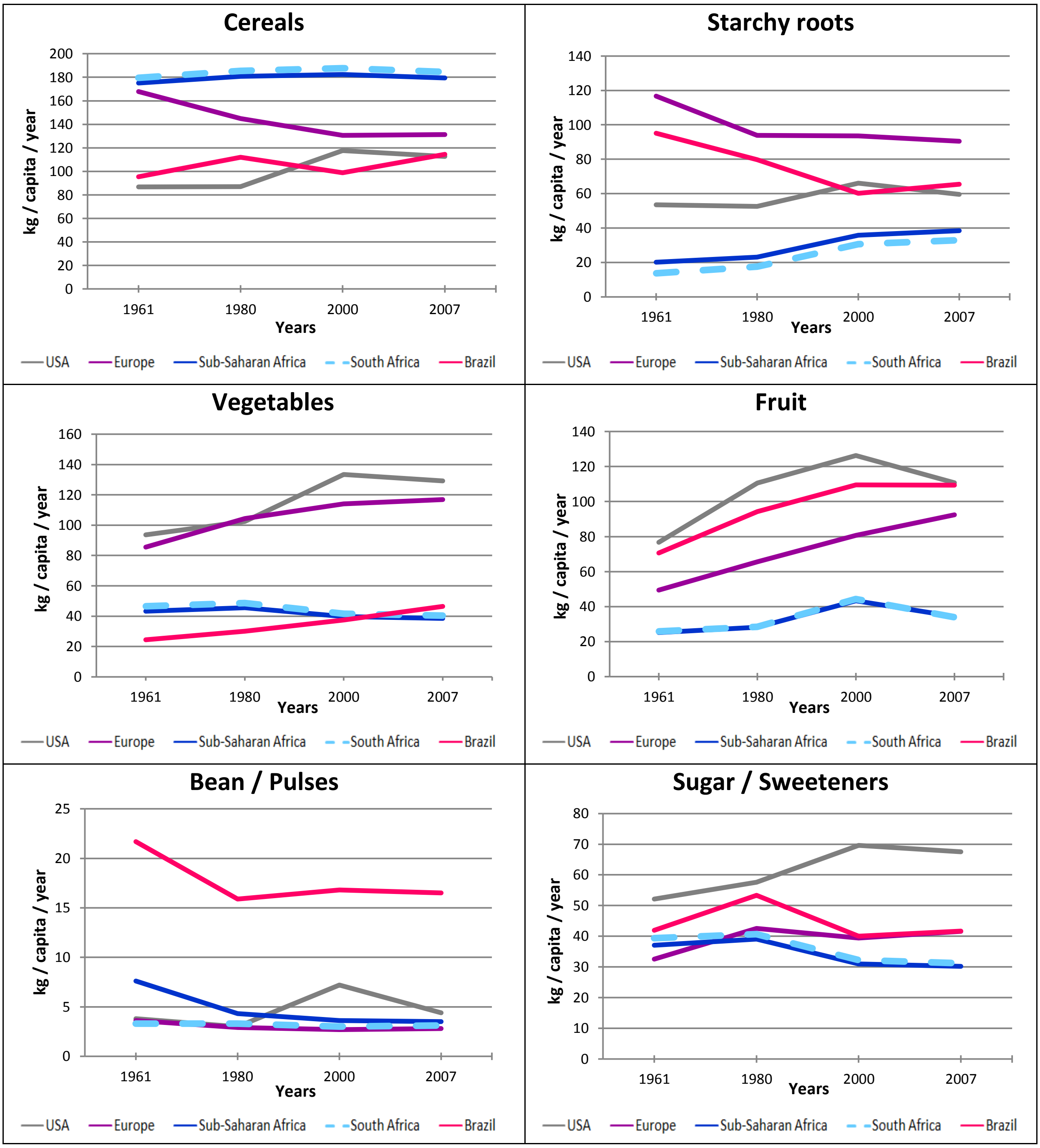
The availability of sugar and sweeteners increased in the most developed countries (Europe and USA) but decreased in Brazil and in South Africa (Figure 19).

Figure 19. Diverse food groups availability trends in different parts of the World, 1961-2007



Source: FAOSTAT Food Balance Sheets 2012

Figure 19. Diverse food groups availability trends in different parts of the World, 1961-2007 (continued)



Source: FAOSTAT Food Balance Sheets 2012

Table 3 below gives an overview of the evolution of food items availability from 1961 to 2007 in South Africa. The overall calorie availability increased. In terms of food items, availability increased for meat, eggs, starchy roots, fruit and vegetable oils whilst the availability for milk and dairy products, fish and seafood, vegetables, animal fats and sugar/sweeteners decreased. Availability for beans/pulses and offals remained stable.

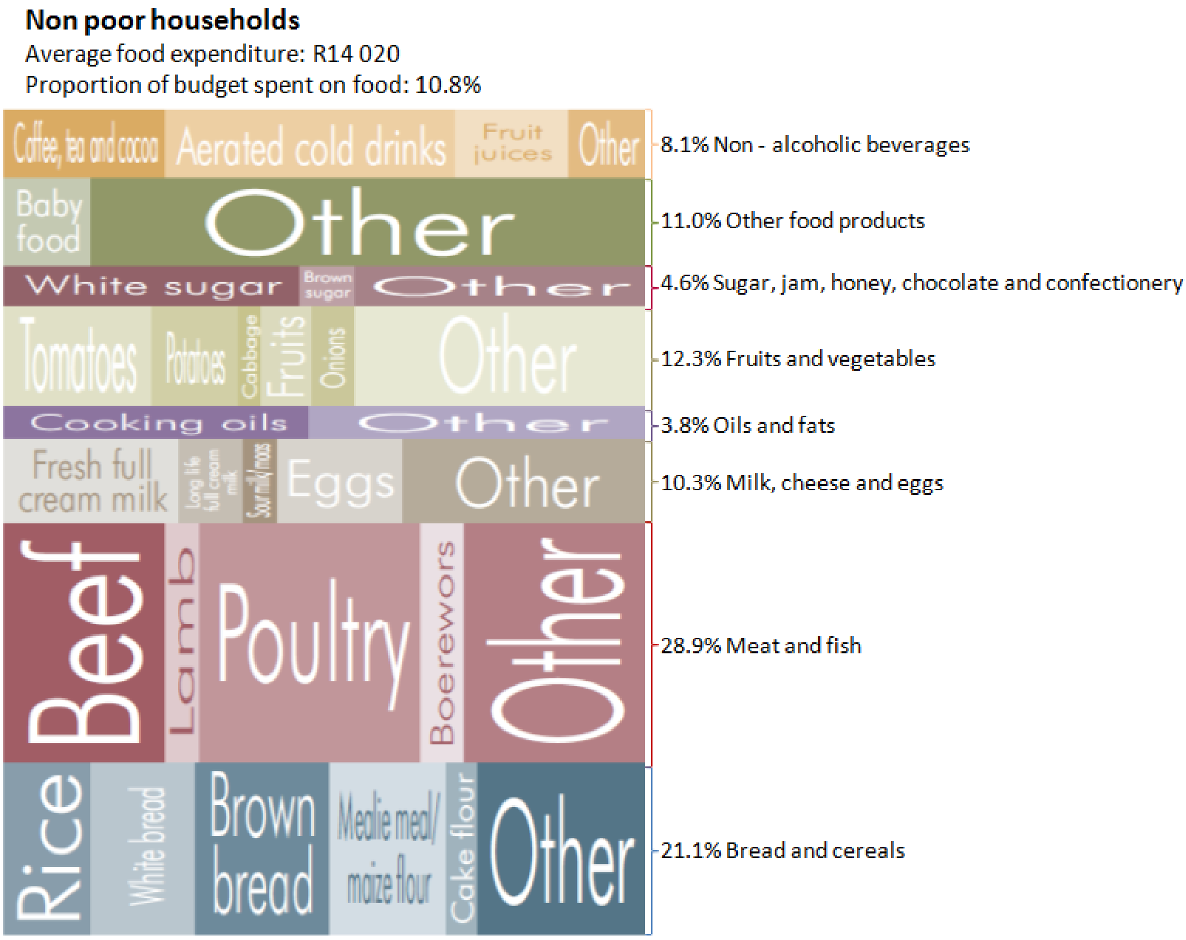
Table 3. Summary of the evolution of food items availability in South Africa from 1961 to 2007

Food groups	Food items	Tendency 1961-2007
Calorie availability	Calorie availability	↑
Animal products	Meat	↑
	Eggs	↑
	Milk/dairy products	↓
	Offals	Stable
	Fish	↓
Vegetal products	Cereals	Stable
	Starchy roots	↑
	Beans/Pulses	Stable
	Vegetables	↓
	Fruit	↑
Oils and fats	Animal fats	↓
	Vegetable oils	↑
Sugar/Sweeteners	Sugar/sweeteners	↓

Figures 20 and 21 below show the food expenditure patterns of poor and non-poor South African households. These figures give a representation of the food patterns of South African and how the patterns of consumption differ between poor and non-poor households. “In order to distinguish between poor and non-poor households, a poverty line (i.e. a line drawn at a particular level of income or consumption; with those households whose incomes or consumption fall below this line are classified as poor) was applied. More specifically, the 2011 inflation-adjusted upper bound poverty line was used to classify poor and non-poor households. The cut-off value used was 620 Rands per capita per month (approximately £29) (Statistics SA 2014)”. Household expenditure food surveys are commonly used to study trends in dietary patterns at the population level. Non-poor households’ annual average food expenditure was R14020 and accounted for 10.8% of total expenditure. In poor households, annual average food expenditure was lower at R8485 but accounted for 33.5% of total expenditure. In non-poor households, 28.9% of food expenditure was on meat and fish (mainly on poultry, beef and other). This was followed by bread and cereals (21.1%); fruit and vegetables (12.3%); other food products (11.0%); milk, cheese and eggs (10.3%); non-alcoholic beverages (8.1%); sugar, jam, honey, chocolate and confectionary (4.6%) and finally oils and fats (3.8%). In poor households, 34.7% of food expenditure was on bread and cereals (mealie meal/maize flour, brown bread, rice and white bread) followed by meat and fish (mainly poultry) (22.4%); fruit and vegetables (12.3%); milk, cheese and eggs (7.4%); other food products (7.4%); sugar, jam, honey, chocolate and confectionery (6.1%); non-alcoholic beverages (4.9%) and finally oils and fats (4.9%).

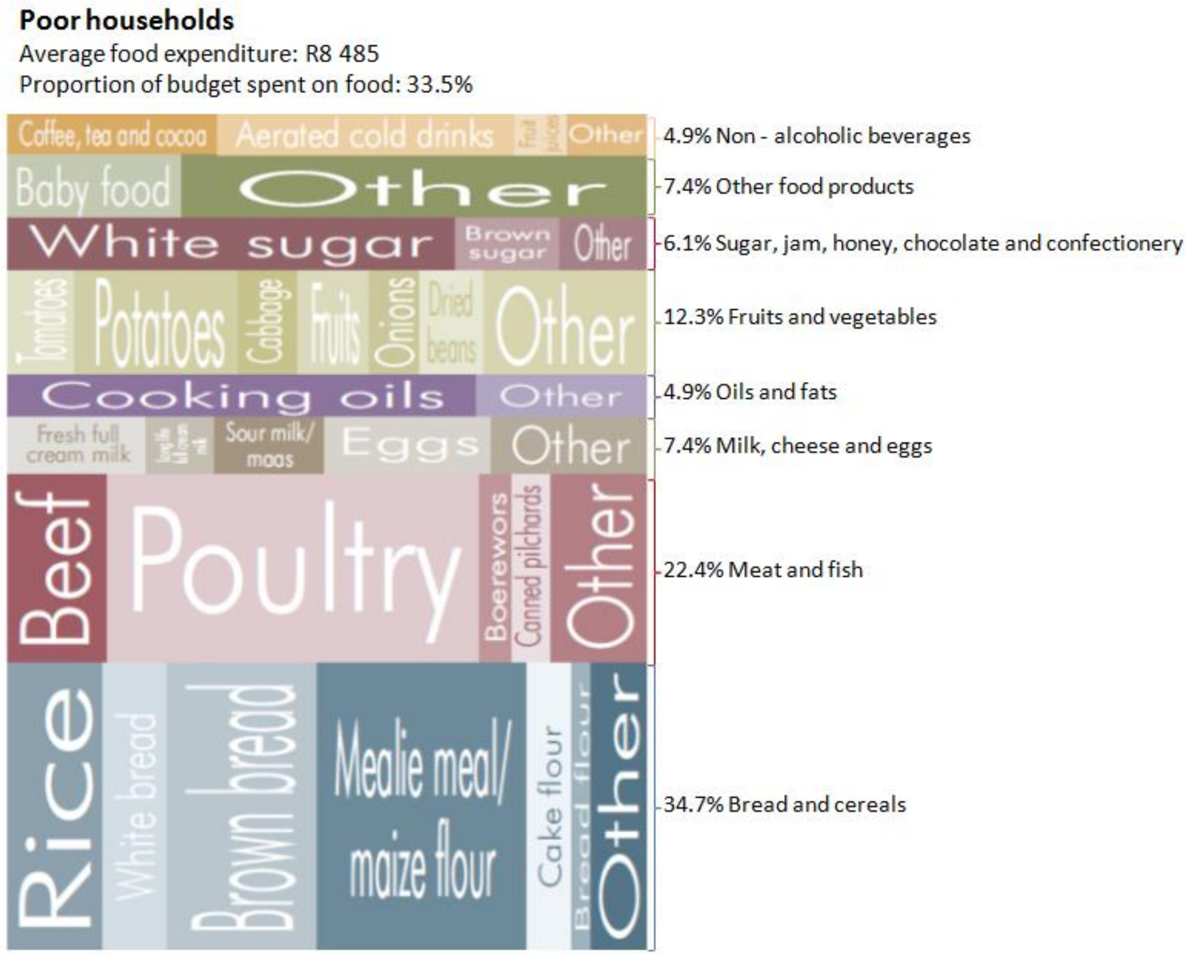
When assessing the spending on bread and cereals, both poor and non-poor households spent in average R 2950 which highlight the importance of bread and cereals in poor households’ diet.

Figure 20. Food expenditure patterns of non-poor households in main expenditure groups



Source: Statistics South Africa 2014

Figure 21. Food expenditure patterns of poor households in main expenditure groups



Source: Statistics South Africa 2014

2.4.3 Nutrition transition

South Africa is currently undergoing the nutrition transition as evidenced mainly by lifestyle behaviours (unhealthy dietary patterns and physical inactivity) and the increasing prevalence of overweight and obesity (Lambert and Kolbe-Alexander 1995; Bourne et al. 2002; Feeley et al. 2009; Abrahams et al. 2011b; Steyn and Labadarios 2011; Steyn et al. 2011; Vorster et al. 2011; Feeley et al. 2012; Steyn and McHiza 2014).

Different stages of the nutrition transition can be seen in LMICs. A study by Abrahams et al. (2011b) showed that 20 of 40 countries in Sub-Saharan Africa are at an early stage of the nutrition transition, whilst several countries such as Ghana, Gabon, South Africa and Cape Verde have reached a stage where lifestyle changes contribute to poor health outcomes for a considerable part of the population. South Africa had the highest nutrition transition score (i.e. the most advanced nutrition transition stage). Indeed, South Africa had the greatest calorie availability at 2999 kcal/capita/day, the seventh highest percentage of energy coming from fat (24.6%) and the third lowest percentage of energy coming from carbohydrates (64.6%).

Vorster et al. (2011), using data from different studies (Vorster et al. 1997b; MacIntyre 1998; Vorster et al. 2000; Kruger et al. 2001; MacIntyre et al. 2002b; Kruger 2005) analysed the trend in macronutrient intake as a percentage of energy intake in urban South African women from 1975 to 2005. Over this period, fat intake was observed to increase from 21% of total energy to 30%. This was alongside a reduction in carbohydrate intake from 65% to 57%. Bourne (1996) report a similar change in a sample of both sexes living in Cape Town. They report that an increasing time residing in the city was associated with an approximate 9% reduction in carbohydrate intake, alongside an 8% increase in fat intake. The BRISK study conducted in a sample of urban African adolescents aged 15-18 years residing in the Cape Peninsula in 1990 (Bourne et al. 1993), found that the adolescents' diet comprise 27% fat, 64% carbohydrates and 13% protein.

Feeley et al. (2009) assessed the fast-food consumption of urban South African adolescents living in the area of Johannesburg/Soweto. The study revealed that over a seven day period, around 30% of adolescents consumed 5-7 fast food items and around 44.0% of adolescents consumed 8 fast food items or more. The authors also reported that 40.3% of the sample visited a fast food outlet 1-3 times in the week and 35.3% visited a fast food outlet 4-10 times in the week. It was found that the frequency of visits to food outlets and the consumption of fast-food items were higher in this South African population compared to the adolescents in the US. The authors argue that adolescents' fast food consumption may have contributed more than 50% to their daily energy intake.

Temple et al. (2006) examined the food items consumed by students (12 to 16 years old) at a school in Cape Town, South Africa. Neither food purchased nor food brought to school contained healthy items, comprising mostly items such as chocolate, French fries, doughnut, fat cakes (deep-fried dough balls), etc. A qualitative study on dietary practices conducted among urban females adolescents in South Africa showed that adolescents tend to choose local, energy dense, fast-food for their breakfast and dinner instead, of food prepared at home, resulting in a poor-quality diet (Voorend et al. 2013).

2.4.4 Health policies for non-communicable diseases

Many LMICs are now experiencing a "triple burden" of disease, characterised by a continuation of the high levels of infectious diseases and under-nutrition, occurring alongside rapid rises in NCDs (cardiovascular diseases (CVDs), cancer and metabolic diseases (overweight and obesity, diabetes). Recent reviews conducted in Sub-Saharan Africa highlight the size of the NCDs epidemic in this region of the world (Dalal et al. 2011; Hall et al. 2011; Adeboye et al. 2012). This “triple burden” of disease presents with health and economic consequences for LMICs (such as lost productivity among the labour workforce; increased cost for the treatment of chronic diseases (at the individual and societal levels) and negative impact on the country’s development) (Abegunde et al. 2007). South Africa is one such country experiencing this triple burden of disease (Mayosi et al. 2009). Indeed, it is estimated that approximately 1 in 5 (19.1%) South African adults aged 15-49 years old is HIV positive (UNAIDS SA 2013). This is paired with male and female prevalences of underweight estimated to be 12.8% and 4.2%, respectively, alongside rates of combined overweight and obesity of 30.7% in males and 64% in females (Shisana et al. 2014). It is not uncommon to find under-nutrition and obesity existing concurrently within the same country, the same community and the same household, but with a higher prevalence observed in urban settings. NCDs account for 44% of total deaths in South Africa (18% for CVDs, 7% for cancers, 3% for chronic respiratory diseases, 6% for diabetes and 10% for other NCDs) (WHO 2014). Communicable diseases and injuries account for 48% and 8% of total deaths respectively (WHO 2014). The South African health system is overstretched as it has to deal with high prevalences of both communicable and non-communicable diseases. In light of these changes in health needs, South Africa, as other LMICs, has to develop integrated policies to respond to this “triple burden” of diseases. Given these complex health conditions existing concurrently in South Africa, it is essential to understand the nature of the South African health system, the agenda setting in the past few years and the policies implemented to deal with overweight, obesity and NCDs at the international and national levels.

2.4.4.1 The South African Health System

Since the ANC party was elected in 1994, significant reforms have been made. In 1996, free primary health care was adopted for all South Africans. Furthermore, free health care for children and pregnant women was also implemented. However, health and health care continue to be a challenge for South Africa (Coovadia et al. 2009). South Africa has a two-tiered health care system, meaning that the government provides free primary health care and that a secondary tier is available for the population who can afford additional health services, usually superior in quality and access. The public sector, known for being underfunded and under-resourced, serves 68% of the population in South Africa whilst the remaining 32% of the population is served by the private sector (Pillay and Skordis-Worrall 2013). Around 80% of the doctors in South Africa work in the private sector (Pillay and Skordis-Worrall 2013). Comprehensive health financing reform (i.e. national health insurance scheme for all) has become a priority for the government and reached the political agenda in 2009, although it was first discussed near the time Apartheid was ending. The National Health Insurance scheme represents an important step in addressing health inequalities in South Africa but is yet to be implemented. A key feature of the South African system is its poor governance, leadership and management resulting in a lack of implementation, monitoring and evaluation of policies developed (Coovadia et al. 2009).

2.4.4.2 Policies in place to address overweight, obesity and NCDs in South Africa

Metabolic diseases such as overweight and obesity as well as NCDs have been neglected on the global health agenda. Although the awareness in terms of the changing health needs of the population living in LMICs increased amongst key stakeholders, this has not been sufficient to generate a significant change into policy action and allocation of resources for the issue of obesity and NCDs. Indeed a recent systematic policy review assessing national responses to NCDs in LMICs, with a focus on two NCD risk factors (diet and physical activity), found that there was a significant shortfall in terms of the responses produced by governments in order to combat NCDs and their risk factors (Lachat et al. 2013). According to Bosu (2013), several factors could explain the low prioritisation of NCDs on the health agenda. These include the lack of reliable data, limited research, limited political interest, low investment from donors and weak surveillance systems in place. Nugent and Feigl (2010) assessed the money spent by donors on NCDs in LMICs from 2001 to 2008. The top three funders for NCDs in between 2004 and 2008 were the WHO, the Wellcome Trust and the World Bank. The authors highlighted that less than 3% of the overall development assistance for health was allocated to the issue of NCDs in 2007 ($503 million out of $22 billion). Although a small contribution was made to the issue of NCDs in LMICs, donor funding for NCDs increased by 618% between 2001 and 2008, with a large increase in funding coming from the private sector, non-profit donors and bi-lateral donors.

Policies implemented to address NCDs and their risk factors at the international and national levels will now be discussed. The main actors involved in tackling the obesity and NCDs epidemics are international organisations, governments in countries affected with the issue, the private sector, civil society organisations (e.g. non-governmental organisations (NGOs)), academic institutions and health charities.

At the international level, the WHO has developed several reports and action plans to address unhealthy lifestyle factors (unhealthy dietary and physical activity patterns) and NCDs (Table 4). NCDs targets will have to be achieved by 2025, including a 25% reduction in premature mortality from NCDs and a decline in obesity rates to levels observed in 2010 (WHO 2013).

At the national level, some countries experiencing the nutrition transition in Sub-Saharan Africa have recently implemented policies to address NCDs. Lachat et al. (2013) in their systematic policy review assessing national responses to NCDs in LMICs, found that 14 countries in Africa had policy actions to reduce unhealthy dietary patterns (reduction in salt and/or saturated fat intake; increase in fruit and vegetable consumption) and promote physical activity. Most of the policies implemented in LMICs involved public education and awareness building.

NCDs reached the South African health agenda very recently as previously, other health reforms have been prioritised on the health agenda (e.g. health care reform and HIV/AIDS policy).

Table 4. NCDs policies implemented at the international level over time

Year	Policies
2000	The World Health Assembly adopted the *WHO Global Strategy for the Prevention and Control of NCDs* (WHO 2000).
2004	The World Health Assembly adopted the *WHO Global Strategy on Diet, Physical Activity and Health* (WHO 2004). This strategy urged all actors to take action at different levels (global, regional and local) to promote healthy diets and physical activity patterns at the population level. The four main objectives of the strategy were to: 1) reduce risk factors for chronic diseases 2) increase the awareness and understanding of the relationship between diet, physical activity and health 3) develop, strengthen and implement policies at different levels to promote healthy diets and physical activity patterns 4) monitor science and promote research on diet and physical activity
2007	The WHO Global Strategy for the Prevention and Control of NCDs was translated into concrete actions (WHO 2007).
2008	The World Health Assembly adopted *the Action Plan for the Global Strategy for the Prevention and Control of NCDs (2008-2013)* (WHO 2008). This Action Plan, with a particular emphasis on LMICs, had six main objectives: 1) to raise the priority accorded to NCDs in LMICs and to integrate prevention and control of NCDs into policies; 2) to establish and strengthen national policies and plans for the prevention and control of NCDs; 3) to promote interventions to reduce risk factors for NCDs; 4) to promote research for the prevention and control of NCDs; 5) to promote partnerships for the prevention and control of NCDs and 6) to monitor NCDs and their determinants and evaluate progress at different levels
2011	The World Health Assembly adopted the Political Declaration of the High Level Meeting of the United Nations General Assembly on the Prevention and Control of NCDs. This Political Declaration commits to improve the implementation of the WHO Global Strategy on Diet, Physical Activity and Health at the global and national levels through interventions and actions (WHO 2011).
2013	The Global Action Plan for the Prevention and Control of NCDs (2013-2020) was adopted to respond to the commitments of the Political Declaration on NCDs. Nine global NCDs targets will have to be achieved by 2025, including a 25% reduction in premature mortality from NCDs and a decline in obesity rates to levels observed in 2010 (WHO 2013).

The South African Department of Health released a comprehensive strategic plan for the prevention and control of NCDs in 2013 (2013-2017) (National Department of Health SA 2013). The three main aims of this strategic plan are to: 1) Prevent NCDs and promote health and wellness at different levels (individual, community and population); 2) Improve the control of NCDs through health systems strengthening and reform and 3) Monitor NCDs and their main risk factors (tobacco, alcohol, physical inactivity and unhealthy diet) and conduct innovative research.

Ten goals and targets in relation to NCDs have been set in this strategic plan and should be achieved by 2020. The target for overweight and obesity is to reduce the prevalence by 10% by 2020. In order to reduce the prevalence of overweight and obesity, two main risk factors should be targeted: unhealthy dietary patterns and physical inactivity.

In regards to unhealthy dietary patterns, the strategy's emphasis is on reducing the consumption of salt, snacks, fast and fried food, sugary foods and drinks and on increasing the consumption of fish, whole grains, fruit, vegetables, legumes and traditional food and dishes. The existing food-based dietary guidelines (Vorster et al. 2001), which were officially adopted in 2003 and recently revised (Vorster et al. 2013), have been utilised as a means of achieving the aims of the strategy. Some examples of the food-based dietary guidelines shared with the public include "use fats sparingly-choose vegetable oils rather than hard fats", "use sugar and foods and drinks high in sugar sparingly" and "eat plenty of vegetables and fruit every day". These guidelines being relatively recent, there is currently no evidence on how these guidelines are understood and implemented by individuals. Overall, improvements in diet are meant to be achieved through legislative measures and awareness campaigns directed to key stakeholders involved in promoting healthier food environments, as well as to individuals.

In regards to physical inactivity, the emphasis of the strategy is on increasing physical activity across all different age groups. Strategies to promote physical activity include: raising awareness about the importance of being active and its benefits for health; implementing evidenced-based physical activity interventions and programmes; and creating opportunities for people to be physically active.

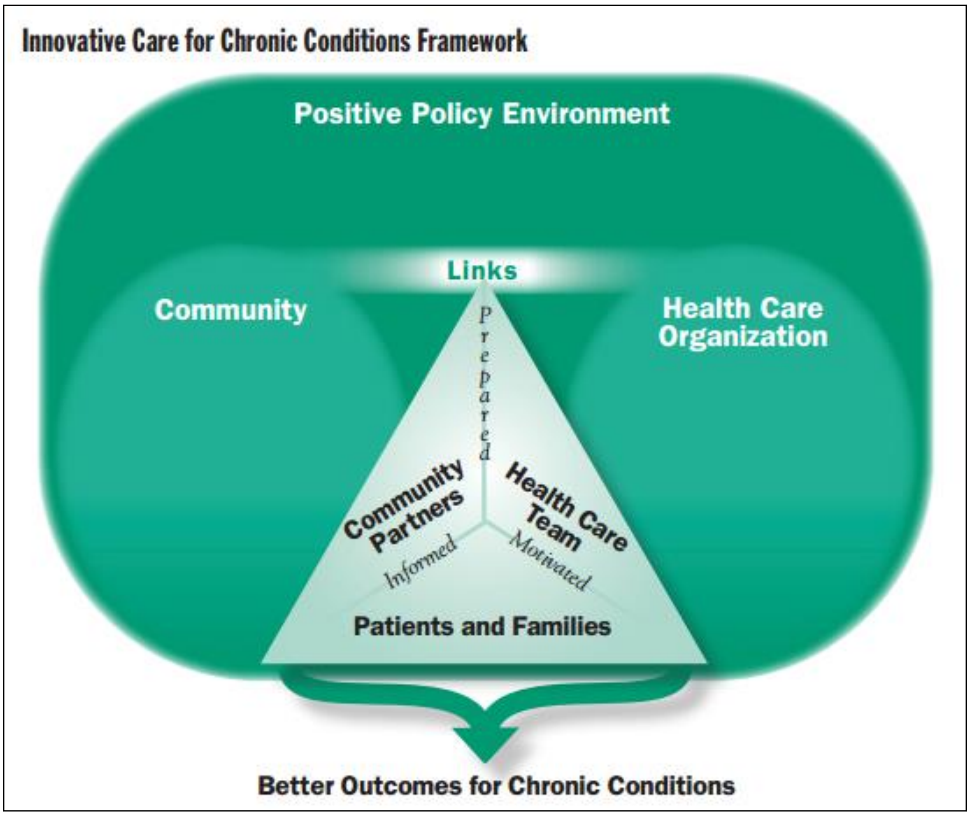
South Africa has started to recognise the changing health needs of its population. The adoption of the 'Strategic Plan for the Prevention and Control of NCDs' at the national level represents an important step in addressing the overweight, obesity and NCD epidemic.

Furthermore the National Department of Health is in the process of repositioning the health care system, which will shift the current infectious disease-orientated model, to one which will integrate both NCDs and infectious diseases in a more effective and balanced manner.

South Africa is using ‘The Innovative Care for Chronic Conditions Framework’ developed by the WHO in 2002 as a template for improving chronic diseases management (Figure 22). This model aims to change the focus of health care provision from an acute, to a chronic model of care (WHO 2002). This framework not only focuses on the care provided within the health care setting, but also emphasizes the importance of engaging patients, families and community actors (WHO 2002). However, the framework will need modifying, as it has been argued, that in its current form, it is inadequate in addressing the issue of multimorbidity (NCDs and infectious diseases) (Oni et al. 2014).

Although South Africa has reached an important milestone in addressing overweight, obesity and the NCD epidemic by implementing this ‘Strategic Plan for the Prevention and Control of NCDs’, there is room for improvement in terms of monitoring and surveillance of NCDs and their risk factors, in order for the goals of this plan to be evaluated. Currently, the SANHANES and the DHS survey provide valuable information for the evaluation of NCDs but this needs to be strengthened and a national surveillance system equivalent to the one existing for infectious diseases needs to be put in place. Finally, given the dual burden of malnutrition existing in the country at different levels and the different SES patterns, it is important to target messages to different audiences as some might experience some structural barriers to achieving these guidelines

Figure 22. Innovative Care for Chronic Conditions Framework



Source: WHO 2002

2.5 Summary

This chapter highlighted some key points on the political, socio-economic and health challenges that South Africa is facing. Between- and within-population group socio-economic inequalities remain in South Africa. The leading cause of death was HIV/AIDS in the overall and youth populations. Diabetes was the third cause of death in the overall population. The combination of epidemics such as HIV, tuberculosis, non-communicable diseases, injury and violence (mainly interpersonal and gender-based) as well as maternal, neonatal and child mortality represents a burden on the South African society. Indeed, amongst the middle-income countries, South Africa has the highest per capita health burden (Coovadia et al. 2009). This chapter also underlined the changing nutrition (increased consumption of fats (saturated fats), refined carbohydrates, sugar) and epidemiology (increased prevalence of overweight and obesity mainly in women, double burden of malnutrition, increased prevalence of non-communicable diseases) of the South African population and thus the importance of studying the determinants of poor diet and anthropometric status in this transitioning society. Finally, the South African health system and health policies in place to deal with overweight, obesity and NCDs in South Africa were described.

Chapter 3: Literature review

3. Literature review

This literature review examines the influence of neighbourhood SES on dietary intake, overweight and obesity in children and adolescents in LMICs. However, information from high income countries is also used to inform this topic because the evidence from LMICs is scarce. The chapter begins with a description of the search strategy and inclusion criteria. The literature review is then presented and starts by defining overweight and obesity in children and adolescents and the methods of classification. Subsequently, the burden of obesity both in developed and in developing countries will be presented along with the consequences and causes of obesity. The middle section reviews the factors which influence dietary choices, overweight and obesity in childhood and adolescence. All influential levels are considered with a particular focus on the importance of the neighbourhood in shaping food dietary habits and physical activity.

3.1 Search strategies

3.1.1 Evidence acquisition

3.1.1.1 Factors associated with childhood and adolescent overweight and obesity

A database search for publications and reviews in social sciences and medical sciences was undertaken using the following key words for independent variables: neighbourhood; neighborhood; community; built environment; environment; dietary intake; food environment; food access; food availability; physical activity; body image; self-esteem; violence; safety; walkability; and school. Keywords for outcomes were health; childhood and adolescents' overweight/obesity. The following key words were added to narrow the search to these areas (OR Boolean term used): LMICs; developing countries; transitioning societies; Africa; South Africa and urban areas. After a preliminary look at the data, the following key words were added: community-based obesity intervention; neighbourhood-based obesity intervention; community-based obesity research and community-based participatory obesity research. Community and neighbourhood obesity intervention were added to the key words in order to measure the importance to intervene at the community level.

The following electronic databases were searched:

-Loughborough Library Catalogue Plus (all databases (i.e. Biological Sciences, BIOSIS previews, The Cochrane Library, Google Scholar, Health and Life Sciences, Loughborough University Institutional Repository, Loughborough University Library Catalogue, PubMed, SAGE, Scopus, Web of Science, Web of Knowledge, MEDLINE, SpringerLink, Wiley Online Survey)

-Science direct

3.1.1.2 Factors influencing dietary intake in children and adolescents

A database search for academic publications and literature reviews related to social and medical sciences was undertaken. For the independent variables, the search was for the following key words and variants: neighbourhood; neighborhood; community; built environment; environment; food environment; food availability; food access; food security; food store availability; corner stores; fast-food; fast food; restaurants; food shops; and food outlets. For the dependent variables, the following words and phrases were searched for: dietary intake; food consumption; eating attitudes; diet; dietary practices; eating behavior; eating behaviour; food choices; and diet quality. The following key words were added as filters to narrow the search results (OR Boolean term used): LMICs; developing countries; transitioning societies; Africa; South Africa; urban areas; youngsters; adolescents; children; and young.

The following electronic databases were searched:

-Loughborough Library Catalogue Plus (all databases as listed in 3.1.1.1);

-Science direct

3.1.2 Inclusion criteria and methodology used to review the articles

3.1.2.1 Factors associated with childhood and adolescent overweight and obesity

Titles and then abstracts were initially reviewed for relevance. There was a large variability among the studies examining the relationship between the environment and health with regards to the studied population. Most studies focused on adults in developed countries and a few examined the health of children and youth in developing countries. There was a wide variation in the outcomes studied, in the definitions of neighbourhoods, and in the areas of observation.

To be included publications must have been conducted on children and/or adolescents and considered general health or overweight/obesity as an outcome. Given the lack of studies examining the relationship between neighbourhood and obesity in LMICs, especially within the population of interest (children and adolescents), it was decided to include studies conducted both in developed countries and in LMICs. Studies considering adults were integrated because of the lack of evidence for children and adolescents. Rural area was used as an exclusion criterion as this thesis focuses on urban health.

The full text was then screened applying the same inclusion criteria as above. Following this, relevant citations from the previously identified publications were reviewed and added to the list where relevant.

3.1.2.2 Factors influencing dietary intake in children and adolescents

Titles and then abstracts were first reviewed for relevance. There was a large variability among the studies examining the relationship between the environment and dietary intake with regards to the studied population. Most studies focused on adults in developed countries, especially in North America, and a few examined the dietary intake of children and youth in developing countries. There was a wide variation in the outcomes studied (energy intake, micronutrients, food diversity, food variety, dietary patterns, etc.), in the definitions of neighbourhoods, communities and areas of observation.

To be included publications must have been conducted on children and/or adolescents (exclusion of pre-school children) and have considered diet as an outcome. Given the lack of studies examining the relationship between the environment and dietary intake in LMICs, especially within the population of interest (children and youth), it was decided to include studies conducted both in developed countries and in LMICs in children and adolescents.

The full text was then screened. Reference lists from each article were carefully perused to identify other studies examining neighbourhood and household socio-economic influences on dietary intake that had not been identified from the database searches.

In order to keep the literature review up to date for the thesis, a system of alert from Google scholar and Zetoc was set up to identify contemporary literature on the topic.

3.2 Overweight and obesity in children and adolescents

3.2.1 Definition of overweight and obesity

Defining overweight and obesity correctly and uniformly in young people is essential for predicting health risks and making comparisons between populations (Lobstein et al. 2004).

Both direct and indirect measures of body fatness exist. Direct measures include dual-energy X-ray absorptiometry (DXA) and bioelectrical impedance analysis (BIA). DXA is a whole body scanning technique used to assess the bone mineral content but is also used to determine the proportions of fat-free mass and body fat (Gibson 2005). Indirect measures of relative fatness include anthropometric measurements such as Quetelet's index (BMI), which is calculated by dividing the weight in kg by square of height in metres and waist circumference (WC) (which is commonly used as a proxy for abdominal obesity).

Power et al. (1997) stated that an ideal measure of body fat should be accurate, precise, accessible, acceptable and well documented. For practical purposes, the most commonly used methods in both clinical and population studies are the anthropometric measures such as BMI and WC.

BMI is a continuous variable and a higher BMI –acting as a proxy measure for body fatness-tends to be associated with increasing risk of NCDs (Lobstein et al. 2004). As weight and height are data that can be collected easily and relatively quickly, BMI is often used in large-scale nutritional and epidemiological studies as a proxy for body fatness and is recognised to be a relatively good tool to estimate fatness or health risk at the population level (Gibson 2005; Bogin and Varela-Silva 2012). The measurement of weight and height data also has the advantage of being non-invasive (Gibson 2005). However, BMI cannot provide information about body composition and the distribution of body fat (Gibson 2005; Bogin and Varela-Silva 2012). Thus, the distinction between weight associated with muscle and weight associated with body fat cannot be made. This represents one of the most important limitations of BMI. Caution should be taken when using BMI to assess body fatness and health risks at the individual level (Bogin and Varela-Silva 2012). In addition, several factors confound the relationship between BMI and body fat (age, sex, and ethnicity) (Deurenberg 1991; Deurenberg 1998).

Percent fat, measured using direct measures, is a more valid indicator of total body fatness and lean mass. However, the location of body fat is as important as the amount of body fat in the assessment of risks for cardio-vascular diseases. It is therefore important to combine, when possible, indicators assessing overall fatness (e.g. BMI or DXA-derived percent fat), with other anthropometric measures such as WC or waist-to-height ratio (WHTR). WC is highly correlated with abdominal fat measures and more specifically, visceral fat, and has been recognised to be a good proxy for abdominal obesity and thus a strong predictor of cardio-metabolic diseases (Brownsing, Hsieh and Ashwell 1995). One of the limitations of WC however, is that it does not correct for people's stature and might therefore under or over-estimate the risks of CVD in short or tall people. WHTR has a high correlation with abdominal fat measures (Ashwell et al. 1996; Gonzales et al. 2007) and as such, its use as a proxy for abdominal obesity has been advocated by researchers One of the main advantages of WHTR is that the same boundary value can be used for different ethnic groups, for men and women and potentially for children and adults (Ashwell and Hsieh 2005).

A systematic review assessing WHTR, WC and BMI as predictors of diabetes and CVD revealed that both WC and WHTR were stronger predictors of cardio-metabolic outcomes, than BMI (Brownsing, Hsieh and Ashwell 2010). A recent meta-analysis (Ashwell, Gun and Gibson 2012) of studies including more than 300,000 adults from different ethnic groups confirmed these findings and showed that WC and WHTR improved the discrimination of adverse outcomes by 3% and 4-5% respectively, when compared to BMI.

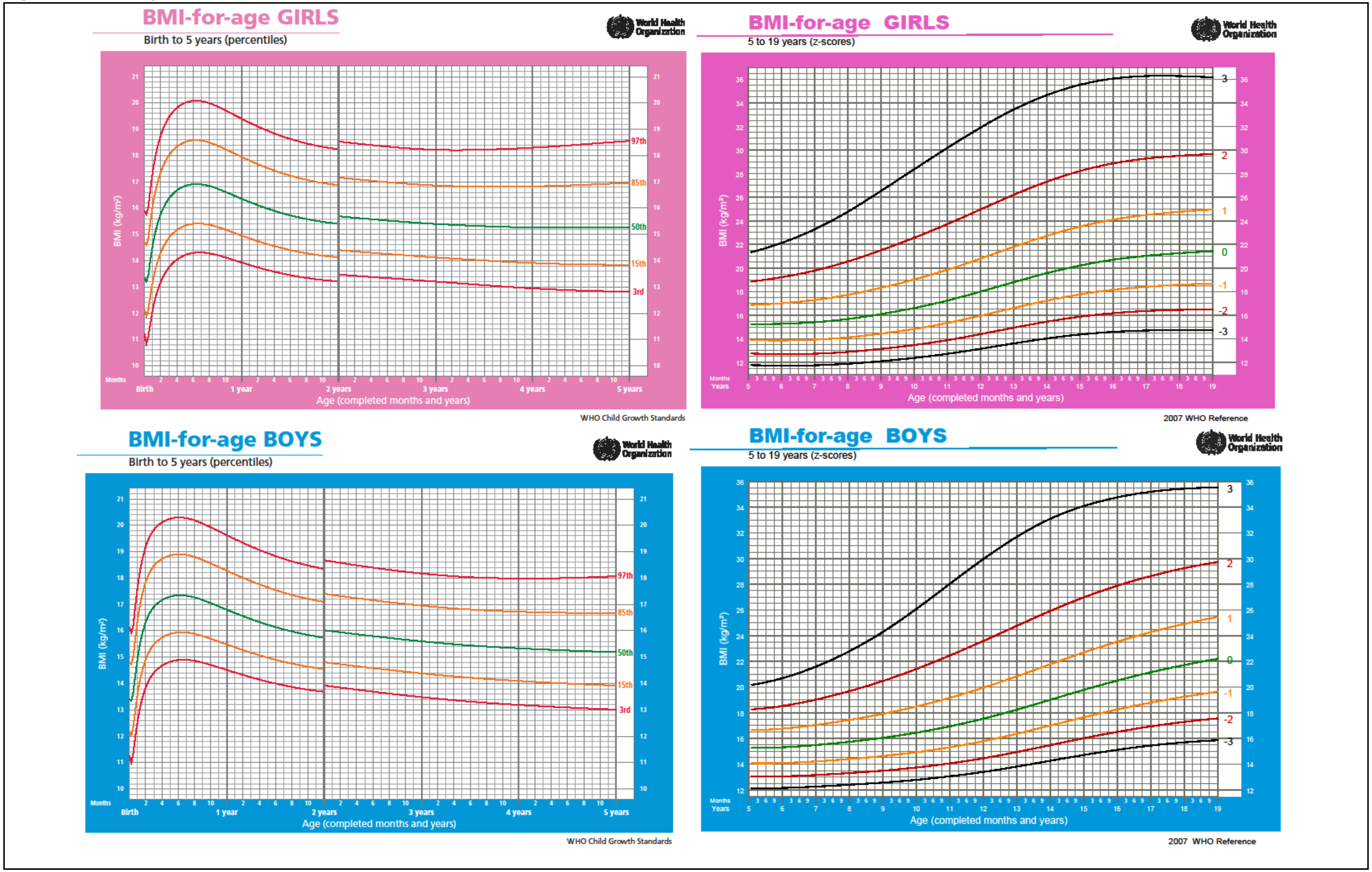
The different methods that exist to classify children and adolescents as overweight or obese using BMI are presented below.

3.2.1.1 BMI for age percentiles

In comparison with adults, BMI during infancy and childhood changes considerably with age with an adiposity rebound around the sixth year of life (Figure 23).

The patterns of growth are also different between boys and girls. Therefore, BMI in children and adolescents needs to be evaluated using age and sex specific reference values. The percentile curves of BMI based on age and sex have been used to determine overweight and obesity in children and adolescents, for example, the US National Center for Health Statistics (NCHS) growth reference charts (Kuczmarski and Flegal 2000). These charts classify children and adolescents with a BMI greater than or equal to the 95th percentile as obese and those with a BMI between the 85th and 95th percentile as overweight. The 90th and 97th centiles are used for clinical purposes (Lob-Corzilius 2007; Singh et al. 2007; Laura 2011).

Figure 23. BMI growth centiles



3.2.1.2 BMI for age z-scores

BMI-for-age z-score charts have also been used. The NCHS/WHO reference is based on a sample of North American children collected during the 60s and 70s. This reference is used worldwide. Children and adolescents with a BMI z-score between +1 standard deviation (SD) and +2SD of a referent similar in age and sex, are classified as overweight. Those with a BMI z-score greater than or equal to +2SD are classified as obese (Onis et al. 2007).

3.2.1.3 BMI based on adult cut-off points

Age and sex specific cut-off points have been developed by extrapolating backwards from the adult BMI cut-offs of 25 kg/m² and 30 kg/m² for overweight and obesity respectively (e.g. the overweight cut-off for a male child of 17 years old is 24.46 kg/m²).

These IOTF thresholds (Cole et al. 2000) have been used internationally and to a greater extent than the WHO 2007 growth reference. The reference population was obtained by averaging BMI data from six different countries presenting different prevalence rates of obesity (Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the USA).

3.2.2 The burden of obesity

Obesity is considered as a global epidemic in high, middle and low-income countries. Since 1980, obesity has more than doubled at the worldwide level (WHO 2015a). According to global estimates made by the WHO in 2014, 1.9 billion adults are overweight and of these, 600 million are obese (WHO 2015a). More global deaths have been attributable to overweight and obesity than to underweight (WHO 2015a).

Even though overweight and obesity affect mainly adults, childhood obesity is now increasingly recognised as a serious public health concern at the global level. In 2013, approximately, 42 million children under five year of age were overweight or obese (WHO 2015a). Childhood obesity is described as having reached epidemic proportions in industrialized countries with the age-adjusted prevalence in these countries reaching between 20 and 30% (Kiess et al. 2006). This problem is also increasing rapidly in LMICs (Lob-Corzilius 2007; Laura 2011). Evidence of a rising prevalence of overweight amongst children and adolescents in LMICs and especially in urban areas, suggests that this burden can no longer be considered a high income country problem alone (Singh et al. 2007). Nearly 31 million overweight children live in LMICs compared with 11 million in high income countries

(WHO 2015b). Representative data regarding secular trends of childhood obesity in African countries are scarce. Indeed, most of the efforts in public health and nutrition have been orientated towards malnutrition and food safety issues (Lobstein et al. 2004). Though the prevalence of childhood obesity in Africa as a whole remains low (Lobstein et al. 2004), some countries such as South Africa are more affected. Shisana et al. (2014) found that 9% of boys and 27% of girls aged 15-17 years were either overweight or obese. Recent data in adults show that South Africa has one of the highest prevalences of overweight and obesity in Sub-Saharan Africa, with 30.7% of men and 64.0% of women being overweight or obese (Shisana et al. 2014; World Obesity Federation 2014). This suggests that between childhood and adulthood, a rapid increase in the prevalence of overweight and obesity occurs.

3.2.3 The consequences of obesity

Childhood obesity, especially in LMICs, has important implications regarding adult morbidity and mortality and represents a risk factor for NCDs, including type 2 diabetes, hypertension, liver disease, certain form of cancers and long term cardiovascular complications (Kiess et al. 2006; Singh et al. 2007; Laura 2011). Obesity does not only affect physical health during childhood and adulthood, but it also has a strong negative impact on the psychological wellbeing, self-esteem and on some social aspects of life (Monasta 2010; Laura 2011). It is also important to consider the financial cost of obesity for society and to the individual (Kiess et al. 2006). It is therefore essential that interventions are developed that aim to tackle the development of childhood overweight and obesity.

3.2.4 The determinants of obesity

Many studies have attempted to identify the determinants of overweight and obesity amongst children and adolescents.

The causes of obesity are understood to be complex and multifactorial (Laura 2011). Genetics can play a role in the development of obesity but this is not the only factor to consider (Singh et al. 2007). Also the rapid increase in obesity rates worldwide implicate environmental or social factors, rather than genetics, as primary causes of the obesity epidemic. Dietary intake and physical activity are defined as proximal determinants for energy balance. The conjunction of poor dietary patterns (energy dense foods high in fat, salt and sugars but low in micronutrients) and insufficient physical activity can lead to obesity (Lob-Corzilius 2007). Obesity is the result of an energy imbalance between calorie intake and calorie expenditure.

Nevertheless, modifications in food consumption and in physical activity patterns are linked to environmental and socio-economic factors at the individual/household or community level (Singh et al. 2007). These factors are called distal determinants.

3.3 Dietary patterns in children and adolescents

3.3.1 Dietary assessment

Different dietary assessment tools exist and aim at characterising the actual or habitual food intake of individuals and groups. They are used as an indirect measure of the amounts of energy and nutrients consumed. They are usually categorised as either records (prospective techniques used to measure current consumption) or recalls (retrospective techniques used to measure past consumption) (Rutishauser 2005). Prospective methods include menu record, weighed or estimated food records whilst retrospective methods include the 24 hour recall, multiple pass recall, food frequency questionnaires (FFQ) and diet history (Willett 1998; Gibson 2005; Rutishauser 2005). The principle, strengths and limitations of each method listed above are summarised in Table 5.

The weighed food records require the respondent or investigator to weigh each item of food and drink prior to consumption usually for a period of one to four days (Gibson 2005; Rutishauser 2005). This method allows a precision of portion sizes; however it is very expensive and represents an important burden for the respondent which leads to a poor response rate {Buzzard, 1998 #513}. Therefore this technique is not frequently used in population based studies.

The two most commonly utilised methods for dietary assessment in population based studies are the FFQ and the 24 hour recall especially in LMICs. Food consumption surveys are difficult to implement in LMICs mainly due to the fact that people share what they eat and sometimes eat from a common dish (FAO 2003). The main difficulties encountered in LMICs for dietary assessment come from various sources such as the culturally specific ways of purchasing, storing, cooking and sharing food; the energy and nutrient content of local foods and recipes and; the level of education of the population (Kigutha 1997).

The FFQ allows an estimation of the frequency of consumption of food or food groups within a given time-frame and thus captures perceived habitual intake (Willett 1998; Gibson 2005;

Rutishauser 2005). This tool is recognised as being the best compromise to enable measurement of food consumption and a comparison of food habits in different regions of the world (Mennen et al. 2001). The FFQ consists of a list of either foods and drinks or food groups. The frequency of consumption of the listed foods is recorded (i.e. in terms of times per day, per week, per month, per year). The FFQ was initially designed to provide qualitative information on dietary patterns. However, its design has evolved and FFQs can also include information on the quantity consumed (semi-quantitative or quantitative questionnaire). Semi-quantitative FFQs will estimate quantities using standard portion sizes (small, medium or large) whilst in quantitative FFQs, quantities will be estimated using household measures, food drawings and/or food models (Cade et al. 2002). The type of items included in the list and its length vary from questionnaire to questionnaire and is dependent upon the overall aim of the questionnaire and the population studied (Willett 1998; Cade et al. 2002). For instance, a questionnaire designed to assess overall energy and macronutrients intakes will require a long list of items.

Different factors have to be taken into consideration when implementing and developing FFQs (Cade et al. 2002). These factors include the aim of the questionnaire, the questionnaire to be used (i.e. modifying a pre-existing questionnaire or developing a new questionnaire), the development of the food list (i.e. type of food items, number of food items), definition of the method of quantification and timeframe and the mode of administration (i.e. self-administered, interviewer-administered). Finally, the reproducibility or precision of a method (i.e. whether the same method provides similar results when used repeatedly in the same situation) and the validity or accuracy of a method (i.e. the method measures what it is intended to measure) have to be assessed (Willett 1998; Cade et al. 2002; Gibson 2005; Rutishauser 2005). The validation of a FFQ is crucial as incorrect intake estimates may produce false relationships between diet and diseases (Cade et al. 2002). The FFQ has to be validated against a superior method (dietary method (i.e. weighed record or repeated 24h recalls) or non-dietary method (doubly-labeled water technique which represents the gold standard in the measurement of total energy expenditure).

FFQs are limited in that the information is memory dependent (both for the identification and quantification of foods consumed) and food intake may be overestimated (Paalanen et al. 2006), especially healthy foods such as fruit and vegetables. The main sources of error in a FFQ are related to the omission or addition of foods, the estimation of food weights, the estimation of the frequency of consumption of each food item and finally errors related to the coding of the dietary data (Gibson 2005).

Despite these weaknesses, the FFQ creates little burden for the respondent, is suitable for large scale surveys and can be completed independently by participants. To conclude, the FFQ is a validated and concise tool for carrying out dietary assessment in population based studies (Gibson 2005).

The other retrospective recall method is the 24h dietary recall which requires the respondent to detail, from memory, all the foods and drinks consumed during the previous day. This recall can be quantitative or qualitative which allows measurement of food variety and diversity. Weaknesses of this tool are that it is memory dependent (both for the identification and quantification of foods consumed) and reliance on respondent accuracy regarding portion size estimates tends to induce under-estimation. The primary limitation is that the record covers just one day which is not representative of an individual's usual intake. Indeed, high day to day variability exists in individuals (Buzzard 1998). The multiple pass 24h recall (similar to the 24h recall but performed on an extended period of time) presents an alternative method to the 24h recall (Table 5). Though the 24h dietary recall does not reflect habitual food intake and often under-estimates the food intake, it is a quick way and inexpensive form of dietary assessment, and the burden on the respondent is relatively low (Gibson 2005). This method has also been used in population based studies (Gibson 2005).

In summary, the food record techniques and the 24h recall which give an idea of actual intake can be used to estimate absolute rather than relative intakes (Buzzard 1998). FFQs are generally used to rank people into broad categories rather than for estimating absolute energy and macronutrient intakes. In comparison to the FFQ, both food record techniques and the 24h recall technique allow a high level of specificity in relation to the foods consumed (preparation, type, source, commensality (i.e. sharing a meal), etc.) as questions are open-ended (Buzzard 1998). Recall techniques in comparison to record techniques do not require the participant to be literate which represents an important strength. Finally, retrospective techniques are less likely to lead to a change in eating pattern as the information is collected after consumption (Buzzard 1998).

Although dietary assessment tools can be precise, they cannot give an accurate estimation of dietary intake (Rutishauser 2005). This is mainly related to bias frequently found in nutritional epidemiological studies (respondent and/or interviewer biases, respondent memory lapses, incorrect estimation of portion sizes/quantities) (Table 6). Measurement errors (random or systematic errors) can arise at different stages of the dietary assessment process (data collection, coding, etc.). Reporting biases (under- or over-reporting) represent the main source of error when assessing dietary intake (memory bias; reporting effect (conscious or unconscious misreporting); observation effect (change in eating pattern mainly seen in prospective studies) and reporting of quantities based on household measures and portion sizes). Under- and over-reporting can be general or selective (i.e. specific food items or drinks). Under-reporting can be due to under-recording or under-eating. Similarly, over-reporting can be the result of over-recording or over-eating. It is important to make the distinction between under-recording and under-eating and between over-recording and over-eating. This can be done by measuring energy expenditure using the doubly-labeled water technique (Goris et al. 2000). When body weight is stable, reported energy intake should be equal to total expenditure (Livingstone and Black 2003). Therefore, any discrepancy between these two measures without any change in weight status would suggest misreporting (i.e. misrecording).

A review by Black and Cole (2001) assessed whether misreporting (under- or over-reporting) was the result of individual characteristics or whether it was related to the dietary assessment tool used. This review included seven studies with repeated measures of energy intake and concluded that misreporting was characteristic of some individuals. Much of the research has focused on individual characteristics of under-reporters as over-reporting was generally less prevalent (Gibson 2005). Socio-demographic characteristics such as age, sex and education level along with weight status have been associated with under-reporting. Indeed, higher BMI, lower education level, being a female, older ages have been significantly related to under-reporting (Hirvonen et al. 1997; Braam et al. 1998; Kretsch et al. 1999; Johansson et al. 2001; Lührmann et al. 2001; Horner et al. 2002; Pikholz et al. 2004). Measurement errors in dietary measures can affect or mask relationships between dietary variables and health outcomes and represent an important challenge for the interpretation of results (Cade et al. 2002; Börnhorst et al. 2013).

Table 5. Summary of dietary measurement methods: principle, advantages and disadvantages

Type of methods	Principle	Strengths	Weaknesses
Prospective methods (records)			
Weighed record	The participant (or investigator) is asked to weigh foods and drinks consumed over a period of time (1-4 days) prior to consumption. Two types of weighed record exist: the weighed inventory (record of foods and drinks as consumed) or precise weighing method (i.e. weights of ingredients, prepared items, eaten items, plate waste)	This method is used widely and gives a precise and accurate estimate of the types and quantities of foods and drinks consumed during the study period. It gives an idea of actual intake	This method is costly and highly time-consuming. The burden placed on the participant is high. It can also influence and modify the eating pattern of the respondent. Furthermore, this method does not represent habitual intake.
Estimated record	The participant (or investigator) is asked to record in detail the foods and drinks consumed over a period of time (1-7 days) usually prior to consumption. Quantities consumed are estimated using household measures, food drawings and/or food models	This method is used widely and is less burdensome than the weighed record method. The eating pattern of the respondent is also less affected by this method in comparison to the weighed record method. It gives an idea of actual intake	This method is costly and estimating the portion sizes vs. weighing might reduce precision and accuracy. Furthermore, this method does not represent habitual intake.
Retrospective methods (recalls)			
24h recall	The participant is asked to list all foods and drinks consumed on the previous day. Quantities consumed are estimated using household measures, food drawings and/or food models.	This method is the most widely used method to obtain quantitative recall data and the burden placed on the participant is relatively low. This method is also appropriate for large scale surveys. Finally, the response rate is higher when using this method in comparison to prospective methods.	The main weakness of this method is that it is memory dependent. Estimating quantities retrospectively can lead to a reduction in precision and accuracy. Also, this method is not representative of the habitual intake unless repeated on multiple days. It also presents bias in recording "good" and "bad" foods.

Table 5. Summary of dietary measurement methods: principle, advantages and disadvantages (continued)

Type of methods	Principle	Strengths	Weaknesses
Retrospective methods (recalls)			
Multiple pass 24h recall	With this method, the diet is usually assessed over a period of 3-5 days. "Multiple pass" refers to the multiple stages involved in the interview process. The first step is to ask the respondent to list all foods and drinks consumed on the previous day using any recall strategy. Participants do not have to list items in chronological order. In the second step, the interviewer will seek for more detailed information by probing for additions. In the final step, the interviewer reviews the list of items which allows further additions if needed.	This method presents the same strengths than the 24h recall. The burden placed on the participant is relatively low and It is appropriate for large-scale surveys. The precision is improved with this method in comparison to a 24h recall.	The weaknesses of this method are the same than the ones presented above for the 24h recall.
Food Frequency questionnaire	Participants are given a list of items with a selection of options for reporting the frequency of consumption of each food item (daily, weekly, monthly, per year or never). The questionnaire can be self-administered or interviewer-administered. Participants or interviewers select the items consumed and how often the items are consumed. FFQs can also include information on the quantity consumed (semi-quantitative or quantitative). Semi-quantitative FFQs will estimate quantities using standard portion sizes (small, medium or large). In a quantitative FFQ, quantities will be estimated using household measures, food drawings and/or food models. The length of the food list varies from questionnaire to questionnaire. The aim of the questionnaire will inform the type and number of items to be included in the questionnaire. For instance, a questionnaire designed to assess overall energy and macronutrients intakes will require a long list of items.	This method is appropriate for large scale surveys. The burden on the participant is relatively low which leads to a better compliance. Due to its standardised form, the questionnaire can be self-completed. It represents a relatively inexpensive tool for interviewing a large number of individuals.	The weaknesses of this method are the large random errors, the lack of precision and accuracy in relation to quantities estimated; the lack of detail obtained about the foods consumed and cooking methods. Possible over-reporting of healthy foods is another issue. Finally, this method needs to be validated against a superior method.
Diet history	The diet history method is different to the previous retrospective methods as it does not involve recall over a specific period of time. The aim of this method is to provide a semi-quantitative picture of habitual intake. The interview will include questions around usual diet along with a three day record of food using household measures.	This method has the potential to capture habitual intake.	This method is time consuming and requires skilled participants and interviewers. Another weakness lies in the semi-quantitative nature of the data.

Source: Willett 1998; Gibson 2005; Rutishauser 2005

Table 6. Bias in nutritional epidemiology

Bias in nutritional epidemiological studies	
Non response bias	Random sample of subjects not representative of the studied population
Respondent biases	Systematic over-reporting or under-reporting of foods consumed; social desirability and approval biases
Interviewer biases	When different interviewers probe for information to varying degrees, omit questions or record responses of subjects incorrectly. Biases could also be associated with the interview setting (distractions, confidentiality, relationship between the interviewer and interviewee)
Respondent memory lapses	Unintentional omission or addition of foods in recall methods
Incorrect estimation of portion size	Respondents failing to quantify accurately the amount of food consumed or from misconceptions of an average portion size
Coding errors	Can arise when portion size estimates are converted from household measures into grams and when food items are assigned codes
Mistakes in the handling of mixed dishes	May result in incorrect estimates of their nutrient content per se, as well as errors in their assignment to a specific food group.

Source: Gibson 2005

3.3.2 Dietary patterns in children and adolescents in high-, middle- and low-income countries

3.3.2.1 The evidence from high income countries

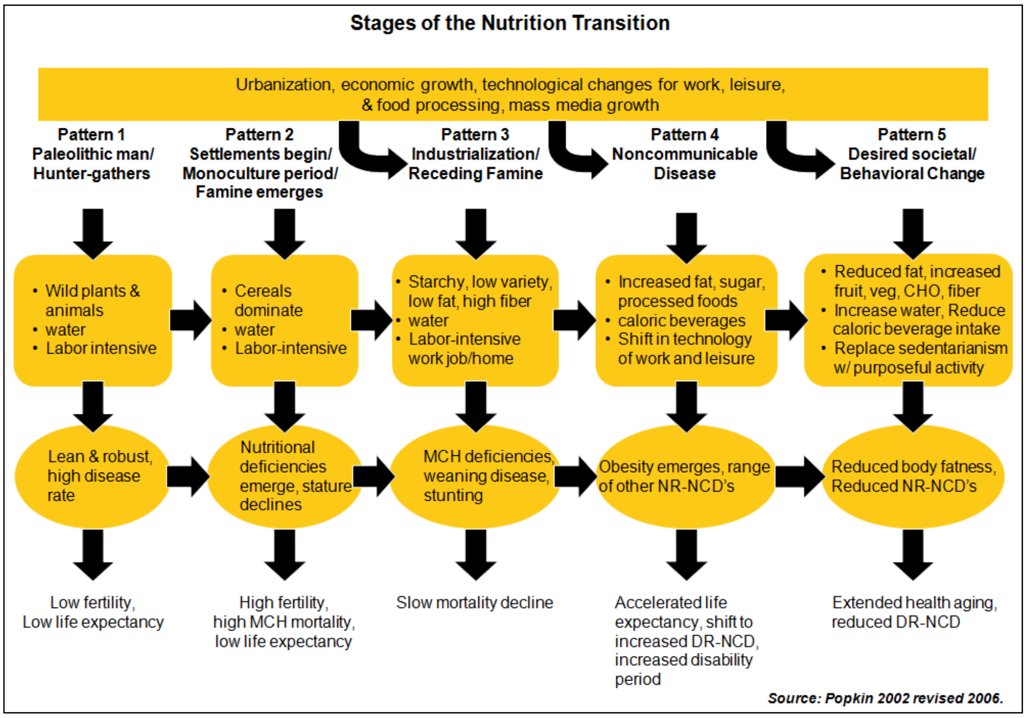
In high income countries, adolescents present early signs of negative nutrition-related conditions such as type II diabetes, CVD and obesity (WHO 2003).

Adolescents in developed countries tend to adopt poor-quality diets not meeting the dietary guidelines. Evidence from studies conducted in the USA, Europe and Australia show, on the one hand, a lower than desirable consumption of fruit, vegetables, dairy products and whole grains and, on the other hand, a higher than desirable consumption of soft drinks, confectionery, and fast foods products (Neumark-Sztainer et al. 1996; Munoz et al. 1997; Yngve et al. 2005). Most studies on adolescent diet have concerned individual food or nutrient intakes (energy intake, proteins, lipids, carbohydrates, vitamins, minerals, etc.) (McNaughton et al. 2008). Recently, dietary pattern analysis has emerged as a popular way of defining the whole diet. Indeed, dietary patterns capture complex behaviours (Mishra et al. 2002; Newby et al. 2006). Dietary patterns give an idea of how foods are combined and related to one another. Most of the research conducted in HICs focusses on adults (Newby et al. 2003; Kant et al. 2004; Newby et al. 2004) with fewer studies focusing on adolescents (Aranceta et al. 2003; Song et al. 2005; Ambrosini et al. 2009; Kourlaba et al. 2009; Wang et al. 2010). Two main patterns of consumption are commonly described in the literature; the 'prudent' and the 'western' pattern. The 'western' pattern was defined by Slattery et al. (1998), as a diet characterised by high consumption of red meat, processed meat, fast food, refined grains and sugar, alongside a low consumption of vegetables and fruits. The 'prudent' pattern was defined as a diet characterised by a high consumption of fruit and vegetables, fish and poultry alongside a low consumption of red meat, processed meat and sugar (Slattery et al. 1998). Many studies conducted in HICs in adults identified these two types of patterns and labelled them according to the definitions given above (Hu et al. 1999; Crozier et al. 2006; Paradis et al. 2009). Cutler et al. (2009) assessed the evolution of dietary intake patterns over time in adolescents in the USA. Middle school (younger cohort group, 12 years old) and high school (older cohort group, 16 years old) students were interviewed at the beginning of the study (time 1) and then again five years later (time 2). During this time, the younger cohort group progressed from early adolescence to middle adolescence and the older cohort from middle adolescence to late adolescence. At time 1, four dietary patterns were identified (using principle component analysis): vegetable, fruit, sweet/salty snack food and starchy food. At time 2, these four identified patterns remained present but a fast-food pattern had also emerged. The frequency of fast-food consumption increased significantly from early to middle adolescence among both males and females. However, from middle to late adolescence, a significant increase occurred only among males. These results highlight adolescence as a key period during which unhealthy eating practices evolve and actions to promote and sustain healthy eating habits need to be implemented (Goh et al. 2009).

3.3.2.2 The evidence from low-and middle-income countries

Many LMICs in the world are experiencing an increase in the incidence of childhood obesity and diet-related chronic diseases with urban areas mostly affected. This phenomenon partly results from changes in dietary patterns. Indeed, LMICs are transitioning to westernised lifestyles. Popkin (2006) defines the five patterns of nutrition transition (Figure 24) and highlights the fact that the diets in many LMICs are transitioning from a 'receding famine pattern' (i.e. starchy staples, low fat, low variety, water, high fibre) to a 'degenerative disease pattern' (i.e. more fat, sugar, processed food, caloric beverages and less fibre).

Figure 24. Stages of the nutrition transition



Source: Popkin 2002, revised 2006

Of note in this shift to a diversified diet is the increase in food groups consumed, including protein-rich and energy-dense diets and in increased preference for convenience foods and beverages. Diet diversification occurs with economic growth due to changes in food supply and demand. Rapid urbanisation, characterised by higher population density in urban areas, higher income and increased access to food, is an important contributor to modifications in dietary patterns, especially through the proliferation of large supermarkets in urban centres. The wide range of food types provided by these supermarkets stimulates the process of diet diversification (Popkin 1999; Pingali 2007).

A recent paper examined worldwide dietary patterns amongst men and women aged 20 years or above (Imamura et al. 2015). Diet quality was assessed at two time points (1990 and 2010) in 187 countries using representative national surveys, large subnational surveys and the Food Balance Sheets from the FAO. Two dietary patterns were created. The first one was based on the high consumption of 10 selected healthy items (such as fruit, vegetables, nuts and seeds, whole grains, fibre, beans and legumes, etc.). The second one reflected the low consumption of 7 selected unhealthy items (such as processed meats, saturated fat, unprocessed red meats, sugar-sweetened beverages, etc.). The findings of the study revealed that over time, dietary scores based on healthy food items improved in middle-income countries. However, dietary scores based on unhealthy items worsened. Furthermore, middle-income countries experienced the biggest deterioration in comparison to other countries between 1990 and 2010. When looking more specifically at South Africa, a middle-income country, the consumption of unhealthy items such as fruit juices, sugar sweetened beverage, processed meat, saturated fat were above the recommendations whilst the consumption of fruit, vegetable, fibre, nuts and seeds were below the recommendations.

Adolescence is a crucial time to study behaviour regarding diet because nutrition behaviours develop during this period. Moreover, evidence show that there is a significant association between food intake in adolescence and food intake in adulthood (Lake et al. 2006). Thus, interventions aiming to improve nutrition behaviours in adolescence appear essential for obtaining long-term health benefits.

In this context, it is essential to identify the factors that influence individual food choices.

3.4 The factors that influence dietary intake and obesity: theoretical frameworks

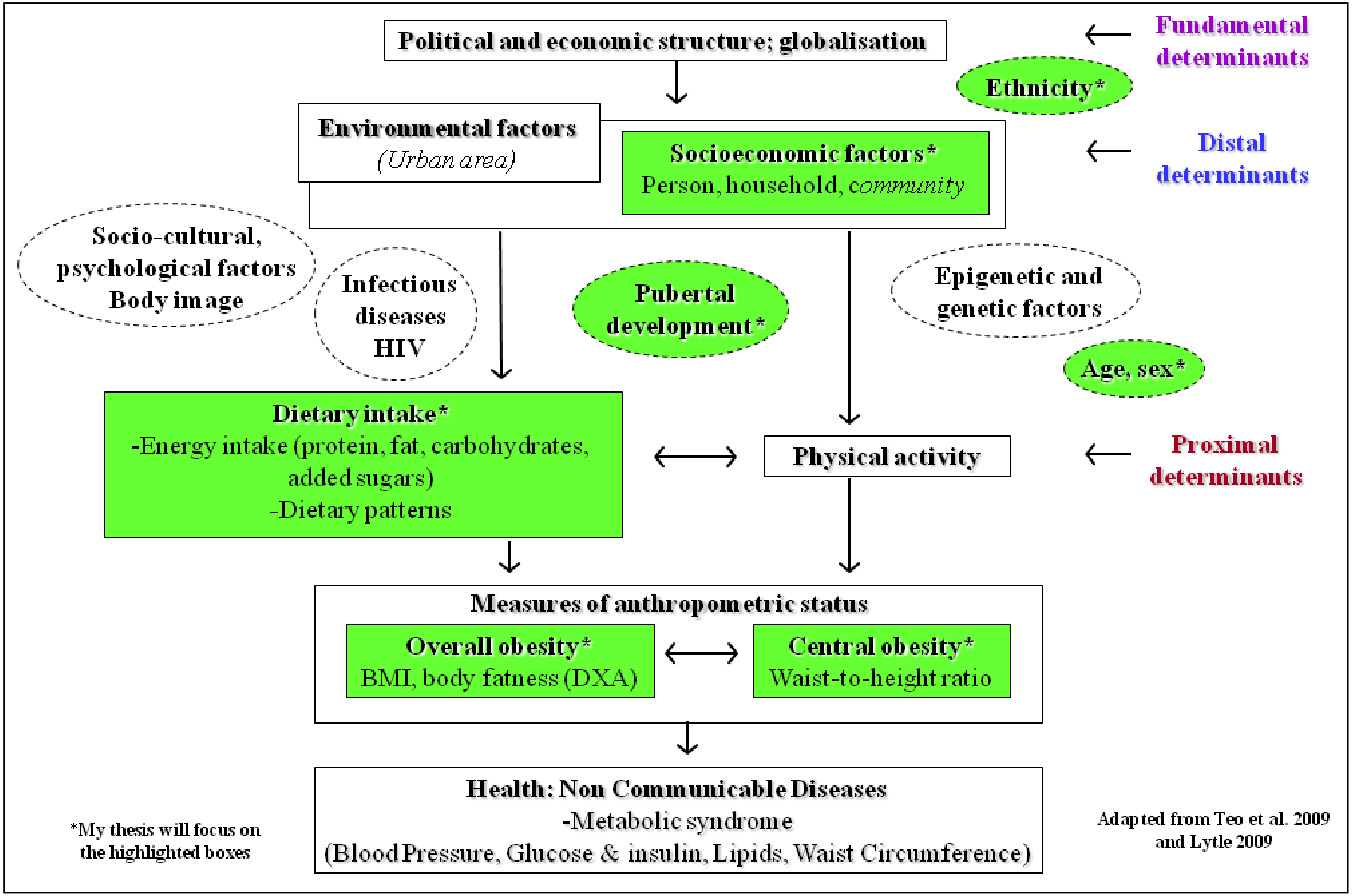
There are a number of theoretical frameworks that have been applied to the study of obesity. The frameworks that will be used in this PhD are described here.

3.4.1 The conceptual model of obesity

Presented below is the conceptual model of obesity (Figure 25), adapted from Lytle (2009) and from Teo et al. (2009). This model integrates different levels of determinants (proximal, distal and fundamental) and its assumption is that the causes of obesity and NCDs involve multi-level influences.

The political and economic structure of a country influences the environmental characteristics and SES at the individual, household and community levels which in turn influence dietary and physical activity patterns. These patterns will then lead to obesity and NCDs.

Figure 25. Conceptual model of obesity



3.4.2 The ecological model of health promotion

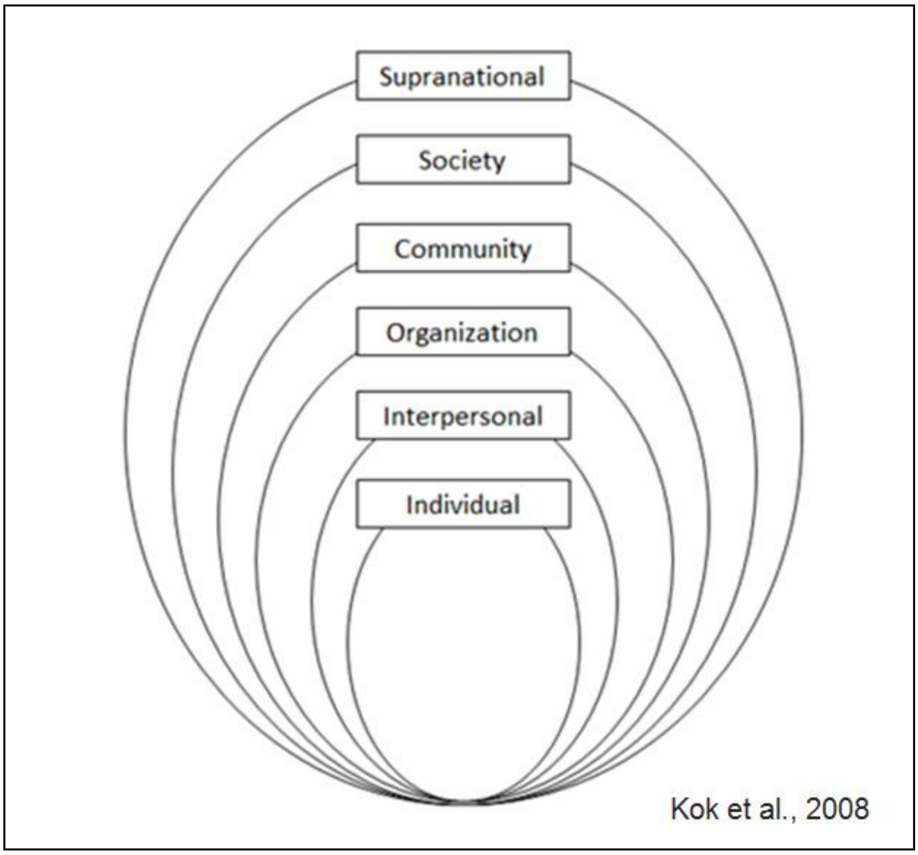
A rationale and clear definition of ecological approaches is provided by Stokols (1992/s18):"The ecological perspective suggests that multifaceted interventions that incorporate complementary environmental and behavioural components and span multiple settings and levels of analysis are more likely to be effective in promoting personal and public health than those narrower in scope."

Different adaptations of the Social Ecological Model exist. However, the most utilised version is the initial model of Bronfenbrenner developed in 1979. This divides the environment into four parts: the macro (intercultural influences), exo (community influences), meso (organisation influences) and micro-environment (interpersonal and individual influences). Bronfenbrenner (1979) highlighted that the environment is not the only factor influencing the individual but rather that the different layers in between will have an impact at subsequent levels. He also reported that all these factors are nested and each level operates within the next larger area. Both top-down effects defining how individuals' choices regarding health are shaped by the environment (McLeroy et al. 1988; Stokols et al. 1996) and bottom-up effects describing how individuals and community can affect the higher levels of the model exist.

The ecological model used in Health Promotion Programmes adapted by Kok et al. (2008) from Richard et al. (1996) (Figure 26) shows the different levels that influence health behaviours. This model gives a clearer vision of the different levels that influence health and thus adds information to the conceptual model of obesity presented above. This model underlines how individual health behaviours and decisions are shaped by the wider environment in which the individual lives and how the individual is in constant interaction with the environment (interpersonal, organisations, communities, society, and supranational systems). The interrelationships between individuals and the different environmental levels should be taken into account when implementing interventions.

The term ecology refers to the interrelationships between organisms and their environments (Oxford dictionary). The health of individuals is not only influenced by the environment but also by personal attributes (i.e. genetic, psycho-social factors, behaviours factors). Health-promoting interventions should therefore, acknowledge the interplay between environmental and personal factors rather than focusing on these factors separately. It is vitally important to consider this ecological approach when studying obesity. In order to understand obesity in a holistic way, aspects of this model and the preceding one need to be combined. Indeed, the two models are complementary as one model covers aspects that the other neglects.

Figure 26. Ecological model of health promotion

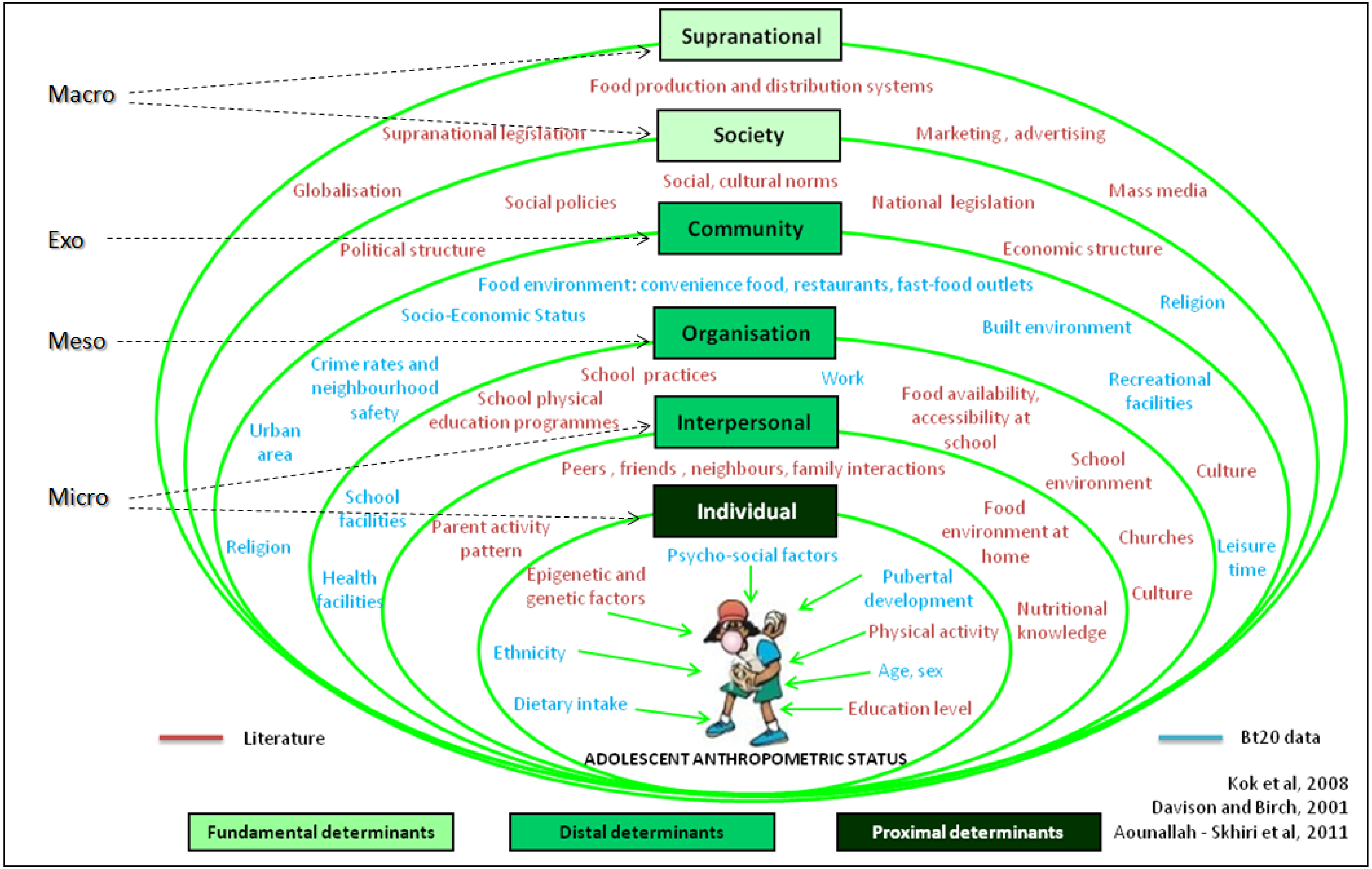


3.4.3 The ecological model applied to the study of obesity

In high income societies a number of frameworks have been developed to explain the importance of ecological influences on nutritional outcomes (Swinburn et al. 1999; Davison and Birch 2001; Kok et al. 2008; Story et al. 2008; Kraak et al. 2014). These frameworks identify the importance of proximal determinants (individual factors such as dietary intake and physical activity behaviours, age, sex, etc.), the distal determinants which include the interpersonal (peers, neighbours and family interactions, etc.), organisational (school, church, etc.) and neighbourhood (SES, built environment, culture, food environment, etc.) levels as well as the fundamental determinants which include societal (national legislation, economic and political structure, etc.) and supranational (legislation, food production and distribution systems) levels.

My thesis will employ the ecological model of obesity factors which has been adapted from the two previously discussed models (sections 3.4.1 and 3.4.2) as well as from the model developed by Davison and Birch (2001) and focuses on factors influencing adolescents' obesity at the different levels (Figure 27).

Figure 27. Ecological model of obesity



3.4.3.1 Influence of the fundamental determinants

The wider society, though more distal to the individual can greatly influence adolescents, families, peers and the community in which adolescents live with respect to dietary and physical activity patterns (Story et al. 2002). The fundamental determinants are not the focus of this study as this would make the objectives of the thesis too broad. Furthermore, the data available did not address these aspects.

3.4.3.2 Influence of the distal determinants

3.4.3.2.1 Defining a community

Families and peers do not represent the only source of influence with regards to healthy lifestyle habits such as diet, physical activity, etc. Physical and social settings in addition to infrastructures and systems of community environments (e.g. local governments, schools, religious organisations, social and civic organisations, services, etc.) can also influence dietary intake.

Communities can be defined geographically, politically, culturally and ethnically. Laws, rules, regulations and other policies as well as traditions, shared customs, rituals, perceptions and expectations exist within a community. Members of a community share historical and current experiences as well as exposures (Koplan et al. 2005). Although, the term community is difficult to define, MacQueen et al. (2001: 1929) define a community as “a group of people with diverse characteristics who are linked by social ties, share common perspectives and engage in joint action in geographical locations or settings”. According to Chaskin, *“Community implies connection”* (Chaskin 1997: 522) this includes social, functional, cultural or circumstantial connections.

Neighbourhood is defined as an area that surrounds dwellings of individuals or households. According to Chaskin, *“Neighbourhood is clearly a spatial construction denoting a geographical unit in which residents share proximity”* (Chaskin 1997: 522).

To date, the definitions for community and neighbourhood remain unclear and a difficulty in distinguishing them is often a cause of confusion. Community has a broader definition than neighbourhood as it involves both geographical and social dimensions whereas neighbourhood only has a geographical meaning (Oxford dictionary). Nevertheless, a strong agreement exists that both neighbourhoods and communities are “viable units of action” (Chaskin, 1997: 522).

The area by which a neighbourhood is defined, is theoretically supposed to influence the nutrition of those regularly exposed to that environment. Nevertheless, in reality, people may be exposed to several environments that could impact their dietary intake (Campbell et al. 2007). For instance, high school students are not only affected by their home neighbourhood but also by their school environment. The neighbourhood environment can be divided into two types: the social and the physical. The social environment includes measures of SES, neighbourhood crime and disorder (Molnar et al. 2004). The physical environment involves the natural environment such as weather, the built environment and the food environment (access to supermarkets, corner stores), land-use, access to recreational facilities, transportation and street connectivity (Jago et al. 2007b; Brownson et al. 2009).

The identification of neighbourhoods suspected to influence eating behaviours can be broken down into three steps. The first step is the acquisition of eating behaviour data on individuals. The second step involves the characterisation of neighbourhood environments including the identification of neighbourhoods, the definition of the neighbourhood boundaries, and an assessment of neighbourhood environment characteristics. The third and final step involves the examination of the relationships between the neighbourhood environment and behavioural data (Dubé et al. 2010).

Measures of neighbourhood environment characteristics are often created using Geographic Information System (GIS) (Brownson et al. 2009). GIS is a system that captures, manages, analyses, displays all forms of geographical information (ESRI 2012). For instance, GIS has been used previously to map and measure patterns in the distribution of food establishments so as to assess the relationship between the spatial distribution of these kinds of establishment and food consumption and obesity. Recently, the identification of food “deserts” with GIS has become a topic of interest (Reisig and Hobbiss 2000). GIS has been recognised as a reliable method (Brownson et al. 2009) for examining the link between food insecurity – defined as the lack of access to healthy foods - and dietary intake in deprived areas in high income countries. However, understanding food environment is difficult in LMICs as shops are transient and GIS might not be adapted in this context. GIS is one method used for defining and researching neighbourhood influences on dietary intake but other methods such as the use of postcode data, census, boundaries, participant defined neighbourhoods, and walkable neighbourhoods exist.

The use of convenient administrative boundaries to define neighbourhoods has been studied by Pickett and Pearl (2001) and Riva et al. (2007). These boundaries "do not correspond to the actual geographical distribution of the causal factors linking social environment to health" (Pickett and Pearl, 2001:112). In the past, census data and household surveys were used to define neighbourhood conditions; however these methods do not take into account the social aspects of life and physical characteristics of the community such as cleanliness and safety. The use of aggregated individual/household level variables to define community may lead to problems of ecological fallacy (Macintyre et al. 2002a). An important limitation with the use of postcode data, census, and boundaries is that resident perspective is lacking (Weiss et al. 2007).

Currently, observations are used to describe the neighbourhood regarding physical aspects (traffic volume, housing conditions, graffiti, trash, etc.) and social aspects (safety, amenities, etc.) (Schaefer-McDaniel et al. 2010).

The measure of community SES represents a challenge in urban areas in LMICs. To date, very limited tools exist to evaluate community SES. Sheppard et al. (2010) developed a questionnaire adapted to the urban South African context to measure neighbourhood SES in adolescents (Appendix I). The questionnaire includes economic, social and school environment aspects. The definition of the neighbourhood was based on adolescents' perspectives of their environment and considered both the geographical area and social networks within that specific area.

3.4.3.2.2 The link between neighbourhood SES and obesity

Many factors in the neighbourhood setting affect the health of children and youth.

- Associations between neighbourhood SES and health in general

During the past twenty years, the concern about the effects of the neighbourhood on residents' health and well-being has become a major issue (Pickett and Pearl 2001; Macintyre et al. 2002a; Riva et al. 2007). Nevertheless, at present there is no consensus on the way to evaluate the neighbourhood attributes. A study conducted by Poortinga et al. (2008) showed that the way people experience their neighbourhood and housing troubles has an impact on the association between neighbourhood deprivation and self-rated health. This finding implies that actions need to be taken both at the place and individual levels.

The non-agreement regarding the way to measure neighbourhood SES impedes comparisons across research.

- Associations between neighbourhood SES and obesity

The link between the environment and obesity has interested many researchers who work in different fields such as geography, economics, epidemiology, behavioural sciences, sociology and nutrition (Feng et al. 2010). A link between the risk of obesity and different measures of the environment was found in previous reviews of literature (Booth and Okely 2005; Papas et al. 2007; Black and Macinko 2008).

The quality of the environment plays an important role in the energy balance. A negative environment characterised by poor physical and social attributes will prevent people from practising physical activity (Frumkin 2002; Handy et al. 2002; Humpel et al. 2002; Saelens et al. 2003) and adopting a healthy diet (Haire-Joshu and Nanney 2002; Morland et al. 2002a; Rose and Richards 2004; Alter and Eny 2005; Zenk et al. 2005) and will contribute to the development of obesity.

Carter and Dubois (2010) who addressed the question of the association between physical and social environmental characteristics with child adiposity in a critical evaluation of the literature reported that neighbourhood deprivation increased child adiposity. The consequences of the built environment for obesity and overweight issues in US children and adolescents was described by Singh et al. (2007). Children living in the least favourable social conditions (unsafe area, poor housing, no access to sidewalks, parks and recreation centres) presented greater risk of overweight and obesity (odds 20-60% higher) compared to those living in a relatively favourable environment. Those most affected were adult females and younger children. Overweight and obese children and youth are likely to remain obese into adulthood (Freedman et al. 2005; Singh et al. 2008). Burdette and Needham (2012) found that this tracking also applies to neighbourhoods and that neighbourhood features during adolescence impact on BMI in adulthood.

3.4.3.2.3 The link between neighbourhood SES and the determinants of obesity

Recently, the potential effect of the contextual environment on obesity and its determinants has been outlined by various reviews (Davison and Birch 2001; Davison and Lawson 2006; Glanz and Sallis 2006).

Health related behaviours cannot only be explained by individual influences but also by contextual determinants (Dunn and Cummins 2007; Sallis et al. 2008). Characteristics of communities or neighbourhoods are theoretically thought to influence obesity through their influence on eating practices as well as physical activity (Wells et al. 2007).

- The link between food environment and obesity

Food environment in the community is an important element in the causal chain of obesity (Kaufman and Karpati 2007).

Food access and food availability are two parameters that determine food purchases within the family and are responsible for inhabitants ‘dietary intake and health in general (Morland et al. 2002a). Cerin et al. (2011) analysed the impact of accessibility, availability, price and quality of food choices on weight status and “utilitarian walking” in an urban neighbourhood. Greater availability and accessibility of healthy products was associated with reduced risk of overweight and obesity. Similar results were described by Burgoine et al. (2011) in the north east of England. Better environments (walkability, food availability) were negatively correlated with BMI and positively associated with fruit and vegetable consumption. Inversely, inhabitants living in a disadvantaged community had higher BMI and did not adopt a healthy diet. This can be partially explained by the lack of quality foods available (grocery stores and supermarkets) in the area and the increased access to unhealthy food stores (Inagami et al. 2006; Galvez et al. 2009).

A large number of studies reported a significant association between fast food restaurants and youth body composition (Davis and Carpenter 2009; Galvez et al. 2009). However, few studies evaluated the association between food environment in the community and children’s and adolescents’ body size. Galvez et al. (2009) and Leung et al. (2011) pointed out that the availability of convenience stores in the neighbourhood was positively correlated with a higher BMI percentile.

It should be noted that all of these studies were cross sectional, thus not allowing any description of the impact of food stores on BMI over time. Moreover, causality cannot be determined.

An additional consideration for adolescents is that they may be more influenced by the community (peers and school) than children, as more time is spent in the community. On the other hand, children are more influenced by parental and household behaviours regarding dietary intake (Von Post-Skagegård et al. 2002). Thus, adolescence is characterised by increasing independence and is potentially a critical period conducive to the development of overweight and obesity.

- The link between food environment and dietary intake

The link between patterns of food availability and food consumption has been of great interest in numerous recent studies (Jeffery et al. 2006; Jago et al. 2007a; Jago et al. 2007b). In order to measure neighbourhood influences on food consumption, neighbourhood food environments have to be defined. Food environments can be defined to include physical environments and related access to certain types of grocery or eating establishment such as supermarkets, corner stores and fast-food outlets. This definition also includes social and consumer characteristics (Glanz and Sallis 2006; Gittelsohn and Sharma 2009). In light of this, supermarkets are used as a proxy for healthy eating practices while fast-food outlets are used as a proxy for a poor/unhealthy diet.

Timperio et al. (2008a) found several associations between the proximity of food outlets and the fruit and vegetable intake of children. As the number of fast-food restaurants and convenience stores close to the home increased, the likelihood of consuming fruit more than twice a day decreased. A similar relationship was observed for vegetables. However, some studies yielded discordant results; Jago et al. (2007b) found the distance to fast-food restaurants and small food stores to be associated with the consumption of fruit and vegetables by male adolescents. However, accessibility to other food establishments did not explain food consumption. A greater availability of fruit juice and vegetables in local restaurants seemed to be linked to a higher intake of these products among African-American adolescents (Edmonds et al. 2001).

A growing body of evidence indicates that people living in deprived areas do not only experience difficulties in accessing healthy food but that they are also surrounded by fast-food outlets. Alwitt and Donley (1997) reported fewer large grocery stores/supermarkets in low SES neighbourhoods. Instead, these deprived neighbourhoods had more small grocery stores. Morland et al. (2002b) as well as Moore and Diez Roux (2006), reported that the wealthiest neighbourhoods presented between two and four times as many supermarkets relative to the poorer neighbourhoods which had four times as many grocery stores and convenience stores. Convenience stores stock largely ready-made and packaged products (higher in calories, fat, and sugar) which are usually of poor nutritional quality (Sloane et al. 2003). These kinds of stores do not sell healthy products such as whole-grain products, low-fat dairy and low-fat meat (Jetter and Cassady 2006). Zenk et al. (2005) have also shown that access is not only related to neighbourhoods' income but also to the population group of the inhabitants. African-American neighbourhoods are at the highest risk of supermarket unavailability. This suggests the existence of economic and racial inequality with regards to access to healthy products in food stores in the US.

The food environment at schools is another important issue. The school environment of low income neighbourhoods contains more fast-food restaurants and convenience stores (Zenk and Powell 2008). Fast-food consumption among children is positively associated with a diet rich in fat and a higher BMI and negatively associated with vegetable consumption and physical activity (Jeffery et al. 2006).

Availability, accessibility – both financial or physical - and quality of food products have been identified as key factors strongly affecting the dietary intake process in high income countries. Consistent evidence from the USA suggests that local food environments vary according to the ethnic and economic composition of the community (Beaulac et al. 2009). Moreover, the types of item present in food stores depend on the social context (Jetter and Cassady 2006). Deprived areas are associated with obesogenic social and environmental conditions and thus positively associated with obesity. Evidence in high income countries suggests that socio-economically deprived individuals are at a greater risk of being overweight or obese (Sobal and Stunkard 1989; McLaren 2007; Wang and Lim 2012) and that this may be driven by their physical environment. For instance, individuals living in an environment located far from shops providing affordable fruit, vegetables and low-energy density foods are affordable and available, may be at higher risk of obesity.

The availability of healthy food products is not the only factor to be taken into account in order to address the problem of obesity, as other factors impact upon food choices such as income, education, the consumer's knowledge and understanding of health and nutrition issues, expected value of food purchases, diet, etc. Though healthy products are available in their environment, people may prefer processed foods for various reasons. Economic factors impact decisions regarding food (Cawley 2004; Hill et al. 2004). Low-income groups highlighted lack of availability and relatively high costs as barriers to adopting a healthy diet (Reicks et al. 1994). Drewnowski and Specter (2004) demonstrated that, diets high in fats, refined carbohydrates and salts represent a lower-cost option than healthy diets. An experiment conducted in high-school cafeterias which halved the price of healthy food, contributed to a four-fold increase in fruit purchases and a two-fold increase in carrot purchases (French et al. 1997; French 2003). Adopting a healthful diet is not only constrained by financial circumstances but also by a lack of time. Fast-food restaurants offer quick, cheap and easy meals. Inexpensive, tasteful and healthy alternatives need to be made available to all people regardless of their income or education level in order to tackle the obesity epidemic.

A qualitative study on the cultural attitudes of overweight African American adolescents towards diet, found that food choices favoured texture, taste, appearance and context (family and peers) over nutritional value (Boyington et al. 2008). Reports suggested that healthy food did not satisfy hunger and that the school provided insufficient support to make the right decisions regarding a balanced diet. Moreover, culture appeared to be a key factor influencing dietary choices as adopting such a diet would mean abandoning their own food culture (Boyington et al. 2008). Monge-Rojas et al. (2005) identified barriers and facilitators to the adoption of a healthy diet among rural and urban Costa-Rican adolescents. Unavailability of healthy food options in the school environment, poor diet within the family and pressure by the peer group (especially for males) emerged as the main factors driving dietary intake. Indeed, males who felt the need to eat in a healthy way were perceived effeminate by the peer group as preoccupations regarding a balanced diet were perceived to be female characteristics. Other factors mentioned were price, food taste, time, media, and habits (Neumark-Sztainer et al. 1999; Neumark-Sztainer et al. 2003; Monge-Rojas et al. 2005). The adolescents felt that a higher nutritional quality of foods available in the school and in their families, in addition to more favourable social norms within their peer group, could equip them to make healthy food choices.

There is a need to conduct additional research regarding neighbourhood influences on dietary intake in children and adolescents due to numerous methodological limitations. Most of the studies of neighbourhood environment influences are cross-sectional and allow the identification of associations between variables. Longitudinal data is now needed to enable causal inferences can be made with longitudinal studies. Another limitation highlighted is the difficulty in defining neighbourhoods. Indeed, children and adolescents may be exposed to different neighbourhood environments during their day and the specification of neighbourhood may be representative of reality leading neighbourhood effects to be underestimated (Cummins and Macintyre 2006). The comparability of studies is limited due to the flexibility of GIS software and the lack of consistency in the selection of covariates for the models of many studies (Bodea et al. 2008). Despite all these limitations, strong evidence exists to affirm that features of neighbourhood environments may impact food consumption. All the current evidence presented comes from high income settings and a gap in research exists with respect to these associations in LMICs.

3.4.3.2.4 The link between neighbourhood SES and physical activity

- The link between physical activity facilities and obesity

A review by Ding et al. (2011) reported "walkability, traffic speed/volume, access/proximity to recreation facilities, land use mix and residential density" to be linked with physical activity among children. Among youth the key factors were "land use mix and residential density". This shows that accessibility of facilities is not the only element to consider when attempting to improve physical activity levels.

Increasing urbanization and a growing preference towards car for individual transportation has changed modern life. Urbanisation has left fewer playgrounds and other places to play outside the home available for children. Moreover, the space is perceived as being unsafe due to traffic on main roads, crime and highways. In some urban areas, lack of safety is probably a justified concern whereas in others, there may be perceptions that outdoor areas are unsafe that may not be substantiated by actual statistics. Other factors like modern technology are responsible for a more sedentary lifestyle. "Past time activities of children have become increasingly more passive and physically undemanding" (Lob-Corzillius, 2007: p587).

Physical activity is influenced by the built environment. Davison and Lawson (2006) found that an association between the community features (access or availability of facilities for physical activity such as parks and public open spaces) and physical activity exists. Parks and public open spaces allow children and youth to engage in various sports (Bedimo-Rung et al. 2005) and to increase their level of physical activity (Epstein et al. 2006). An inverse correlation was reported by Timperio et al. (2004) between the number of parks and walking and cycling in girls aged 10-12 years. Though the existence and number of parks appear to be important factors in determining physical activity in children and youth (Trilk et al. 2011), evidence is missing regarding the park features that contribute to the increase of physical activity (Bedimo-Rung et al. 2005). However, few studies have evaluated the link between characteristics of parks, public open spaces and engagement in physical activity. The important characteristics of parks for physical activity tend not to be the same among children and adolescents (Timperio et al. 2008b). Further investigation is needed to confirm associations.

Another important determinant of physical activity is the neighbourhood walkability (based on land use mix, retail density, street connectivity and residential density). According to Kligerman et al. (2007) neighbourhood walkability and the recreation environment are positively associated with physical activity. Most studies on the relationship between environment and physical activity are centred on adults with very little research involving young people. However, research studying the link between environmental features and sports among youth is increasing. Inhabitant's perceptions of their neighbourhood can also influence their engagement in physical activity (Carver et al. 2008a; Stronegger et al. 2010). Stronegger et al. (2010) found a positive perception of the social environment to be linked with higher levels of leisure time physical activity and physical activity for transportation.

The safety and comfort of the neighbourhood is also important (Carver et al. 2008c; Carver et al. 2008b; Franzini et al. 2010). Franzini et al. (2010) reported that poor and non-White neighbourhoods (US) could not engage in outdoor physical activity due to a lack of safety. Carver et al. (2008c) suggested that insecurity in the neighbourhood restrained children's physical activity. Moreover, parents concerned by their children's safety will make decisions that may limit opportunities for physical activity.

3.4.3.3 Influence of the proximal determinants

The proximal determinants (age, gender, pubertal development, ethnicity, household SES, caregiver education, etc.) have been well defined in the literature as predictors of obesity (McLaren 2007; Case and Menendez 2009; Wang and Lim 2012; Cohen et al. 2013).

3.5 Interventions to tackle obesity in children and adolescents at the neighbourhood level

In the last few years, growing interest in the field of obesity prevention has emerged with interventions targeting environmental conditions. For instance, consumption of healthy foods has been encouraged and sedentary behaviours discouraged (Lobstein et al. 2004).

The need for community involvement in efforts to prevent obesity and promote healthy eating behaviours has been identified (Koplan et al. 2005). The community can influence proximal and distal determinants giving it a pivotal role in shaping diet and weight control behaviours (Kumanyika 2002). Indeed, in the ecological model of health behaviours the community is positioned as the unit that filters between the macro and the micro-environment, mediating the various outcomes.
However, communities are at different stages in terms of readiness and this is known to be a fundamental determinant for the success of implemented interventions (Edwards et al. 2000). Therefore, interventions that aim to incorporate the community must make an initial assessment of its readiness.

3.5.1 Church-based programmes

Increasingly, Churches are recognised as being popular settings for implementing health promotion programmes (Ammerman et al. 2003; Corbie-Smith et al. 2003; Campbell et al. 2007; Baruth et al. 2008). The unique role of the Church as a cultural institution relies on its ability to reach individuals, families and people of all ages (Kumanyika 2010). Therefore, Church seems to be an interesting avenue for intervention. A review by DeHaven et al. (2004) on studies published between 1999 and 2000 identified 53 church-based health promotion programmes implemented in the USA. The focus of the programmes was mainly on health issues such as CVDs, cancer, smoking cessation, nutrition (fruit and vegetable intake) and weight control. Religious organisations offer social, organisational, and religious as well as health services (Baruth et al. 2008). The key role is played by the pastor who is considered “the guiding force” especially in African American churches (Demark-Wahnefried et al. 2000). The pastor has a pivotal role in the community and acts as a role model. The efficacy of an intervention conducted through the Church is influenced by church size, age of the church, existence of health activities in the church, the pastor’s characteristics and the pastors’ attitudes towards dietary behaviours and weight loss activities (Corbie-Smith et al. 2003).

3.5.2 School-based programmes

School based-programs for obesity prevention in children and adolescents are better implemented and more efficient in countries where school is compulsory and most of the children are in the education system (Lobstein et al. 2004). These programs are feasible, cost-effective and can cover large areas. However, the burden for the school personnel is considered an important disadvantage.

In SA, the environment at school seems to be hostile and unfavourable for the implementation of school-based programmes. Indeed, the abolition of apartheid led certainly to a decrease in political violence but was replaced with community and interpersonal violence (Barbarin and Richter 2001b). Children in post-apartheid South Africa were exposed to extreme violence and psychosocial distress (Lockhat and Van Niekerk 2000). Indeed, school is one of the institutions where children and adolescents were susceptible to face structural, psychological as well as physical violence such as corporal punishment (Burnett 1998). Safety, acceptance, and pride at school are three elements essential for school connectedness (McNeely et al. 2002; Brookmeyer et al. 2006). The school climate is a key element that determines school absenteeism. Class and school size are inversely related to school climate (Brookmeyer et al. 2006).

Preliminary analysis on the neighbourhood SES data on 501 adolescents aged 16 years old from the 1990 born Johannesburg-Soweto Birth to Twenty cohort showed that different forms of problems exist in school (35.5% of overcrowding; 52.3% of bullying/teasing; 62.5% of absenteeism; 45% of violence; 6.6% of rape; 12.4% of sexual relationships between teachers and learners) (unpublished data).

The burden of large numbers of children in classes, violence, mistrust between teachers and learners, high prevalence of non-enrolment in schools, and absenteeism in South Africa schools implies that school might not be the best avenue for intervention in this specific context.

3.6 Summary

This literature review has mainly examined the influence of the neighbourhood SES environment on dietary intake, overweight and obesity in children and adolescents in LMICs and developed countries but has also considered possible obesity prevention intervention strategies.

To date, there is a lack of research into the effects of contextual factors and especially the effects of neighbourhood on obesity in children and adolescents in urban areas of LMICs, including South Africa. Little is also currently known about the mechanisms and pathways through which community influences would be associated with obesity. There is a need for research to fill this gap in knowledge and facilitate the identification of pathways for intervention.

The ecological context has to be taken into account in order to address childhood obesity. The community acts as the interface between society and the individual and acts as a filter. It is important to integrate the community level in order to develop sustainable and effective strategies (Lob-Corzilius 2007) which will allow people to have access to a healthy lifestyle and make better decisions regarding nutrition and physical activity. An individual's choices are therefore determined by the environment in which they live. Moreover, children and adolescents have less control over their behaviours than adults yet spend more time in their community. The community is therefore a very important and influential factor at this stage of life. It is also extremely important to recognise the contribution of household and neighbourhood SES to childhood obesity so as to allow policy makers to implement appropriate interventions. Such interventions might require participation of public-sector and private-sector stakeholders. Interventions in the field of neighbourhood environments present serious challenges. So far, interventions targeting only neighbourhood influences on dietary intake and obesity have had limited effects. These interventions however, may impact a larger number of people compared to interventions at the individual level. In light of these results, initiatives concerning health promotion should involve the individual as well as the wider environment to which they are exposed (Giles-Corti and Donovan 2002; Giles-Corti 2006).

The review of this literature has led to the formulation of the research objectives presented below.

Chapter 4: Methods

4. Methods

This chapter is divided into three main parts. The first part introduces the data source for the quantitative analysis (Birth to Twenty Plus cohort (Bt20+)). The unique nature of the cohort study will also be discussed in this section. Following that, the work undertaken during the fieldwork will be described. Finally, the quantitative and qualitative research methods will be presented.

The fieldwork description section is split into two main paragraphs. The work carried out for the quantitative data processing and analysis will be presented first followed by the work completed for the qualitative data collection and analysis.

The quantitative research methods section starts with a description of the aims and specific objectives and is followed with information about the sample, measures and statistical analysis. The data cleaning and data management are also discussed in this section.

The qualitative research methods section describes first the rationale for using focus group (FG) interviews combined with the Community Readiness Model (CRM) survey. The interview organisation (administration of the survey and FG), recruitment and data analysis are then presented.

4.1 The Birth to Twenty Plus Cohort Study

Bt20+ (originally Birth to Ten and then Birth to Twenty) is a multidisciplinary longitudinal cohort study (n=3273) of births occurring over a seven week period between April 23rd and June 8th 1990 to mothers who were permanent residents in Johannesburg-Soweto (Richter et al. 2007). The overall aim of the cohort study was to “determine the biological, environmental, economic and psychosocial factors associated with the survival, health, well-being, growth and development of children living in an urban environment” (Yach et al. 1991, p212). Bt20+ is the largest and longest running cohort study of child health and development in Africa and its longitudinal design brings a unique opportunity to analyse the changing role of SES on health in childhood and adolescence (Richter et al. 2007).

At that time, health facilities in the area of Johannesburg and Soweto were divided by residential area and thus by population group (Yach et al. 1990). The sampling process for Bt20 enrolment was not divided by population group as the aim of the study was to adopt a “unified metropolitan approach” to recruit singleton births that occurred in public delivery centres from all population groups (Black African, Mixed Ancestry, Indian/Asian and White) in all suburbs (Yach et al. 1991). At the time the cohort was set up, all delivery centres were required to report new live births to the relevant governmental department. It was therefore possible to use birth notification forms to obtain birth information for the Bt20 study. Non-resident births were excluded from the cohort. Only mother and infant pairs still living in the area six weeks postpartum were considered as residents and therefore included in the cohort study (Yach et al. 1991).

As private health facilities were excluded from the Bt20 enrolment, differences exist between the Bt20 cohort and the general population of births. White participants were recruited from public antenatal facilities and therefore represent a less wealthy population of White mothers. The wealthier White mothers, who generally attended private health care facilities, are therefore under-represented in this sample (Richter et al. 2007). In addition, fewer of the births enrolled in the cohort occurred in suburban Johannesburg and inner city health service facilities which led to White and Indian/Asian groups being under-represented in this cohort study (Richter et al. 2004). The attrition rate in this study was estimated to be around 30% when participants were aged 16 years old (Richter et al. 2007).

To date, data have been collected from Bt20 participants at 24 time points through questionnaires (self-completed and interviewer administered), physical examinations and routine blood screening. The main themes of data collection comprise growth, pubertal development, anthropometric status, dietary intake, risk behaviours, household and neighbourhood SES, educational achievements and cognitive ability, physical activity and health.

4.2 Fieldwork description

4.2.1 Quantitative data

The three main objectives of the fieldwork in Johannesburg (September 2012-February 2013) were to code, clean and check quantitative data. These objectives were to:

- *Quantify dietary intakes from FFQs of adolescents*; Every item consumed within a 7 day recall period was manually coded on the paper questionnaire and then the coded data were entered into a software package (FoodFinder) in order to calculate the total energy, and percent energy from fat, protein, carbohydrates and processed sugars. Quality checks were undertaken in order to make sure that the data were correctly coded and entered in the database.

This work was challenging as the coding and capturing process were both repetitive and time-consuming. We managed to code and enter 656 FFQs out of the 1700 FFQs planned initially. Needing to reduce the sample size taught me to be flexible in my approach to the research and enabled me to think about sample size calculations (see section 4.3.3) to drive the number of questionnaires needed to complete the work for my PhD. Other challenges included the number of staff who could be involved, software problems, and network failure or power cuts which further slowed down the process. However, being in charge of the dietary data coding and entering process gave me a better understanding of the data and also of the limitations and benefits of using that tool in this population and context. I was involved in training staff and carrying out quality controls of a team of people coding the questionnaires.

- *Collate and clean neighbourhood SES data* (n=2000); The cleaning process involved a 10% random sample check to identify potential problems with the data entered and required the paper questionnaires to be pulled out in order to re-enter completely one section of the questionnaire. Cleaning checks of other variables were also undertaken and missing questionnaires entered in the database. This was undertaken so that these data could be matched to the height, weight and percent body fat of adolescents, along with the dietary intake data.

- *Collate and clean household SES data* (n=2000); The cleaning of the household SES data involved pulling out the paper questionnaires as two questions needed to be re-entered. Only half of the household SES data was cleaned during my fieldwork. Recommendations were given to the local team so as to finish the data cleaning. However, due to logistical issues and lack of resources, the task was not undertaken and I therefore decided to use the cleaned household SES data available at 16 years of age instead of 18 years of age. It is likely that the household SES measures at 16 years of age are better measures to use to answer the research questions of this thesis as the population has been exposed to this environment before the outcome being studied is observed.

Both the cleaning of the household and neighbourhood SES data were repetitive and time-consuming but this work was essential in order to improve the quality of the data and be able to rely on the data. This process helped me to realise the importance of training people to enter data as this is a key phase of the research process.

4.2.2 Qualitative data

I was responsible for designing the qualitative study, piloting it and collecting the data. The objective of the qualitative fieldwork was to:

- *Conduct six focus group discussions* (FGDs) with religious leaders (pastor, bishop, teachers, elders, etc.). FGDs were conducted in six different Christian religious organisations with up to ten key religious leaders. A survey was also administered at the beginning of each of these sessions and before the FG started. The CRM survey was chosen to collect personal beliefs about obesity prevention among adolescents in religious institutions but also to determine the stage of readiness of this particular community regarding the obesity issue. The survey was used in combination with focus groups discussions to capture group beliefs and gain insight into factors that influence opinions, behaviours or motivation relating to diet and physical activity.

Prior to starting the qualitative work, an ethics application was submitted to Loughborough University and to the University of Witwatersrand, and approved. Following this, the survey and FGDs were piloted. The survey and FGDs were conducted by me with help from a local research assistant, who facilitated communication and translation where necessary. The FGDs were recorded and then transcribed by a local transcriber. Coding of transcripts was undertaken after returning from fieldwork.

This qualitative work was challenging but working with participants was essential to my understanding of the context and thus for interpreting the findings of my analyses. I had to face some logistical issues (difficulty in gathering a high number of religious leaders at the same time, finding a suitable room for the FGDs, obtaining good quality recordings, car breakdowns, research assistant unavailable, etc.) but I developed my skills in organisation, resilience and adaptability. I have also gained some qualitative experience in conducting and analysing FGDs.

4.3 Quantitative research

4.3.1 Aim of quantitative research

The aim of the quantitative research was to evaluate the associations between neighbourhood and household SES, dietary intake and anthropometric status in urban South African adolescents.

4.3.2 Objectives of quantitative research

The specific objectives of the quantitative research were to:

1. Examine adolescents' perceptions of their socio-economic and school neighbourhood environments;
2. Investigate dietary patterns;
3. Investigate the relationship between neighbourhood and household SES and dietary intake (e.g. energy intake, protein, fat, carbohydrates, and added sugar intakes);
4. Investigate the relationship between neighbourhood and household SES and anthropometric status.

4.3.3 Sample

This research focuses on a secondary analysis of data collected in the 17-19 year data collection waves from the Johannesburg-Soweto born Bt20 cohort.

Data on approximately 2000 adolescents were available for the main analysis (neighbourhood SES, household SES, and anthropometric measures). A small effect size was observed between SES and anthropometric outcomes in various studies (Morgenstern et al. 2009; Zhang and Wang 2012; Griffiths et al. 2013). To calculate the sample size required to test the thesis hypotheses, it was assumed that $z\alpha=1.96$ (95% confidence), $z\beta=0.84$ (power=80%) and that the effect size is small a linear regression analysis with eight predictor variables and BMI as the outcome would require 757 participants (Cohen 1992). This suggests that this sample is more than adequately powered to include the required number of explanatory variables (i.e. population group, sex, pubertal development, smoking status, birthweight, neighbourhood SES variables, household SES wealth index, caregiver education) with 2000 adolescents.

Data on 656 adolescents were available for the sub-analysis which focuses on the diet outcome (neighbourhood SES, household SES data, and dietary data). Diez-Roux et al. (1999) reported a small effect size between SES and dietary intake. To calculate the sample size required to test the thesis hypotheses, it was assumed that $z\alpha=1.96$ (95% confidence), $z\beta=0.84$ (power=80%) and that the effect size is small. A linear regression analysis with five predictor variables (population group, sex, neighbourhood SES variables, household SES wealth index, education) and dietary intake (% protein, carbohydrates, fat, z-scores of energy intake) as the outcome would require a sample size of 645 (Cohen 1992).

4.3.4 Measures

4.3.4.1 Anthropometric and body composition

Anthropometric data were collected following standard procedures (Cameron 1984) by trained investigators. Weight was measured to the nearest 0.1kg using digital electronic scales (Dismed, USA). The participant was asked to stand on the scales, ensuring both feet were completely on the base unit, and to look straight ahead. Height was measured using a Holtain wall-mounted stadiometer (Holtain Ltd., UK) graduated to the nearest 0.1 cm in the Frankfurt horizontal plane. The participants removed their shoes and wore light clothing for both measurements. These measurements were used to calculate the BMI (weight (kg)/height (m) ^{2}).

Waist circumference, taken approximately half-way between the iliac crest and the lowest rib, was measured using a non-stretchable measuring tape to the nearest 1 cm. DXA scans were performed according to standard procedures using a Hologic QDR 4500A dual-energy X-ray absorptiometer (software version 12.5:7, Hologic Inc., Bedford, MA, USA) by a trained technician. Whole body fat (kg), lean mass (kg) as well as percent fat mass and lean mass were calculated.

4.3.4.2 Pubertal development

The pubertal stage of development was assessed using a self-completed questionnaire which uses the Tanner scaling of pubic hair and breast/genitalia development (Tanner 1962). Norris and Richter (2005) validated this tool in black South African adolescents. Females were also asked to specify whether or not they had achieved menarche and if so, the date was recorded.

4.3.4.3 Socio-economic status

4.3.4.3.1 Neighbourhood SES measures

At 18 years, neighbourhood SES was assessed using a novel questionnaire adapted to the urban South African context. In this study, neighbourhood was defined for each individual as an area that is approximately 2 km from the participant's house in every direction. This radius was chosen as it is the distance from the residence that can be walked in approximately 20 minutes (Sheppard et al. 2010). This definition was reached based on qualitative work (FGDs and in-depth interviews) conducted with the cohort when they were aged 15 years (Sheppard et al. 2010). Through the qualitative research, adolescents were asked to participate in a mapping exercise where they had to draw what they perceived as part of their neighbourhoods. Adolescents' expressed that their neighbourhood environment included both the geographical area and social networks within that specific area. Although this thesis used a seemingly geographical definition of neighbourhood, the study also aimed to assess perceptions of their place of residence as a community.

The questionnaire included questions about economic aspects (wealth, living standards, housing type, housing condition, services, facilities, type of roads, neighbourhood problems, etc.); social aspects (safety, crime, most common type of crime, security measures to ensure safety, social networks, community spirit, peer pressure, liveliness, noise, trust, happiness, type of activities, etc.) and school environment aspects (type of school attended, number of learners per class, safety, facilities, problems experienced at school, after-hours activities, etc.) of the neighbourhoods (Appendix I).

4.3.4.3.2 Household SES measures

Caregivers were asked to assess household SES using a questionnaire about education (including maternal, paternal or caregiver), private medical insurance coverage, home ownership, housing type, water/toilet facilities, marital status and consumer durable ownership when adolescents were aged 16 years old (Appendix II). The level of education was assessed according to the number of years completed at primary, secondary or tertiary level.

4.3.4.4 Dietary data

The dietary assessment tool used in this thesis was a 7 day quantitative FFQ developed specifically for the context of South Africa (Appendix III). This tool has not been validated yet, though it has been used extensively in both urban and rural areas, in different population groups. Data were collected by trained interviewers. The questionnaire took on average 40 minutes to complete and included a total of 214 commonly eaten foods.

These food items were derived from analyses of 11 dietary surveys conducted in rural and urban South Africa since 1983, and the list includes all foods eaten by at least 3% of the population (Nel and Steyn 2002; Whati et al. 2005). The FFQ was piloted on adolescents from the Bt20 cohort at 15 years (Zingoni et al. 2009) and amended accordingly. Changes were made to the content (e.g. insertion of food codes and insertion of prompts), structure and flow (e.g. order of food items in the questionnaire), and length of the questionnaire. In addition, the way frequency questions were asked was modified and it was also advised to involve caregivers in the interview process to get more accurate information on cooking methods, brand and type of foods consumed at home.

The FFQ used food flash cards (high quality photographs) of the food items (Steyn et al. 2005). Participants were asked to separate the food flash cards into a series of piles: firstly, they went through each food card and created a pile of food items they ‘rarely/never’ ate or drank. Secondly, they went through the remaining food cards and created a pile of food items they eat/drink less frequently (‘occasional’), and a pile they eat regularly and in the past seven days. The participant was then asked to give information on the frequency and amounts of the food items consumed in the past seven days. The information was recorded on the paper questionnaire.

Portion sizes were estimated using household measures and a combination of two-dimensional life-size drawings of foods and utensils, and three-dimensional food models (Figure 28) (Steyn et al. 2005; Steyn et al. 2006).

The coding process involved the conversion of the household measures (for example one cup/one serving spoon/one slice) into grams so that an average intake over the previous seven days could be calculated (Figure 29). The total seven day intake was then divided by seven to obtain an average daily intake. This was done manually on the paper questionnaires (Figure 30). Different materials were used to facilitate the coding process. The materials included a food portion manual developed by the South African Medical Research Council

(MRC); a dietary assessment education kit; the South African food composition table and an assumption document developed by the senior nutritionist (Appendix IV). The good functioning and accuracy of the coding process were dependent upon the quality of the information collected on paper questionnaires. For example, if the household measure written down in column D of the questionnaire (Figure 30) was either missing, incomplete (i.e. one slice of brown bread but no mention of the size of the slice) or misleading (i.e. three yoghurts reported in column D then three times a day reported in column E, in this case a decision has to be made on whether one yoghurt has been consumed three times or three yoghurts three times in a day), the person in charge of the coding had to make a decision and try to be consistent across all the questionnaires if the same problems were seen. The within coder consistency was crucial but it was important to communicate decisions that were made with other coders to ensure between coder consistency. Indeed, at the end of each coding day, the persons in charge of the coding reported any problems encountered and decisions made to the senior nutritionist who then updated and shared the coding instructions sheet with the members of the team. Quality checks were also undertaken to ensure between coder consistency. Another key point is that the guide used to convert household measures into grams did not always include all the food items and thus approximate estimations were made.

Nutrient composition was estimated using FoodFinder3, a nutrient analysis software program based on the South African MRC food composition tables (Langenhoven et al. 1991). The software allowed the extraction of two different outputs on Excel.

The first output included the mean of energy intake and a detailed list of macronutrients for each participant (i.e. total protein (plant protein, animal protein); total fat (saturated fat, mono-unsaturated fat, poly-unsaturated fat, total trans fatty acids, cholesterol); total carbohydrates (starch, sugar, added sugar); alcohol; fibres (insoluble and soluble)).

The second output included the list of each food item consumed (item code, label of the food item, food group to which the food item belongs to) and the quantity (g/day) for each participant.

Figure 28. FFQ data collection (tools used for the estimation of quantities)

Figure 29. FFQ questionnaire with conversions of estimated portion sizes to weights

TEA, COFFEE — DAIRY 1

FOOD ITEM AND CODE	FOOD ITEM AND CODE
4038 tea, regular	4037coffee, brewed, instant
4053 tea, herb	4005 sugar, brown
4054 tea, rooibos	3989 sugar, white
	Milk added, see Dairy 2

PORTION SIZES AND WEIGHTS

Cups and mugs (see generic sketches)

Food Item	½ tea cup	Full tea cup	½ mug	Full mug
Tea and coffee	90g	180g	125g	250g

Glasses (see generic sketches)

Food Item	½ big glass	¾ big glass	Full big glass	½ small glass	Full small glass
Tea and coffee	125g	190g	250g	62.5	125

Spoons (see generic sketches)

Food Item	Level teaspoon	Heaped teaspoon	Level table spoon	Heaped table spoon	Level serving spoon	Heaped serving spoon
Sugar, any	4g	6g	15g	25g		

Other portion sizes (sketch and weight)

Points to remember
* Ask if sugar was added
* Ask if spoon with sugar was heaped
* Ask if milk was added

• Ask whether cup or mug was used
• Use sketches of cup or mug

Figure 30. FFQ questionnaires (columns A-H) with manual coding (last columns)

Generic Sketch (look up)	A. Food items (with FPM numbers)	B. Description of food item	Tick for yes	C. Item code	D. Amount usually eaten(g) Generic/amount = g	E. Eaten every day	F. Eaten every week	G. Eaten Occasionally	H. Never eaten
						Times/ day	Times/ week		
	DAIRY-BLUE								
	1.Tea	Ordinary	✓	4038	mug	3/4	1	187,5/7	26,8
		Herbal		4053					
		Rooibos		4054					
	1. Sugar in tea		✓	3989	tsp heaped.	3	1		2,6
	2. Milk in tea No.	Full cream							
		Low fat 2%							
		Skim fat free							
		Other							
	1. Coffee		✓	4037	mug	3/4	1		26,8
	2. Milk in coffee	Full cream							
		Low fat 2%	✓	2772	mug ful	1	2		71,4
		Skim fat free							
		Other							
	2. Sugar in coffee		✓	3989	tsp heap	3	1		2,6
	2. Milk as a drink	Full cream							
		Low fat 2%							
		Skim fat free							
	3. Buttermilk/maas	Buttermilk		2713					
		Maas		2787				✓	
	4. Milk drinks, flavoured							✓	
X	5. Yoghurt	Flavoured						✓	
		Plain							
	1. Sugar (extra)								

4.3.4.5 Smoking data

The smoking status of adolescents was assessed using a self-reported questionnaire. Participants were asked whether or not they smoked and if so, the number of cigarettes and frequency of consumption were also recorded.

4.3.4.6 Physiological data

Data on sex, age and population group were collected. Population group was identified by the mother as Black African, White, "Coloured" or Indian (terms used in the Bt20+ questionnaire) around the time of birth. The term 'Mixed Ancestry' is used to describe the "Coloured" group in this thesis.

4.3.4.7 Residential data

Data on place of residence (e.g. addresses, suburbs) were collected for each participant.

4.3.5 Data cleaning procedures

The cleaning process for the dietary and socio-economic data was undertaken during fieldwork in Johannesburg as access to the original paper data collection files was required. All other data used for the quantitative analysis had been cleaned by the South African team previously.

4.3.5.1 Dietary data

Quality control checks for dietary data coding and entering were undertaken frequently in order to make sure that the data were correctly coded (appropriate code for the food item consumed, correct estimation of the portion size, correct estimation of the amount consumed per day) and entered in the database (missing values, spurious data).

The quality checks of the coded questionnaires involved ensuring that the estimations made were as accurate as possible, that no coding was omitted and that calculations made by hand were correct. This was done by the senior nutritionist and the coders for every single questionnaire. Feedback and training had to be given frequently to the coders to avoid reiterating the same mistakes. Once the questionnaires were checked and amended, they were given to the person in charge of the data entry (different persons to the ones who collected or coded the data).

The quality control checks of data entered into the software was also carried out by a person who had not been involved in data entry. The first strategy entailed checking the paper questionnaires with the data entry recorded for each participant. This approach was far too time consuming and given the lack of time, computer equipped with the software and staff, the checking process was reconsidered. The second strategy involved running a 10% random sample check. A one percent error limit was set. Based on the results of repeated 10% random sample checks, a decision was made to check again every single questionnaire as the error rate was high (25-50%) and this was consistent for the two people in charge of data entry. The checking process was amended and cleaning was done by running frequencies on the database to finding potential outliers or erroneous values. The first element checked was the total energy intake in kcal/day and questionnaires were sorted from largest to smallest values of energy intake. The median was around 5000 kcal and this value was chosen as a cut-off point. Questionnaires with energy intakes above or equal 5000 kcal were checked first followed by questionnaires with energy intakes below 5000 kcal. If missing or implausible values were identified, paper questionnaires were checked and changes were made to the database. If implausible values matched with the information on the paper questionnaires, no changes were made to the database as outliers would be dealt with during the data management process.

4.3.5.2 Socio-economic status data

The cleaning process of both the neighbourhood and household SES data involved a 10% random sample check to identify potential problems with the data entered. A one percent error limit was set. Following the 10% random sample check, a number of potential problems were identified with one section in the neighbourhood SES dataset and with two questions in the household SES dataset. A decision was made to pull out every questionnaire from storage and re-enter the responses to these questions. Cleaning checks of other variables (identification of missing values, inconsistencies, and data values out of the expected range) were also undertaken and missing questionnaires entered in the database.

4.3.6 Data management

4.3.6.1 Anthropometric data

BMI was used as either a continuous variable or dichotomous variable. Age- and sex-specific international cut-off points were used to define anthropometric status based on BMI (thinness, normal weight, overweight and obese) for adolescents aged less than 18 years old (Cole et al. 2000; Cole et al. 2007). Overweight was defined as an age specific (17.5 years) BMI≥24.7 for males and ≥24.8 for females. Obesity was defined using the same reference (BMI≥29.7 for males and ≥29.8 for females) (Cole et al. 2000). Thinness was defined as an age specific (17.5 years) BMI≤18.28 for males and ≤18.38 for females (Cole et al. 2007). Adult cut-offs were used for adolescents aged 18 years or above (WHO 2000). Dichotomous variables were created for thinness (thin vs. normal) and overweight, including obesity, because the prevalence of obesity was low (overweight/obese vs. normal). The ratio of overweight to thinness was calculated in the sample (total and males/females separately) to provide an indication of the levels of thinness and overweight and as such the nutrition transition (Mendez et al. 2005; Mamun and Finlay 2014).

WC was used to generate the waist-to-height ratio (WHTR). The waist-to-height ratio was used as a continuous variable or dichotomous variable. Cut-off points were used to define the risk for metabolic diseases based on WHTR (low, normal and high) (Ashwell 1998; Ashwell and Hsieh 2005). Low WHTR was defined as <0.40; normal WHTR was defined as ≥0.40 and <0.50; and high WHTR was defined as ≥0.50. Dichotomous variables were created for high WHTR (high vs. normal) and low WHTR (low vs. normal).

Fat mass was used as a continuous variable or dichotomous variable. Age and sex specific cut-off points based on the US NHANES III were used to define the different classes of fat status according to percent fat (below average (≤15th percentile), normal (≥15.01th and ≤85th percentile), and above average (≥85.01th percentile) (Frisancho 2008). For the analyses, dichotomous variables were created for high percent fat (high vs. normal) and low percent fat (low vs. normal). Whole body fat with head was used for comparison purposes with the Frisancho reference (fat mass measured using bioelectrical impedance). Dichotomous variables were created for high percent fat (high vs. normal) and low percent fat (low vs. normal).

Low birthweight was defined as a weight at birth of less than 2500g (WHO, 1992).

4.3.6.2 Pubertal development data

Based on the Tanner scaling, only 39% of the female cohort reached stage 5 of pubertal development at 18 years old. As menarche was a more readily defined event in pubertal development, age of menarche was used to indicate timing of sexual development in females. The Tanner stages were used in males as an indicator of pubertal development. Binary variables were created for pubertal development for males (Tanner stage 2-3 (late maturers) vs. Tanner stage 4-5 (early maturers) and for females age of entry into menarche (<13 years (early maturers), ≥ 13 years (late maturers)).

4.3.6.3 Neighbourhood SES data

The neighbourhood socio-economic questionnaire contained more than 100 questions assessing different aspects of the neighbourhood environment. Seven indices of neighbourhood SES (i.e. neighbourhood economic index, neighbourhood availability of services index, neighbourhood problem index, neighbourhood security index, neighbourhood social support index, neighbourhood school economic index, and neighbourhood school problem index) were developed using PCA in order to avoid problems of collinearity in the multivariate analyses. Separate PCA analyses were run on groups of variables which were included in the questionnaire in order to ascertain particular aspects of the neighbourhood socio-economic environment. These groupings were based on those developed by Griffiths et al. (2012) on the sample of 16 year olds in the Bt20 cohort (Table 7). These were then used to obtain novel indices for this sample of 18 year olds. The neighbourhood economic index, availability of services index and problem index reflect the economic aspects of the neighbourhoods. The security index and neighbourhood social support index reflect the social aspects of the neighbourhoods. The school environment aspects are reflected by the school economic index and the school problem index. For each index, the first component score was extracted and the assumption that all eigenvalues should be above 1 was verified. Tertiles were then created for each index. The first tertile of each index always represents the most disadvantaged neighbourhoods. For example, the first tertile of the neighbourhood security index reflected lower SES with less sophisticated and elaborate security measures used in the neighbourhood.

These indices have been previously used in several different analyses assessing the relationship between neighbourhood SES and health outcomes (Griffiths et al. 2012) (Griffiths et al. 2013). Whilst a novel set of indices could have been created, the ones developed by Griffiths et al. (2012) were appropriate to answer the research questions set in this thesis. The first aim of the thesis was to examine adolescents’ perceptions of their neighbourhood environments. In order to get an overall idea of their neighbourhood environments, it was decided to assess both their socio-economic and school neighbourhood environments as they spend time in both communities (around their home and in school). The second and third aims of the thesis were to assess the relationship between the neighbourhood SES environment, diet and anthropometric status. In this instance, only the neighbourhood economic and social indices were used in the analysis as the influence of the school environment (especially because no information was available regarding the food environment in schools) on the anthropometric status was less obvious. The neighbourhood security index (part of the neighbourhood social indices) was also not included as there did not seem to be a direct association between the neighbourhood security index and anthropometric status. One limitation with the indices used is that they did not include any food environment variables. As these variables could potentially influence dietary intake, it was decided to assess the effect of these variables separately. Only four variables were related to the food environment in the questionnaire (distance to fast-food outlets, restaurants, shopping mall, food outlets), meaning there was no need to create a separate index as the variables were studied independently.

Table 7. Description of the variables included in the seven neighbourhood SES indices

Neighbourhood economic index variables: perceptions of neighbourhood wealth; outsiders perceptions of neighbourhood wealth; perception of equity of neighbourhood living standards; housing quality and condition; availability of yard space; parking space and fencing/walls around properties.
Neighbourhood availability of services/facilities index variables: primary and secondary schools; hospitals, health centres; community centres; sports facilities; parks; street lighting; piped water; policing.
Neighbourhood problem index variables: traffic congestion; road safety; sewerage; illegal dumping; pollution, overcrowding; in migration of non-South Africans; homelessness; repossession of properties; unemployment; prostitution; alcohol/drug abuse; shebeens; and gangs.
Neighbourhood security index variables: information on whether most households to prevent crime keep weapons; employ security; have dogs; have fences; security doors; barred windows; and security lights.
Neighbourhood social support index variables: information on the liveliness, spirit and trust levels in the neighbourhood; whether neighbours help in a time of need; whether neighbours could be trusted to look after their house; happiness and level of pride in the neighbourhood.
School environment index variables: type of school (government-funded or private) ethnic composition of the school; how safe the individual feels in the school; and school facilities.
School problems index variables: whether the school has problems with poor academic standards; lack of resources; lack of discipline; overcrowding; lack of dedicated teachers; teachers who cannot teach well; bullying; absenteeism; smoking; alcohol; drugs; weapons; violence; teen pregnancy; rape; and sexual relationships between learners and teachers.

Source: Griffiths et al. 2012

4.3.6.4 Household SES data

The household SES variables included both information on material living conditions and caregiver education. One approach would have been to group all of this information together to create an overall SES index encompassing different dimensions of SES. However, as caregiver education is known to be a strong independent predictor of health outcomes, it was decided to look at the effect of material wealth (using the household wealth index) and caregiver education independently on diet and anthropometric status, and therefore kept these variables separate.

The household wealth index, proxy for material wealth, was created using PCA applied to indicators of the household environment (consumer durable ownership as well as water/toilet facilities) to avoid problems of collinearity in the multivariate analysis (Filmer and Pritchett 2001). Tertiles were then created, with the first tertile representing a poor household and the third tertile representing a relatively wealthy household.

A categorical variable was created for *caregiver education* using the information given (less than or equal to primary school; secondary school; higher education).

4.3.6.5 Dietary data

4.3.6.5.1 Energy and macronutrient analysis

The main problem encountered with the dietary data was the high reported energy intakes (Figure 31). In order to deal with outliers (mainly over-reporters in our study), two different approaches could have been adopted: either a conservative, or an exclusion approach (Willett 1998). The conservative approach entails including all the subjects (even the ones presenting improbable levels of energy intake) or include them all but adjust for energy intake. The exclusion approach involved excluding cases based on plausible thresholds from the literature (Goldberg et al. 1991; Willett 1998; Mccrory et al. 2002).

The Goldberg cut-offs (i.e. exclusion approach used to identify under- and over-reporters of energy intake) are obtained using specific equations including different components (physical activity level (PAL), average value of within-subject variation in energy, within-subject variation in measured or estimated basal metabolic rate and total between-subject variation in physical activity level).

The equations are as follows:

$$Cut - off\ value\ (lower\ limit) = PAL\ \times \exp\ \left[SD \min\ \times (S/100)/\sqrt{n}\right]$$

$$Cut - off\ value\ (upper\ limit) = PAL\ \times \exp\ \left[SD\ max\ \times\ (S/100)/\sqrt{n}\ \right]$$

Where:

- SD min=-2 if 95% CI and SD min=-3 if 99% CI and SD max=+2 if 95% CI and SD max=+3 if 99% CI
- $S = \sqrt{\left(\frac{CV^2 wEI}{d} + CV^2\ wB + CV^2\ tP\right)}$
- CV wEI represents the within-subject variation in energy intake
- d is the number of days
- CV wB is the within-subject variation in measured or estimated BMR
- CV tP is the between-subject variation in PAL

Goldberg et al. (1991) recommended using the following values for the different components included in the equations: PAL=1.55; CV wEI=23%; CV wB in measured BMR= 2.5%; CV wB in estimated BMR=8%; CV tP=12.5%). In 2000, Black et al. revised the values and suggested the following values: PAL= according to population PAL; CV wEI=23%; CV wB in measured BMR= 4%; CV wB in estimated BMR=8.5%; CV tP=15%).

As PAL was not assessed in our study, we used the component values suggested by Goldberg et al. (1991). BMR was estimated for males and females separately using specific equations (Schofield et al. 1985) as BMR was not measured in our study. The cut-offs for 95% CI derived from this equation were 0.90 (lower limit) and 2.68 (upper limit). Participants with an EI/BMR ratio below 0.90 were classified as under-reporters whilst participants with an EI/BMR ratio above 2.68 were classified as over-reporters. The Goldberg cut-offs identified 50.2% of the sample as misreporters (2.0% under-reporters and 48.2% over-reporters) and 49.8% as accurate reporters (Table 8). Using this technique, half of the sample (n=324) would have been excluded from further analysis. The mean energy intake after removing the misreporters was 3095.8 kcal/day (n=322).

Willett (1998) defined an arbitrary allowable range for males and females separately, with adjustment of nutrient intakes for total energy intake to compensate for overall under- and over-reporting. Males' values for plausible reported energy intake ranged from 800 to 4000 kcal/day whilst females' values ranged from 500 to 3500 kcal/day. The Willett cut-offs identified 58.1% of the sample as misreporters (all over-reporters) and 41.9% as accurate reporters (Table 8). This technique would have excluded more than half of the sample from further analysis (n=381). The mean energy intake after removing the misreporters was 2779.5 kcal/day (n=275).

Table 8 also gives evidence that the Goldberg and Willett cut-offs do result in selective omission of some participants. Given the high proportion of over-reporters (>50%), it was decided to run a logistic regression (data not shown) to identify socio-demographic and anthropometric characteristics associated with over-reporting. The logistic regression was performed on both the Goldberg and Willet samples.

Characteristics associated with over-reporting on the Goldberg sample were ethnicity, education, household SES and BMI. Indeed, being Mixed Ancestry vs. Black African reduced the odds of over-reporting (OR=0.62 [0.39-0.96], living with a caregiver who achieved secondary school vs. higher education increased the odds of over-reporting (OR=1.98 [1.19-3.31]), being relatively poor vs. relatively wealthy increased the odds of over-reporting (OR=1.58 [1.03-2.40] and finally being overweight or obese vs. underweight reduced the odds of over-reporting (OR=0.50 [0.29-0.86]).

Characteristics associated with over-reporting on the Willet sample (data not shown) were ethnicity, education and household SES. More specifically, being Mixed Ancestry or Indian/Asian vs. Black African significantly decreased the odds of over-reporting (OR=0.47 [0.30-0.72] and OR=0.12 [0.02-0.58] respectively). The odds of over-reporting were higher in adolescents living with a caregiver who completed secondary school vs. higher education (OR=1.88 [1.15-3.10]) and in adolescents living in poor households vs. relatively wealthy ones (OR=1.68 [1.19-2.55]). BMI did not have an effect on over-reporting when using the Willet sample.

Thus if over-reporters were removed, a selection bias would have been introduced into the models, with Mixed Ancestry adolescents, adolescents living with a caregiver with either primary or higher education and adolescents living in relatively wealthy households being more likely to be in the sample.

In both analyses, no differences were seen between sexes in terms of over-reporting.

These findings complement the results presented in table 8 and give more insight into the factors associated with over-reporting in this sample of adolescents. These analyses confirmed that over-reporters were systematically significantly different from the "accurate" reporters in terms of ethnicity, caregiver education and household SES.

Exclusion techniques are usually not preferred as they might lead to a modification of the sample and also introduce a source of unknown bias. Both methods (Goldberg and Willett) would have led to a significant loss of participants and a compromise between the two approaches was therefore favoured.

The energy intakes (kcal/day) were converted to a z-score distribution (internal sex-specific z-scores) in order to place energy intake into a relative ranking within the cohort rather than using an absolute energy intake. The macronutrients (protein, fat, and carbohydrates) expressed in grams were converted to kcal and then percentages of macronutrients were calculated by dividing the macronutrients in kcal by the total energy intake. The energy outliers were removed using the z-scores distribution. Based on the distribution, a decision was made to keep only the values that fell within the +/-2.58 z-scores (99% of the distribution). This led to a loss of 13 subjects out of the sample of 656. The mean energy intake was 4303.4 kcal/day after removal of the 13 cases and no significant differences in socio-demographic characteristics were found between the included and excluded sample (Table 8).

Figure 31. Distribution of energy intake (kcal) in the sample of adolescents aged 18 years old (n=656)

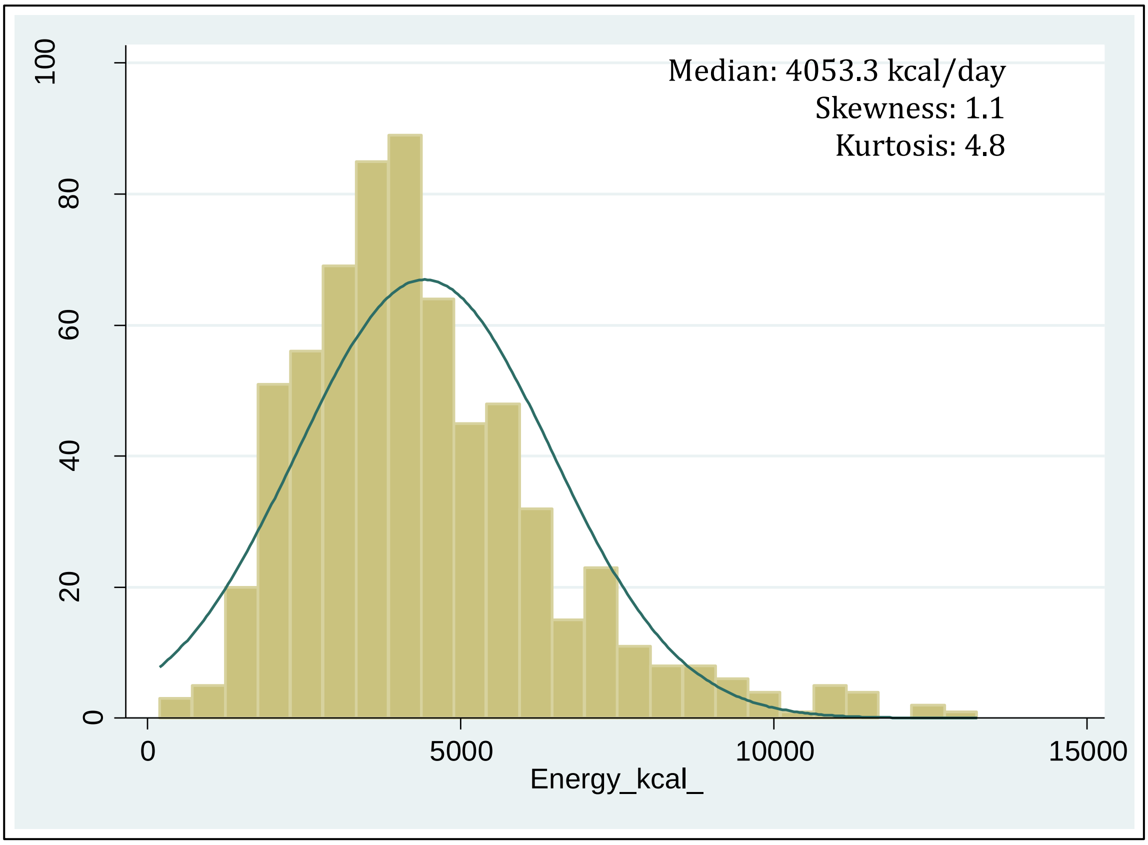


Table 8. Description of the dietary sample and the three remaining samples after exclusion of outliers using different cut-offs

	Whole sample		**Goldberg sample**					**Willett sample**					**z-score sample**					
			Misreporters		Accurate reporters			Misreporters		Accurate reporters			Misreporters		Accurate reporters			
	n=656		n=324 (50.2%)		n=322 (49.8%)			n=381 (58.1%)		n=275 (41.9%)			n=13 (2.0%)		n=643 (98.0%)			
Mean energy intake (kcal/day) (s.e)	4461.1 (88.7)				3095.8 (45.5)					2779.5 (43.7)					4303.4 (73.1)			
Sex	n	%	n	%	n	%	p [1]	n	%	n	%	p [1]	n	%	n	%	p [1]
Males	304	46.3	153	47.2	150	46.6	0.87	185	48.6	119	43.3	0.181	4	30.8	300	46.7	0.255
Females	352	53.7	171	52.8	172	53.4		196	51.4	156	56.7		9	69.2	343	53.3	
Ethnicity																	
Black African	546	83.2	283	87.4	256	79.5		337	88.5	209	76.0		12	92.3	534	83.0	
Mixed Ancestry	98	15.0	39	12.0	56	17.4	0.008 **	42	11.0	56	20.4	<0.0001 ***	1	7.7	97	15.1	0.657
Asian/Indian	12	1.8	2	0.6	10	3.1		2	0.5	10	3.6		_	_	12	1.9	
Caregiver education																	
≤ Primary school	82	13.7	40	13.5	42	14.4		43	12.4	39	15.5		1	8.3	81	13.8	
Secondary school	440	73.6	230	77.4	203	69.5	0.029*	269	77.5	171	68.2	0.026*	10	83.4	430	73.4	0.74
Higher education	76	12.7	27	9.1	47	16.1		35	10.1	41	16.3		1	8.3	75	12.8	
Household wealth index																	
Low	187	32.2	101	35.8	84	29.1		118	35.5	69	27.7		5	41.7	182	32.0	
Medium	215	37.0	104	36.9	105	36.3	0.107	124	37.3	91	36.6	0.046*	4	33.3	211	37.1	0.771
High	179	30.8	77	27.3	100	34.6		90	27.1	89	35.7		3	25.0	176	30.9	
BMI																	
Underweight	115	17.8	61	18.8	54	16.8		63	16.8	52	19.2		2	16.7	113	17.8	
Normal	418	64.7	220	67.9	198	61.5	0.018*	255	67.8	163	60.4	0.129	9	75.0	409	64.5	0.672
Overweight/Obese	113	17.5	43	13.3	70	21.7		58	15.4	55	20.4		1	8.3	112	17.7	

*p<0.05; **p<0.01; ***p<0.001

[1] Chi square

4.3.6.5.2 Dietary pattern (data management and analysis)

Principal Component Analysis (PCA), a data reduction technique was used to detect patterns of food consumption emerging in this cohort of adolescents. PCA was used to identify independent axes that explain most of the variance in the data.

There are six steps involved in the dietary pattern analysis: classification of the food items; choice of input variables; PCA analysis; choice of components to be retained; interpretation of the components retained and finally the labelling of each component. The first four steps will be presented thoroughly hereinafter. The interpretation of the components retained and the labelling of each component will be presented in the results chapter (Chapter 6, section 6.4).

In order to run the dietary patterns analysis, the second output from the MRC FoodFinder software was used (version 3). This included a detailed list of each food item consumed per participant and the food group to which the food item belongs to. There were 14 food groups (Table 9) and about 800 different food items in the database. The paper questionnaires only included a list of 214 different food items. However, the software comprised much more combinations for one single item (i.e. “scrambled eggs low fat milk sunflower oil”, “scrambled eggs whole milk hard margarine”, “scrambled eggs semi skimmed milk sunflower oil”, etc.). Depending on the information provided on the paper questionnaires, different combinations could be chosen by the person in charge of the data entry which led to a high number of food items in the dataset. The 14 food groups classification was too broad (i.e. high level of grouping (e.g. cereal products, meat and meat products, fish and seafood, etc.) to characterise adolescents’ food consumption patterns and it was therefore decided to create more subsets of food items within each food group (i.e. a more fine grained classification). The number of food items included in a PCA may impact the results and is dependent upon the number of participants (McCann et al. 2001). Given the number of participants in this study (n=656), the 800 food items were recoded into 36 smaller groups (Table 9) to allow a robust analysis using PCA. This categorisation was based mainly on nutrition composition (nutrient content and usage) and information available in the literature (McCann et al. 2001; Aounallah-Skhiri et al. 2011). For example the cereal and cereal products food group was divided into different food items: refined grains, whole grains, snacks (e.g. crisps, popcorn, crackers etc.), desserts (e.g. custard jelly, cakes, puddings, trifle, eclair, etc.), pizzas and samosas, savoury tarts, biscuits and pastries (e.g.

cookies, rusk, muffins, scones, doughnut, pancake, etc.). The meat and meat products category was divided into red meat, chicken, offals and processed meats (biltong, sausages, pate, etc.). The fish and sea food group was divided into fresh fish, canned fish (tuna, sardines, etc.), processed fish (e.g. fish cakes, fish fingers, battered fish, etc.). The beverages category (i.e. liquid drinks) was divided into three groups: beverages (i.e. fresh fruit juices, smoothies, milkshakes, drinking chocolate), soft drinks and alcohol. The fats group was split into: oils and dressings, margarine, butter and cream. The dairy product group was split into high fat (i.e. cheese, whipping cream etc.) and low fat (milk, yoghurt, etc.) dairy products. Finally, the fruit group was split into: fresh fruit and processed (canned/dried) fruit, as nutritional composition differ slightly. It was important to make the distinction between fresh vs. canned/processed, high fat vs. low fat, soft drinks vs. other beverages, refined vs. whole grains, as some of these items are markers of the nutrition transition.

Table 9. Classification of food items from food frequency questionnaire

Classification 1: 14 food groups	Classification2: 36 food sub-groups
Beverages	Beverages (fresh fruit juices, smoothies and milkshakes)
Cereal and cereal products	Refined grains; whole grains; snacks; desserts; pizzas and samosas; tart/pies; biscuits/pancakes/muffins/cakes
Eggs	Eggs
Meat and meat products	Red meat; poultry; offals; processed and dry meat
Fish and seafood	Fresh fish and sea food; processed fish; canned fish
Milk and milk products	High fat dairy products; low fat dairy products
Legumes and legumes products	Legumes and legumes products
Vegetables	Vegetables; potato chips
Fruit	Fresh fruit; processed fruit (canned and dried)
Fats and oils	Butter and cream; oils and dressings; margarine
Sauces, seasoning and flavourings	Sauces, seasoning and flavourings
Sugar, syrups and sweets	Soft drinks; sweets; chocolate; sugar/jam/honey
Nuts and seeds	Nuts and seeds
Miscellaneous	Alcohol; tea; coffee; soups

The second step involved choosing the type of input variables. The dietary output included the weight in g/day for each food item. These were standardised into z-scores to remove any portion size effect. Relative amount of food items rather than absolute amount were then obtained. At this stage, outliers based on +/- 6 z-scores (Crozier et al. 2006) were removed from the dataset (n=51) resulting in a sample size of 601 for the PCA analysis.

The next steps entailed running the PCA and analysing the different components to decide on the number of factors to be retained. This decision was based on both statistical information and interpretation of the indices created given current knowledge on nutrition (Crozier et al. 2006). The scree plot of eigenvalues below (Figure 32) represents the variance explained by each component in the dataset. It displays a representation of the variance explained by the first component and then shows the additional variance explained by each of the following components. Based on the scree plot results and interpretability, the first four components were retained (more interpretable and robust). The subsequent components (5 to 11) had an eigenvalue above 1 but each component added very little variance (Figure 32) and were therefore not retained. Furthermore, when exploring further the interpretability of these components (5-11) by observing the factor loadings (data not shown), it was difficult to give a meaning to the components.

Figure 32. Scree plot of eigenvalues after PCA

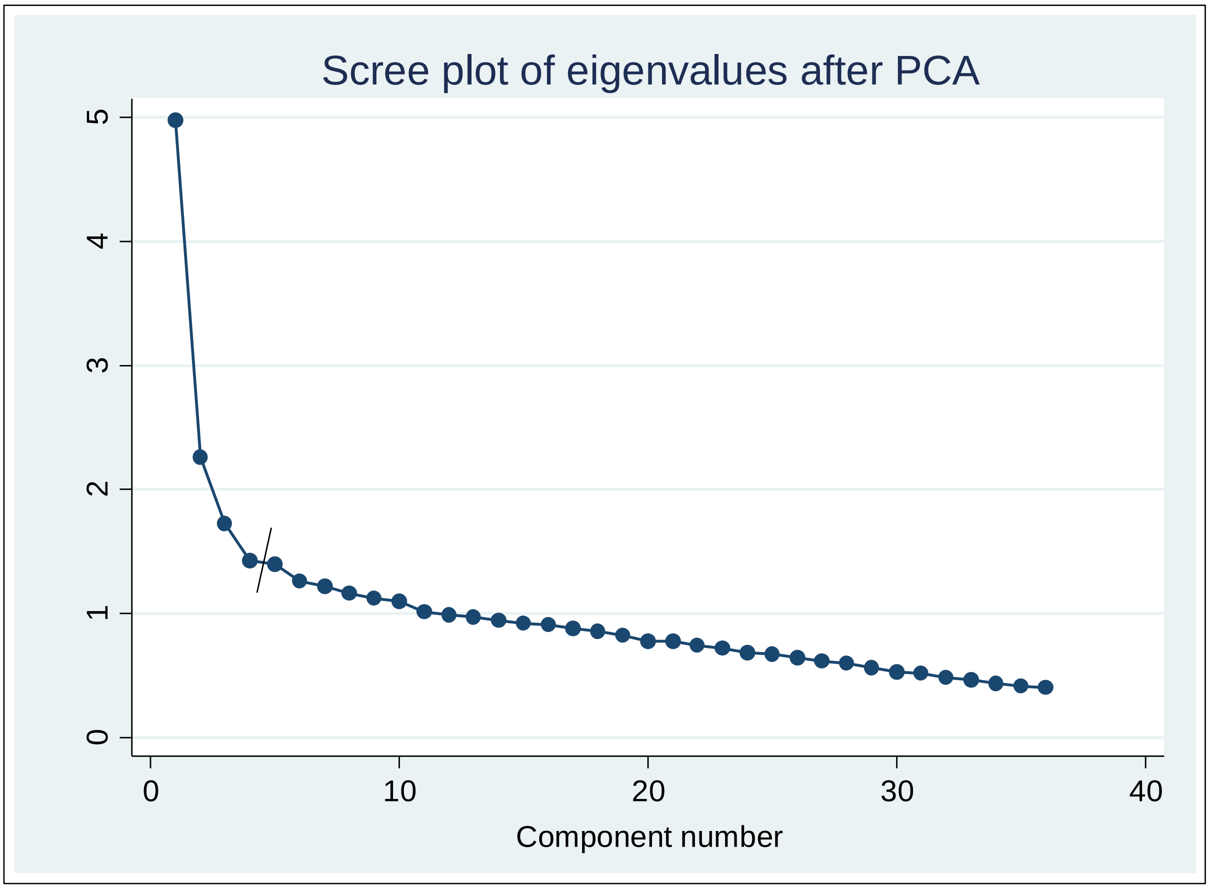


Table 10 below shows the factor loadings for each component (each loading gives a measure of the correlation between the variable and the component). Food items with a factor loading of at least 0.2 were considered to load highly on that component (Smith et al. 2013). The four principal components retained explained 28.9% of the variance in the sample. The interpretability and labelling steps will be discussed in the dietary results chapter as mentioned above.

Finally, a summary score was generated for each subject for each pattern identified. This was obtained by summing up the products of the factor loading coefficients and standardized weight in grams (McCann et al. 2001; Smith et al. 2013).

Table 10. Dietary patterns retained in the adolescent sample through PCA

	Components			
Food items (36)	**1**	**2**	**3**	**4**
Alcohol	0.075	-0.058	-0.161	-0.260
Beverages	0.129	-0.225	-0.071	0.120
Soft drinks	0.191	-0.193	-0.251	-0.055
Tea	0.074	0.334	-0.139	0.189
Coffee	0.065	0.076	-0.019	0.242
Fresh fruit	0.195	0.036	0.169	0.159
Processed fruit	0.075	-0.028	0.259	0.09
Vegetables	0.227	0.187	0.269	-0.073
Legumes	0.102	0.099	0.225	-0.099
Nuts and seeds	0.124	0.231	0.036	0.138
High fat dairy product	0.210	-0.242	0.041	0.086
Low fat dairy product	0.200	0.046	-0.096	0.266
Offal	0.184	0.126	0.039	-0.239
Poultry	0.235	-0.111	0.016	-0.232
Processed meat	0.290	-0.082	-0.104	-0.171
Red meat	0.262	-0.081	0.136	-0.177
Eggs	0.157	0.106	-0.117	-0.204
Fresh fish	0.091	-0.055	0.367	0.050
Canned fish	0.079	0.139	0.257	-0.175
Processed fish	0.104	-0.126	0.245	-0.107
Butter and cream	0.046	-0.019	0.117	0.192
Margarine	0.107	0.221	-0.161	-0.046
Oils and dressing	0.122	-0.006	0.156	0.096
Refined grains	0.197	0.159	-0.247	-0.124
Whole grains	0.152	0.282	0.046	0.119
Savoury tarts	0.058	-0.146	0.231	0.152
Pizzas and samosas	0.105	-0.296	0.089	-0.038
Potato chips	0.237	-0.113	-0.238	-0.119
Biscuits	0.255	0.018	-0.035	0.091
Chocolate	0.116	-0.196	-0.094	0.327
Dessert	0.193	-0.293	0.014	0.243
Sugar	0.179	0.344	-0.092	0.206
Sweet	0.138	-0.047	-0.226	0.068
Sauces	0.258	0.010	0.017	-0.112
Snacks	0.143	0.029	-0.044	0.234
Soup	0.138	0.128	0.182	-0.096
Eigenvalue	4.98	2.26	1.73	1.42
Variance explained (%)	13.8	6.3	4.8	4.0
Total variance explained (%)	**28.9**			

Factor loadings with magnitude 0.2 or greater were retained

High factor loading   Negative factor loading

4.3.6.6 Smoking data

Adolescent's smoking status was classified as current smoker, previous smoker or never smoked.

4.3.6.7 Residential data

For the analyses, a dichotomous variable was created for place of residence, representing adolescents living in Soweto or in the rest of Johannesburg metropolitan municipality. This was done using geographical mapping systems via Google (https://maps.google.co.za/) and a South African postal code system (http://postalcodez.co.za).

4.3.7 Ethics

The protocol of the secondary data analysis has been approved under protocol number M980810, The University of the Witwatersrand and generic protocol G08P9, Loughborough University.

4.3.8 Hypotheses, statistical analysis and model building

The main outcomes were dietary intake (energy and macronutrients intakes) and body composition (BMI, WHTR, percent fat). The data analysis for each of the thesis objectives is presented below. All analyses were conducted using Stata/SE version 12 (Stata Corporation, College Station, Texas, 2011).

4.3.8.1 Neighbourhood deprivation of urban South African adolescents

The null hypotheses tested in this chapter were:

- *There will be no significant differences in neighbourhood socio-economic and school perceptions between different population groups in urban South African adolescents;*
- *There will be no significant differences in neighbourhood socio-economic and school perceptions between black Africans living in Metropolitan Johannesburg and black Africans living in Soweto.*

The sample of 2013 participants comprised 81.1% black adolescents (n=1633), 6.2% whites (n=126), 11.2% Mixed Ancestry (n=225) and 1.5% South Asians (n=29). Those participants with data on population group, age, sex, place of residence, caregiver education, and neighbourhood SES were included in the current analyses. Information on caregiver's education was missing for 203 cases due to the fact that contact was required with the caregiver as well as the adolescent to ascertain this information. Indian participants were removed from the analyses due to their small sample size (n=29). Adolescents living outside of the area of Johannesburg and Soweto were also excluded (n=173) in line with the aim of this study which was to compare living conditions of adolescents living only in those two areas (n=173). For the neighbourhood security index, 596 observations were either missing or “don’t know” answers and were therefore removed in order to run the PCA. For the neighbourhood school environment indices, the sample size was also significantly reduced, as approximately 745 adolescents were not attending school anymore either because they had discontinued attending or moved onto higher education. These cases were removed for analysis purposes for the relevant indices.

Descriptive statistics were performed on neighbourhood SES and caregiver education data; and individual data. Associations between population group, caregiver education or place of residence and the neighbourhood SES tertile measures were examined using ordered logistic regression or generalised ordered logistic models when the parallel regression assumption was violated (Williams 2006). Initial unadjusted models were explored and followed by multivariate analyses. All the multivariate models included all variables that were tested in the univariate models (sex, place of residence, caregiver education and population group) and all variables were entered simultaneously in the models. The analyses were performed first on the whole sample and then stratified by population group and place of residence. The decision to stratify was based on the assumption that socio-economic and school neighbourhood perceptions will differ by population group and place of residence and therefore that different patterns could be observed for these groups.

The type I error risk was set at 0.05. Results are presented as odds ratios (OR) and 95% confidence intervals (CI).

4.3.8.2 Neighbourhood and household SES influences on dietary intake

The null hypotheses tested in this chapter were:

- *There will be no shift to a westernised diet (food items and dietary pattern analyses);*
- *There will be no SES gradient (neighbourhood, household) in dietary intake in urban South African adolescents.*

PCA was used to identify patterns of food consumption emerging in this cohort of adolescents as described in section 4.3.6.5.2. Pearson's correlation tests were performed between the four different dietary patterns retained and nutrient intake (energy intake and macronutrients).

Participants with data on population group, age, sex, neighbourhood SES, household SES and diet were included in the analyses. Only Black African and Mixed Ancestry adolescents were included in the analysis as no data were available for White and Indian/Asian participants. Before the coding process, it was evident that there was no FFQ data for White and a very small sample for Indian/Asian participants. Therefore, the next stage of coding FFQ was not possible for the white sample and deemed not worthwhile for the Indian/Asian group. Consequently, these two population groups were excluded from the analysis. Descriptive statistics on socio-demographic and dietary factors (energy and macronutrients intake) were performed. Descriptive, univariate and multivariate analyses were stratified by sex due to different dietary patterns between males and females. Univariate analyses were performed on the maximum sample size. The multivariate analysis was based on the sample that had complete data for all variables included in this stage of analysis (complete cases).

Associations between intrinsic variables, household and neighbourhood SES tertile measures and dietary outcomes were examined using linear regression. Relationships between individual neighbourhood variables (availability of fast food, restaurants, shopping mall, and food outlets) which were believed to be conceptually associated to dietary intake were also tested.

Univariate models were explored followed by step-wise multivariate regression analyses. The variables shown in the fully adjusted models were retained based on their significance in the univariate models ($p<0.1$).

Variables were entered in the following order: intrinsic level variables (age, population group) followed by the main variables of interest (neighbourhood level variables (neighbourhood SES indices, place of residence, neighbourhood individual food environment variables) and finally the household level variables (caregiver education and household wealth index). This model building process allowed looking at the mediating effect of the household level variables on the association between neighbourhood SES variables and the different dietary outcomes. The type I error risk was set at 0.05. Results are presented as mean differences (crude and adjusted) and 95% CI.

4.3.8.3 Neighbourhood and household SES influences on anthropometric status

The null hypothesis tested in this chapter was:

- *There will be no SES gradient (neighbourhood, household) in anthropometric measures (BMI, percent fat, and waist-to-height ratio) in urban South African adolescents.*

Participants with data on population group, age, sex, pubertal development, smoking status, birthweight, neighbourhood SES, household SES and anthropometry were included in the analyses. Descriptive statistics on socio-demographic and anthropometric factors were performed on the maximum sample size for each outcome (n=2019 for BMI, n= 1945 for WHTR, and n=1728 for percent fat mass). Due to their small sample size (n=27 (1.3%) for BMI, n=20 (1.0%) for WHTR, n=20 (1.2%) for percent fat mass), Indian/Asian participants were removed from the univariate and multivariate analyses for each outcome.

Anthropometric statistics (weight, height, BMI, waist circumference, waist-to-height ratio, percent fat) in boys and girls, stratified by age (17-17.99; 18-18.99; 19-19.99) were calculated. Age and sex specific z-scores for weight, height, BMI, waist circumference and body fat were derived using the comprehensive Frisancho reference (Frisancho 2008). These were used to display anthropometric information for ages 17-19 combined.

Univariate and multivariate analyses were stratified by sex due to different anthropometric status patterns between males and females. Univariate analyses were performed on the maximum sample size for each outcome (overweight (n=758 for males and n=934 for females), high waist-to-height ratio (n=705 for males and n=909 for females), high fat mass (n=338 for males and n=764 for females), thinness (n=894 for males, n=771 for females), low WHTR (n=885 for males and n=749 for females), low fat mass (n=795 for males and n=676 for females). The multivariate analysis was based on the sample that had complete data for all variables included in this stage of analysis (complete case).

Relationships between individual neighbourhood variables (availability of parks, sports facilities, fast food, restaurants, shopping mall, and food outlets) which were believed to be conceptually associated with under- and over-nutrition, were tested. However no significant associations were found and no further analysis was performed.

Associations between intrinsic variables, household and neighbourhood SES tertile measures and anthropometric outcomes were examined using binary logistic regression. Univariate models were explored followed by step-wise multivariate regression analyses. The variables shown in the fully adjusted models were retained based on their significance in the univariate models ($p<0.1$).

Variables were entered in the following order: intrinsic level variables (age, age of entry into menarche, Tanner stage of pubertal development, population group, and low birthweight) followed by the main variables of interest (neighbourhood level variables (neighbourhood SES and place of residence) and finally the household level variables (caregiver education, household wealth index, and smoking status)). This model building process allowed looking at the mediating effect of the household level variables on the association between neighbourhood SES variables and the different anthropometric outcomes. Stage of pubertal development was included to control for the known changes in body composition during different stages of adolescence (Ginsburg et al. 2013). Smoking status was included because of the known association between smoking, body weight and body composition (Chiolero et al. 2008). All the fat mass models were adjusted for height (Wells et al. 2002).

The type I error risk was set at 0.05. Results are presented as odds ratios (crude and adjusted) and 95% CI.

4.4 Qualitative research

4.4.1 Aim of qualitative research

The general objective of the study was to explore the potential for religious groups, such as Churches, as community-based organisations for obesity intervention by assessing the readiness of leaders from such organisations to engage in such interventions.

4.4.2 Objectives of qualitative research

The specific objectives of the study were:

1. To determine the stage of readiness of the religious communities to prevent obesity in adolescence;

2. To identify community members such as religious group leaders who might want to be involved in obesity prevention intervention;

3. To gain qualitative insight on community factors that could affect the implementation of an obesity prevention intervention.

In order to answer the research question, it was decided to interview religious leaders. The rationale for conducting religious leaders' interviews will be further described in this section. The CRM survey was chosen to collect personal beliefs about obesity prevention among adolescents in religious institutions but also to determine the stage of readiness of this particular community regarding the obesity issue. The survey was used in combination with focus groups discussions to capture group beliefs and gain insight into factors that influence opinions, behaviours or motivation. The rationale for using FGDs and the CRM survey with religious leaders will be given in detail below.

4.4.3 Rationale for conducting religious leaders' interviews

In order to approach a complex problem such as childhood obesity, strategies need to be implemented at numerous levels (Huang et al. 2009). Interventions involving only the individual level have not been successful in preventing obesity at population levels (Summerbell et al. 2005). The acknowledgement of social, cultural and environmental factors that influence obesity has encouraged a change towards community-based interventions. Thus, obesity preventive intervention strategies should target both the individual and the community. Research has shown that it is important to integrate the community into interventions in order to develop sustainable and effective strategies (Lob-Corzilius 2007) and to allow people to have access to a healthy lifestyle and make the right decisions regarding nutrition and physical activity. An individual's choices are therefore determined by the environment in which they live. To date, a small number of multilevel interventions for childhood obesity prevention have been evaluated, however the existing research on these kinds of interventions has produced encouraging results (Flynn et al. 2006).

In the last few years, growing interest in the field of obesity prevention has emerged with interventions aiming at modifying the environmental conditions such as encouraging the consumption of healthy foods and discouraging sedentary behaviours (Lobstein et al. 2004). The need for community involvement has been identified for the prevention of obesity and promotion of healthy eating behaviours (Koplan et al. 2005). However, not all the communities are at the same stage of readiness to mobilise to tackle obesity (Slater et al. 2005). The implementation of an intervention should take into account both the willingness to change of the community as well as the ability and resources of the community to address childhood obesity. Communities (large or small) may face several problems when implementing preventive intervention programmes. This is mainly due to different attitudes towards a programme across communities, different levels of resources and political climate (Edwards et al. 2000).

The community has a key role as it can influence proximal to distal determinants that shape diet and weight control behaviours (Kumanyika 2002). Communities as individuals (Sliwa et al. 2011) are at different stages in terms of readiness and this is known to be a fundamental determinant for the success of implemented interventions (Edwards et al. 2000). Therefore, interventions that aim to incorporate the community would need to assess that readiness.

One obvious community where adolescents spend time is within the school environment. School-based programmes for obesity prevention in children and adolescents seem to be ideally implemented and efficient in countries where most of the children are in the education system and where school is compulsory (Lobstein et al. 2004). Feasibility, large coverage and cost-effectiveness are the three main advantages of such programmes. However, the burden on school personnel is considered an important disadvantage. In South Africa, the environment at school seems to be hostile and unfavourable for the implementation of school-based programmes (see chapter 3, section 3.5.2 for more information on school-based programmes).

Increasingly, churches are recognised as being popular settings for implementing health promotion programmes (Ammerman et al. 2003; Corbie-Smith et al. 2003; Campbell et al. 2007; Baruth et al. 2008)(see chapter 3, section 3.5.1 for more information on church-based programmes). Previous qualitative work conducted with adolescents in the South African urban context has identified the Church as being an important part of adolescents' community (Sheppard et al. 2010). Descriptive statistics on religious beliefs of 18 year old adolescents of the Bt20 cohort showed that 69.1% of the sample reported belonging to any religious group (Table 11). Amongst those who reported belonging to a religious group, the majority of the adolescents reported being Christian (88.6%). The largest Christian group was protestant (35.3%) followed by Catholic (21.2%), African Independent Churches (17.1%) and other non-denominational Christian groups (15.0%). In terms of importance of religion in adolescents' lives, 39.5% reported religion as important and 51.1% as very important.

Regarding religious events attended in the past six months, 61.1% reported attending ordinary weekly services (6.1% occasionally, 22.7% sometimes and 32.3% weekly). Most of the adolescents declared that attending religious services or activities was their own decision and was not due to pressure from parents (72.3%) or friends (88.4%). The majority of the sample stated that religion had a positive influence on their lives and actions and helped them to deal with life and difficulties. 71.3% of the adolescents reported that "religious beliefs make it important for them to help others", 68.8% reported that "religious beliefs make them responsible for promoting fairness and justice", 61.8% declared that "religious beliefs guide their behaviour in personal relationships" and 76.9% stated that "religion helps them to cope with life".

The motivation for our study to focus on Christian groups through Churches comes from the findings presented above. These findings show the importance of the Church and religion in adolescents' lives and suggest that the Church community might therefore be a useful vehicle for intervention. There would however be a need to understand the readiness of the Church community and other religious communities within the South African context as vehicles for intervention as no evidence currently exists in the literature regarding religious communities being used as a vehicle for obesity intervention efforts in South Africa.

The questionnaire data therefore identified the Church as a potential community organisation, and religious leaders within churches as potential participants for the CRM survey and FGDs.

Table 11. Religious data from a sample of 18 year old adolescents enrolled in the Bt20 cohort

	No		Yes					
Do you belong to any religious group	n	%	n	%				
	618	30.9	1384	69.1				
Type of religious group	n	%						
African Independent Churches	235	17.1						
Catholic	291	21.2						
Protestant	484	35.3	88.6					
Other Christian groups (non-denominational)	205	15.0						
Other (Hindu, Muslim, African traditional)	156	11.4	11.4					
	Never		**Occasionally**		**Sometimes**		**Every week**	
Events attended in the past 6 months	n	%	n	%	n	%	n	%
Ordinary weekly services	775	38.9	122	6.1	451	22.7	643	32.3
Special/festival services	1065	53.5	379	19.0	475	23.8	73	3.7
Youth meetings	1379	69.2	190	9.6	242	12.1	181	9.1
Choir	1595	80.1	92	4.6	138	6.9	167	8.4
Prayer meetings/vigils	1400	70.4	178	8.9	290	14.6	122	6.1
Ceremonies (life cycle)	1286	64.6	283	14.2	390	19.6	32	1.6
Minister counselling/advice	1703	85.8	92	4.6	161	8.1	30	1.5
Healing/blessing services	1389	69.7	206	10.3	317	15.9	80	4.1
Bible study	1388	69.8	153	7.7	286	14.4	163	8.1
Church of religious institutions volunteer work	1706	86.0	78	4.0	155	7.8	44	2.2
How important is religion in your life	n	%						
Not important	187	9.4						
Important	785	39.5						
Very important	1014	51.1						

Table 11. Religious information from the Bt20 adolescent sample (continued)

	Not true at all		Neutral		Very true	
How true are the following statements about your religious beliefs	n	%	n	%	n	%
My religious beliefs make it important for me to help others	232	11.6	340	17.1	1420	71.3
My religious beliefs make me responsible for promoting fairness and justice	235	11.8	386	19.4	1369	68.8
My religious beliefs are similar to my parents	467	23.5	265	13.3	1258	63.2
I attend religious services/activities because my parents expect this for me	1439	72.3	201	10.1	350	17.6
I feel that I am spiritual religious but I do not follow any organised religion	1180	59.2	308	15.5	504	25.3
I attend religious services/activities because many of my friends do the same	1761	88.4	108	5.4	123	6.2
My religious beliefs guide my behaviour in personal relationships	435	21.8	327	16.4	1230	61.8
My religious beliefs affect my choices around work/study	902	55.0	236	14.4	501	30.6
My religious beliefs affect my sexual behaviour	935	57.0	180	11.0	525	32.0
I am well informed about the teachings of my religion	302	15.2	305	15.3	1385	69.5
My religion helps me to cope with life	207	10.4	252	12.7	1529	76.9

4.4.4 The use of the CRM survey

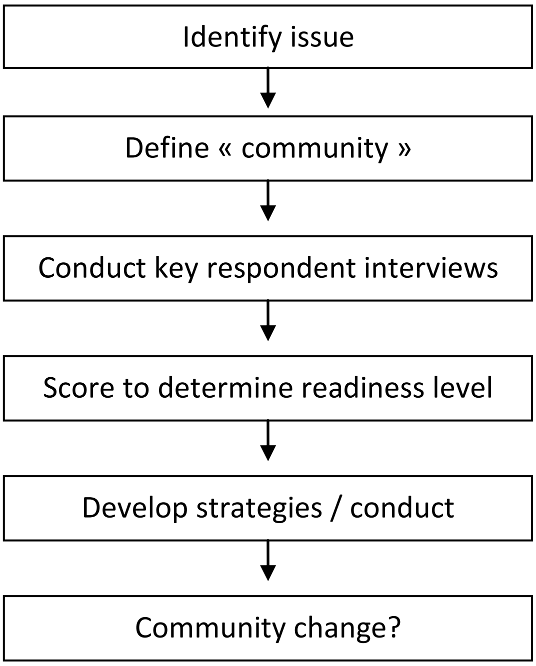
The CRM was created initially for alcohol and drug abuse prevention programmes at the Tri-Ethnic Centre for Prevention Research at Colorado State University (Edwards et al. 2000). However, it is now broadly used and applied at the international level in different areas of health and nutrition prevention programmes (HIV/AIDS, depression, reduction of sexually transmitted diseases (STDs), eating disorders, obesity, high-fat diets, anxiety and panic disorders, disabilities, sedentary lifestyles, pregnancy and smoking, sun exposure) but also in environmental prevention and in social prevention programmes (suicide, partner violence) (Edwards et al. 2000). The CRM has mainly been applied in developed countries in low-income populations especially African American, American Indian, Mexican American and Native Alaskan groups. Very little is known about the application of the CRM in developing countries. Indeed, only a few studies have used this tool to assess community readiness for HIV/AIDS in rural Bangladesh (Aboud et al. 2010) and in Liberia (Kennedy et al. 2004) and for the study of disability in India (McElroy et al. 2011).

The CRM is a model "that integrates a community's culture, resources, and level of readiness" (Plested et al. 2006:3) in order to approach problems existing in the community. It serves as a theoretical framework for understanding and improving community readiness (Edwards et al. 2000). The term readiness is defined as "the degree to which a community is prepared to take action on an issue" (Plested et al. 2006:3) and also as the observable and psychological factors that affect the ability to change of a community (Beebe et al. 2001; Chilenski et al. 2007).

The CRM has been applied to childhood obesity prevention in the USA (Findholt 2007; Sliwa et al. 2011; Frerichs et al. 2015), in the UK (Kesten et al. 2013) and Australia (Millar et al. 2013). Key informant interviews were conducted with school administrators, school nurses, a nutritionist; community youth programme leaders and parents in six communities in Union County, Oregon. The CRM was recognised as an easy and appropriate tool for developing childhood obesity prevention (tool easily adapted to the obesity issue, good understanding of the questions by community leaders, no specific difficulties for the scoring system, simple method for the estimation of community readiness relative to this issue) (Findholt 2007).

The CRM finds its roots in the transtheoretical model of personal readiness developed by Prochaska and DiClemente (1992). They identified five stages of individual readiness: precontemplation (minimal awareness of problem and no motivation); contemplation (awareness of problem without commitment to action); preparation (decision to change); action (behaviour change) and, finally maintenance (preventing relapse and consolidating gains). Those stages of readiness have by analogy been adapted to communities (Table 12). Thus, the transtheoretical model of Prochaska and DiClemente (1992) made a considerable contribution to the development of the CRM. The match between an intervention and the level of readiness of the community is absolutely crucial (Edwards et al. 2000). The types and intensity of relevant strategies are proposed with the model at each stage of readiness (Plested et al. 2006). The steps for using the CRM are presented below (Figure 33).

Figure 33. Application of the Community Readiness Model to health interventions



Source: Plested et al. 2006

The second step of the CRM requires that the community is defined. However, the term “community” is hard to define. The CRM defines a community as a “geographical area, a group within that area, an organisation, or any other type of identifiable “community” (Plested et al. 2006). Kok et al. (2008) defines a community as "collectives of people identified by common values and mutual concern for the development and well-being of their group or geographic area” (Kok 2008, p 437). It is therefore important to consider what constitutes a community regarding the issue under study.

The evaluation of the stage of readiness is based on interviews conducted with key informants from the chosen community. The interview includes questions on six different dimensions (Table 12) related to the way that communities face and address a specific issue (Edwards et al. 2000). Scores are then created corresponding to a readiness stage of the six dimensions which are then averaged to produce an overall stage of community readiness (range 1-9). Finally, the results are compared to the nine different stages of community readiness defined in this model (Table 13). The scores obtained for the six different dimensions and for the overall readiness will then be used to develop appropriate strategies for the community under study. The scoring process will be further detailed at the end of this section (see section 4.4.8 Qualitative analysis).

Table 12. The six dimensions of readiness that influence a community's preparedness to take action on an issue

Dimension of Readiness	Definition
A. Community efforts	To what extent are there efforts, programmes, and policies that address the issue?
B. Community knowledge of the efforts	To what extent do community members know about local efforts and their effectiveness, and are efforts accessible to all segments of the community?
C. Leadership	To what extent are appointed leaders and influential community members supportive of the issue?
D. Community climate	What is the prevailing attitude of the community toward the issue? Is it one of helplessness or one of responsibility and empowerment?
E. Community knowledge of the issue	To what extent do community members know about the causes of the problem, consequences, and how it impacts your community?
F. Resources related to the issue	To what extent are local resources - people, time, money, space, etc. - available to support efforts?

Source: Adapted from Plested et al. 2006: 9

Table 13. Anchor statements for each of the nine levels of Community Readiness

Stage of Readiness	Definition
1. No awareness	Issue is not generally recognised by the community or leaders as a problem (or it may truly not be an issue).
2. Denial/ resistance	At least some community members recognise that it is a concern, but there is little recognition that it may be occurring locally.
3. Vague awareness	Most feel that there is a local concern, but there is no immediate motivation to do anything about it.
4. Pre-planning	There is clear recognition that something must be done, and there may even be a group addressing it. However, efforts are not focussed or detailed.
5. Preparation	Active leaders begin planning in earnest. Community offers modest support of efforts.
6. Initiation	Enough information is available to justify efforts. Activities are underway.
7. Stabilization	Activities are supported by administrators or community decision makers. Staff are trained and experienced.
8. Confirmation/ expansion	Efforts are in place. Community members feel comfortable using services, and they support expansions. Local data are regularly obtained.
9. Professionalization	Detailed and sophisticated knowledge exists about prevalence, causes, and consequences. Effective evaluation guides new directions. Model is applied to other issues.

Source: Plested et al. 2006: 12

The first objective of the qualitative research was to determine the stage of readiness of religious leaders to engage in obesity prevention interventions in adolescents. The CRM survey was deemed appropriate to address this objective as it has been used in other populations with regard to the readiness of communities to address obesity. Furthermore, previous research within the cohort revealed that religious leaders were important in adolescents' lives and represent role models. Thus, prior to the implementation of obesity interventions through church-based religious leaders, it was necessary to gauge their level of readiness as no studies have been conducted in this setting. The CRM tool also helps to identify actions that need to be taken in order to increase the level of readiness and for an intervention to be successful. In order to gain insight into the scores obtained from the CRM tool, it was decided to conduct FGDs with the religious leaders who completed the CRM survey. FGDs were preferred to in-depth interviews due to time and resource constraints. Indeed, FGDs allowed us to get opinions and experiences from numerous religious leaders simultaneously. The FGDs methodology will now be discussed in detail.

4.4.5 The use of focus group discussions

4.4.5.1 Definition of a focus group

Similarly to in-depth interviews, FGDs offer in-depth opinions and experiences. They also allow gathering perspectives on a specific topic from numerous people simultaneously. FGDs are defined as an interactive discussion between participants who share common characteristics that relate to the topic under study (Morgan 1997). The group interaction and synergism are key features of FGDs and are essential to generate and gather information (Kitzinger 1995; Morgan 1996). The communication and interaction (both complementary and argumentative) between respondents are highly encouraged (Kitzinger 1994) by the researcher who plays an active role in creating a friendly environment in which respondents can feel at ease to give their opinions (Morgan 1996). This technique has been shown to be a valuable tool to examine people's thoughts and experiences in a specific cultural context but also how they think that way and why (Kitzinger 1995). The purpose, size and composition of the group and procedures should be defined clearly to ensure the success of this technique (Morgan 1996).

4.4.5.2 Characteristics of Focus Groups

4.4.5.2.1 Number of groups

The number of focus groups required to obtain data of quality is not defined. However, most projects include four to six focus groups (Morgan 1996; Krueger and Casey 2000). The main explanation for this is that saturation of ideas is usually reached after conducting this range of focus groups (Morgan 1996; Krueger and Casey 2000). Generally, the moderator reaches a point where no new information on the topic emerges and they can also start guessing the ideas that participants will develop (Zeller 1993). The more diverse the participants or topics to be discussed, the more focus groups will have to be conducted to reach theoretical saturation of ideas (Morgan 1992). The number of focus groups is also dependent upon the aims, design of the study, time and resources available (Kitzinger 1995).

4.4.5.2.2 Group size

The number of participants to invite to a focus group is not defined properly in the literature and is based more on researcher's experience. The number of participants included in focus groups can range from four to twelve participants (Krueger and Casey 2000) and is dependent upon the topic under discussion. Indeed, Morgan (1992) stated that smaller groups are more suitable when discussing a sensitive topic. A smaller group will give all the participants the opportunity to share their ideas and perceptions whereas a larger group will bring a wider range of perceptions (Krueger and Casey 2000). It is also advised to recruit more participants to account for people who won't attend the session and to avoid a potentially poor discussion (Stewart et al. 2007).

4.4.5.2.3 Focus group composition

People who participate in a FGD usually share similar characteristics (Krueger and Casey 2000). Most of the time, the researcher will seek for homogeneity within the group so as to gain people's shared experiences (Kitzinger 1995). However, in some cases, capitalising on people's different opinions and perspectives within a group will be more beneficial for the research and therefore a more diverse group is more suitable (Kitzinger 1995). Another element to take into account when defining focus group composition is how a social hierarchy or dominant individuals can affect the data by monopolising conversation (Kitzinger 1995; Morgan 1996). It is the responsibility of the moderator to deal with dominant forces in the group.

4.4.5.2.4 Level of moderator involvement

A focus group is the only qualitative technique that requires the presence of a moderator. The moderator, also called facilitator has a key role in guiding and facilitating the discussion process. The two common ways of facilitation are "structured" and "less structured" (Morgan 1996). A group is termed "more structured" when the facilitator is more in control of the group discussion (Morgan 1996). It is important to mention that a discussion can be structured in two different ways. The first way is to control the topics under discussion and the second is to control group interactions (Morgan 1992).

4.4.5.2.5 Focus group atmosphere and length

Kitzinger (1995) stated that the interview sessions should be held in a comfortable setting, with refreshments available to create a relaxed environment. Sitting round in a circle is usually advised as it puts everyone at the same level (researcher and participants). The sessions may last one to two hours maximum.

4.4.5.2.6 Focus group questions

There are two ways of developing a questioning route. The first possibility is to use a standardised questioning route which implies that no change is allowed and that the same guide is used across the different groups. The second option is that the questioning route can evolve between the different sessions based on what has been heard in the previous focus group (Morgan 1996). The questions used in a focus group should use simple words, should be easy to say, clear, short, open-ended and should sound conversational (Krueger and Casey 2000). Other methods besides just questioning participants exist. Some researchers advocate the use of incorporating other activities to stimulate group participation such as pile sorting or picture prompts.

4.4.5.3 Data analysis of focus groups

"Focus group analysis is systematic, sequential, verifiable, and continuous" (Krueger and Casey 2000, p128). The most common approach adopted to analyse interview transcripts in the field of Public Health is thematic analysis (Moreau et al. 2004; Braun and Clarke 2006). This method consists of searching across the dataset to identify repeated patterns of meaning (i.e. themes) (Braun and Clarke 2006). It relies on questioning the data content and reducing it by coding and finding themes and categories (Morgan 1996). A code is a word or a sentence that summarises a portion of data. They are then used to sort data into emerging themes or categories (Morgan 1996). It is important to mention that two types of thematic analysis exist: inductive (i.e. data driven approach in which the themes identified are strongly related to the data themselves) and deductive or theoretical (i.e. analyst driven approach in which the themes identified are strongly related to the researcher's theoretical interest in the area) (Braun and Clarke 2006). The different stages of thematic analysis are: familiarising with the data, generating initial codes, searching for themes, reviewing themes identified, defining and naming the themes identified and finally producing a report which is a crucial part of data analysis (Braun and Clarke 2006). Once the themes have been identified, a codebook is created that summarises the themes and their meanings (Morgan 1996).

The researcher should pay attention to divergent opinions and perceptions, and also compare and contrast data between the different focus groups (Kitzinger 1995). The difference between analysing focus groups and other qualitative data remains in the necessity to capitalise on the group interaction and synergism and to report the group effect on the data (Kitzinger 1995). Kitzinger (1994) stated that too few studies focus on the interaction between respondents and do not report quotations from more than one respondent at the same time.

An independent evaluation of the transcripts by a trained qualitative researcher and a comparison of agreement in the definition of the codes can be beneficial for the reliability of the analysis (Mays and Pope 1995).

As mentioned above, the CRM scores provide a limited amount of information as to why particular scores were achieved. When used in conjunction with the CRM tool, FGDs provide a more complete understanding of the situation within the community and highlight vital information which may aid the design and implementation of interventions.

4.4.6 Data collection organisation

Prior to organising any data collection (administration of the CRM survey and FGDs), the main researcher (RP) visited churches in Johannesburg-Soweto, and approached the pastor to discuss potential study participation. In some cases, the researcher contacted the churches through information letters and telephone calls before attending the service, and other times she visited the churches through snowball sampling as the guest of acquaintances. FGDs were scheduled after discussing the project with the pastor.

If study participants agreed to participate, they were given a participant information letter and then gave consent on the day of the interview when the FGD was scheduled. The inclusion criteria were: 1) those who were affiliated with the church, 2) those who had a leadership role in the congregation (teachers, coaches, pastors, bishops, elders), 3) those who could participate in one of the scheduled focus groups and 4) those who were also comfortable communicating in English (the language of the researcher).

In addition to the main researcher (RP), a local research assistant was present for each FGD to take notes and in order to provide clarification at the end of the FGDs if certain dialects had been used. Focus groups were held at a time convenient for study participants in their religious institution. Participants were provided with food (fresh fruit, raisins and nuts, cereal bars) and drinks (fruit juices) for their participation in the focus groups.

Participants: Six interviews (focus groups (n=6) and administration of the CRM survey (n=51)) were conducted (from November 2012 to January 2013) with a sample of predominantly black South African religious leaders, including pastors, bishops, teachers, and elders, recruited from Christian religious organisations in the area of Johannesburg and Soweto. Interviewing was stopped after six FGDs as saturation of ideas had been reached. One FGD included a mix of black African, mixed ancestry and white participants, and five FGDs were conducted with black African participants only. Four FGDs were conducted in relatively poor/medium SES neighbourhoods (Congregational Church in Soweto, Pentecostal Church in Johannesburg, Methodist Church in Soweto and Roman Catholic Church in Soweto) and two FGDs were conducted in relatively wealthy neighbourhoods (Methodist Church in Johannesburg, Evangelical Church located in the suburb of Johannesburg). Group discussions lasted between 60 and 90 minutes and had between four and twelve study participants.

Data collection: The FGDs and CRM survey were designed to examine people's beliefs about eating behaviours and obesity in their religious community and their readiness to support relevant obesity prevention interventions. The CRM survey consisting of 37 semi-structured questions addressing six readiness dimensions was used (Appendix V). The CRM survey was adapted from the CRM questionnaire (Plested et al. 2006) to suit the aim of this particular study. Unfortunately, the CRM survey could not be tested with members of staff as the questions were relevant only for religious leaders. The first interview session with the religious leaders was then used as a test for the CRM survey. This session revealed that some questions were difficult to understand (e.g. formulation of the questions, semantics used, Likert scales) by the participants and thus it was decided to rephrase the questions that presented problems. The Likert scales used in the survey to measure opinions were really challenging for the participants therefore a culturally adapted example was used at the beginning of the questionnaire to facilitate the understanding of the scale system. Smiley faces were also added to the scales in order to aid comprehension (Appendix V).

Open-ended questions used in the FGDs addressed people's social perceptions of the body, perceived determinants of obesity, and the role of the Church in adolescents' health (Table 14). People's social perceptions of the body were collected using the body image assessment for obesity (BIA-O) validated tool (Williamson et al. 2000). The BIA-O has been utilised in Caucasian and African-American women and men (Williamson et al. 2000). Four male and female silhouettes representing different body shapes were used for the discussion around body image perceptions ranging from thin to obese (Table 14). The researcher, who was the

FGD moderator, held an image in front of the group and the group then discussed what they thought of that image.

Prior to the beginning of the study, the focus group interview guide was piloted with members of the Bt20 team in the University of Witwatersrand in order to identify any problems with the interview question wording and appropriateness for the South African context (understanding of the questions and elicitation of the desired information). A small number of changes were made to the interview guide as a result of this pre-testing where necessary. Focus groups were led by the main researcher (RP) who acted as moderator and were observed by one trained assistant. At the beginning of each group, participants completed demographic questions about age, sex, years of education, marital status, role in the congregation, years spent in the congregation and the CRM survey. Then, the moderator asked each participant to introduce her/himself and describe their role in the Church to familiarise with the participants and put them at ease before the start of the FGD. The FGDs were audio-recorded and extensive field notes were recorded by an observer as well as the researcher (RP). The written notes were used to supplement the information gleaned through the audiotapes.

Table 14. Focus group interview guide

Themes	Questions
Issues in the community	What is the most important issue of concern that comes to mind?
	What are the second and third most important issues that come to mind?
	Why is X the most important issue for adolescents in the congregation? Do you think these concerns in your congregation reflect the greater community/area where you live? Tell us why or why not.
Body image perceptions (silhouettes)	
Obesity definition	Could you define obesity? Can you describe what obesity is?
	When you think about the word obesity, what comes to mind? Do you use other words to describe obesity?
	How are obese people perceived in your congregation? Are all obese people perceived in the same way?
	Why do you think people are obese? What are the causes of obesity in your congregation?
	What makes someone obese? What foods might contribute to obesity? What are factors other than food that might make somebody obese?
	Can you tell us about any risks or benefits associated with being obese?
Unhealthy dietary habits	Could you tell us something about unhealthy dietary habits that you are aware of in your community?
	What are healthy and less healthy foods for adolescents?
	What foods are healthy? Do adolescents commonly consume these foods?
	What foods are unhealthy? Do adolescents commonly consume these foods?
	What are the risks of adopting unhealthy dietary habits?

Table 14. Focus group interview guide (continued)

Themes	Questions
Role of the Church	What is the role of the Church in adolescents' health?
	What is the role of the Church in relation to adolescent obesity? What role does your congregation play in adolescents' knowledge about obesity?
	What is the role of the Church in relation to adolescent dietary habits?
	Tell me anything that your congregation does to encourage adolescents to eat healthy or less healthy foods? What makes the congregation do these things to encourage these eating patterns?
	What is the role of the Church in relation to encouraging adolescents to take part in physical activity (exercise)?
	What types of activities are available in your congregation for adolescent health? From where do you think that the adolescents in your congregation receive information about health?
Relationship between the religious leaders and adolescents	Who do you think the adolescents in your congregation perceive to be a role model? Which leaders in the Church are seen as the biggest role models for adolescents?
Resources	What resources do leaders in the community have to help adolescents maintain healthy weights?
	What are some of the challenges leaders in the Church face with regard to adolescent obesity? What additional resources might make it possible for the Church to work with adolescents regarding obesity?
	What are some opportunities leaders in the Church have for making an effect on adolescent obesity in the congregation? What are some of the constraints that would make this more difficult?

4.4.7 Ethics

The protocol of the qualitative study was approved by the Witwatersrand University in Johannesburg, South Africa (M120904) and an ethics checklist was approved by Loughborough University.

4.4.8 CRM and qualitative analysis

The responses of the CRM survey were entered in SPSS version 19. Descriptive statistics were performed on socio-demographic characteristics.

The surveys were scored according to the CRM protocol explained above and using the CRM handbook available (Plested et al. 2006). Each survey was scored by two independent scorers (RP and Joanna Kesten (JK) (a researcher with prior experience using the CRM in UK populations)). The first step of the scoring process was to read through the survey entirely before starting scoring to get a general idea of the content. Following that, the scorers had to refer to the nine anchored rating statements given in the handbook for the dimension being assessed (Plested et al. 2006). Anchored rating statements were available for each dimension (A to F) (Appendix VI). If evidence existed towards the fact that the community met the first statement (e.g. 'No awareness of the need for efforts to address the issue' (dimension A)), the researchers moved to the next statement (e.g. 'no efforts addressing the issue') until reaching the statement that was not observed in the community. The previous statement's number was then chosen and recorded (in previous example 'no efforts addressing the issue'). The same process was applied to the different dimensions.

At this stage, the two independent scorers compared their results and discussed until consensus was reached on the scores. Once all the dimensions for every survey were scored, average scores per dimension were calculated. For that, the total for one specific dimension had to be taken and then divided by the number of surveys. The same was done for each specific dimension. An overall score per Church was then calculated by adding up all the average scores obtained previously and dividing them by the number of dimensions. Finally, an overall score (for the six churches combined) was calculated by summing up the overall scores per Church and divide that by the number of churches (n=6). The level of readiness of religious leaders to prevent obesity in adolescents was finally obtained. It is advised to round down the overall score rather than up (Plested et al. 2006). Finally, results were compared to the nine different stages of community readiness defined in this model (Table 13).

FGDs were transcribed verbatim by a local trained transcriber and reviewed by the researcher (RP) for accuracy. Thematic analysis was used in order to identify specific themes from the FGDs (see section 4.4.5.3 in this chapter for more detail on thematic analysis). The analysis was performed manually as, despite having received training in the use of NVivo, the researcher felt more comfortable using manual coding (Krueger and Casey 2000; Green and Thorogood 2004). The coder, after familiarising herself with the transcripts, generated initial codes. Pattern themes, defined as concepts that occurred frequently across FGDs, were identified from the analysis of the coded text. Themes were identified if the topic was raised in more than one group and by more than one individual in each group, meaning that a grounded approach was taken to coding. One coded transcript out of the six was reviewed and checked by a second coder. They had to agree on the final code definition and rules for its use before it was applied in coding. At this stage, a final codebook was created and used to code all transcripts. Seven themes and 24 sub-themes were identified during the analysis (Table 15).

Table 15. Results of the thematic analyses

Themes	Sub-themes	Codes
Community issues	*Health issues*	STDs, HIV
		Teenage pregnancies
		Obesity
		Unhealthy dietary habits, inadequate food for families
		Access to health care and information
	Social issues	Peer pressure, image, stress, depression
		Technology (radio, tv, social networks)
		Change in family structure, single parenthood, dysfunctional families
		Loss of identity
		Environmental change
		Cultural change
		Discipline, delinquency, unruliness
		Shifts in lifestyle, working patterns
		Unemployment
		Lack of development activities, empowerment programs
		Hopelessness, uncertainty about future
		Inequalities, poverty
		Drugs, alcohol
	Safety issues	Violence
Obesity	*Definition*	
	Causes	Genetic
		Knowledge
		Laziness
		Medication
		Disease
		Affordability
		Diet, lack of fasting, alcohol
		Physical activity, lack of resources for young people to embark on exercise
		Depression, stress
		Lack of educational programs
		Parental influence
	Consequences	Early death, prone to diseases, serious health problems
		CVDs, high cholesterol
		Hypertension
		Diabetes
		Low self-esteem, target of ridicule, stereotyping, stigmatization, social outcast
		Mobility reduction, decrease in concentration levels

Table 15. Results of the thematic analyses (continued)

Themes	Sub-themes	Codes
Unhealthy dietary patterns	*Definition of healthy foods*	Non fatty meat, fruit and vegetables, white meat, unrefined maize-meal, mopani worms, organic foods, freshly cooked food, food fresh out of the soil, pap
	Definition of unhealthy foods and unhealthy dietary habits (meal structure, portion sizes)	Refined maize-meal, full cream milk, potatoes, chocolate, fat cakes, eggs, mango-atchar, fried potato chips, bunny chows, red meat, fast foods and take-away, sweets, noodles, unhealthy ways of preparing foods, sauces, Huge portion sizes, light meals in the morning and heavy meals in the evening, preference for easy to prepare foods, easily accessible, high consumption of fizzy drinks and processed food
	Definition of "eating well"	Having a balanced meal regularly, take away food once in a while, balanced breakfast, lunch and supper in controlled portions
	Reasons for adopting unhealthy dietary habits	cheaper, quick, convenient, habit, taste, poverty, taste over nutrient content and over substance issue, ignorance, time factor
	Cultural change	
Physical activity patterns	*Causes*	Cost, safety, technology, modernisation
Body image perceptions	*Sex differences*	
	Age differences	
	Size differences	
	Urban vs. Rural differences	
	Cultural change	
Church's role	*Role of the church in adolescent life*	Counselling and teaching, influential role, spiritual influence, listening and guiding
	Role of the church in adolescent health (obesity, diet, etc.)	
	Relationship between leaders and adolescents	Role models
	Resources	Knowledge Time Facilities Bible writings Church's members (adolescents, people attending services)
	Challenges	Time, knowledge, lack of speakers on health issues
	Opportunities	Networks, inventory of members' skills, role models
Key informants in community	*Religious bodies, families, social workers, schooling system*	

4.5 Summary

This chapter highlighted the different methods adopted in this thesis and showed their appropriateness in answering both the quantitative and qualitative research questions. The tools used alongside the data management and analysis have been extensively described in this chapter. Strengths and weaknesses of these methods will be presented in the discussion section.

Chapter 5: Perceived neighbourhood deprivation of urban South African adolescents

5. Perceived neighbourhood deprivation of urban South African adolescents

This chapter will firstly present the descriptive statistics in relation to the neighbourhood socio-economic and school environments. These results will be displayed for the overall sample and stratified by population group.

The univariate and multivariate analysis assessing the relationship between population group, caregiver education, place of residence and the neighbourhood socio-economic and school environment indices will then be reported. Results in relation to the neighbourhood economic environment will be first discussed, followed by results on the neighbourhood social environment and neighbourhood school environment. For each dimension (economic, social or school), results will be presented first on the overall sample and then on the Black African sample only.

5.1 Descriptive statistics

In terms of neighbourhood economic environment, Table 16 shows that the majority of Black African and Mixed Ancestry adolescents lived in government housing (37.9% and 30.1% respectively) and improved government housing (34.4% and 29.1% respectively) whilst White adolescents lived predominantly in bond housing (privately owned), flats or townhouses (95.0%). Half of the Indian adolescents lived in bond housing, flats or townhouses (51.7%).

Around half of the Black African, Mixed Ancestry and Indian sample reported living in good condition housing (49.1%, 47.3% and 51.7% respectively) as opposed to 77.0% in the White sample. Fewer White adolescents perceived themselves as poor (4.8%) compared with 13.6% and 16.8% of Black African and Mixed Ancestry adolescents respectively.

Black African adolescents reported a lower availability of public services such as schools (30.5% for primary schools, 40.3% for secondary schools), health facilities (72.7% for hospitals, 61.7% for primary health clinic), community and recreational facilities (65.0%) than Whites (11.9% for primary schools, 19.9% for secondary schools, 33.3% for hospitals, 40.5% for primary health clinic, 43.7% for community and recreational facilities). The same tendency was seen for Mixed Ancestry adolescents in comparison to Whites. Black African, Mixed Ancestry and Indian adolescents reported a lower availability of sports facilities, park and police officers patrolling neighbourhood in comparison to Whites. Mixed Ancestry, Black African and Indian groups experienced more problems in their neighbourhood compared to the White group. The main problems reported were unemployment, alcohol abuse, shebeens (bars), drugs, gangsterism and illegal dumping. Although similar patterns were observed between Black African and Mixed Ancestry adolescents, the prevalence of problems related to drugs and gangsterism was higher in the Mixed Ancestry group. 79.6% and 74.2% of Mixed Ancestry adolescents reported problems with drugs and gangsterim respectively compared to 60.1% and 59.9% in the Black African group. The prevalence of problems related to prostitution was higher in the Mixed Ancestry group (19.2%) compared to the White group (7.9%).

In terms of neighbourhood social environment, Black African and Mixed Ancestry groups were more likely to report feeling unsafe in their neighbourhood (13.6% and 13.9% respectively) as opposed to 5.6% in the White group (Table 16). 31.7% of the Mixed Ancestry sample and 22.7% of the Black Africans reported a lot of crime in their neighbourhood and this was significantly different to the White sample (7.9%). Black African, Mixed Ancestry and Indian adolescents reported spending time with their friends more often than White adolescents. Indeed, 36.2% of Black African adolescents, 48.7% of Mixed Ancestry adolescents and 51.8% of Indian adolescents reported spending time with their friends on a daily basis as opposed to 13.5% in the White group. The atmosphere in the neighbourhood and the community spirit was reported predominantly as lively and strong in the Black African, Mixed Ancestry and Indian groups. For instance, the community spirit was reported as strong by 38.4% of Black African adolescents and 35.3% of Mixed Ancestry adolescents as opposed to 9.5% in the White group. The prevalence of security measures used to ensure safety was high across the different population groups although noticeably higher in the White group. Among the Black African and Mixed Ancestry groups, the security measures mainly adopted were dogs, high walls and barred windows.

The proportion of adolescents who reported feeling unsafe or only moderately safe at school was substantial at 19.3% (Table 16). The proportion of adolescents feeling unsafe was higher in the Black African (6.5%) and Mixed Ancestry (2.6%) groups compared to Whites (1.0%). Black African and Mixed Ancestry adolescents reported experiencing more problems at school such as teenage pregnancy, violence, bullying, weapons, poor educational environment (lack of discipline, teachers who cannot teach well, lack of dedicated teachers, poor academic standards, teachers under the influence of alcohol during teaching hours) in comparison to Whites.

Table 16. Descriptive statistics (overall and by population groups) related to the neighbourhood socio-economic and school environment reported by urban South African adolescents aged 18 years

	Total		Black Africans		Mixed Ancestry		Indians		Whites	
	n	%	n	%	n	%	n	%	n	%
Type of housing	1980		1609	***	223	***	29	***	119	
Shacks	89	4.5	77	4.8	11	4.9	1	3.5	0	0
Government housing/flats	685	34.6	610	37.9	67	30.1	5	17.2	3	2.5
Improved government housing/flats	630	31.8	554	34.4	65	29.1	8	27.6	3	2.5
Bond housing/flats/ townhouses	576	29.1	368	22.9	80	35.9	15	51.7	113	95.0
Housing condition	2007		1626	***	226	***	29	**	126	
Bad	162	8.0	132	8.1	27	12.0	2	6.9	1	0.8
Average	828	41.3	696	42.8	92	40.7	12	41.4	28	22.2
Good	1017	50.7	798	49.1	107	47.3	15	51.7	97	77.0
Perceptions of wealth	2008		1627	***	226	***	29	**	126	
Poor	267	13.3	221	13.6	38	16.8	2	6.9	6	4.8
Average	1401	69.8	1169	71.8	147	65.0	23	79.3	62	49.2
Wealthy	340	16.9	237	14.6	41	18.2	4	13.8	58	46
Lack of availability of services										
Primary school	567	28.4	494	30.5***	51	22.7*	7	24.1	15	11.9
Secondary school	754	37.6	654	40.3***	68	30.1*	7	24.1	25	19.9
Hospital	1386	69.2	1179	72.7***	153	67.7***	12	41.4	42	33.3
Primary health clinic	1202	60.0	1002	61.7***	134	59.6**	15	51.7	51	40.5
Community/ recreational centre	1253	62.5	1054	65.0***	129	57.1*	15	51.7	55	43.7
Sports field, pool or tennis courts	1237	61.8	1050	64.7***	129	57.1***	17	58.6*	41	32.5
Park	1047	52.3	896	55.3***	113	50.0***	13	44.8**	25	19.8
Street lighting in working conditions	1009	50.4	838	51.6***	126	55.7***	16	55.2**	29	23.2
Piped water supply	769	38.4	655	40.4***	90	39.8***	11	37.9**	13	10.3
Police officers patrolling neighbourhood	1528	76.3	1257	77.5***	173	76.5**	24	82.8*	74	58.7

Significance values are for trends from unadjusted logistic or ordered logistic regression using whites as reference category
*p<0.05 **p <0.01 *** p<0.001

Table 16. Descriptive statistics (overall and by population groups) related to the neighbourhood socio-economic and school environment reported by urban South African adolescents aged 18 years (continued)

	Total		Black Africans		Mixed Ancestry		Indians		Whites	
	n	%	n	%	n	%	n	%	n	%
Problems in neighbourhood										
Unemployment	1624	81	1370	84.4***	187	83.1***	19	65.5**	48	38.1
Alcohol abuse	1496	74.7	1254	77.3***	170	75.6***	20	69.0**	52	41.3
Shebeens (bars)	1477	73.7	1256	77.4***	179	79.6***	15	51.7**	27	21.4
Drugs	1216	60.8	975	60.1***	179	79.6***	21	72.4***	41	32.5
Gangsters	1178	58.8	972	59.9***	167	74.2***	16	55.2***	23	18.2
Illegal dumping	1142	56.9	946	58.2***	146	64.6***	16	55.2**	34	27.0
Delinquency	1098	54.8	913	56.3***	141	62.7***	11	37.9	33	26.2
Overcrowding	771	38.5	673	41.5***	82	36.3***	5	17.24	11	8.7
Sewerage	741	36.9	637	39.2***	87	38.5***	6	20.7	11	8.7
Road rage	614	30.6	479	29.5	86	38.0	11	37.9	38	30.2
Minority attacks	547	27.3	457	28.2***	81	35.8***	4	13.8	5	4.0
Homelessness	517	25.8	382	23.5*	83	37.0	12	41.4	40	31.7
Prostitution	239	11.9	180	11.1	43	19.2**	6	20.7	10	7.9

Significance values are for trends from unadjusted logistic or ordered logistic regression using whites as reference category
*p<0.05 **p <0.01 *** p<0.001

Table 16. Descriptive statistics (overall and by population groups) related to the neighbourhood socio-economic and school environment reported by urban South African adolescents aged 18 years (continued)

	Total		Black Africans		Mixed Ancestry		Indians		Whites	
	n	%	n	%	n	%	n	%	n	%
Feeling of safety	**2001**		**1623**		**223**		**29**		**126**	
Unsafe	259	13.0	220	13.6	31	13.9	1	3.5	7	5.6
Moderate	619	30.9	492	30.3	76	34.1	7	24.1	44	34.9
Safe	1123	56.1	911	56.1	116	52	21	72.4	75	59.5
Level of crime	**2002**		**1623**	*	**224**	***	**29**		**126**	
A lot	454	22.7	368	22.7	71	31.7	5	17.2	10	7.9
Some	587	29.3	477	29.4	57	25.5	9	31.0	44	34.9
Average	467	23.3	376	23.2	48	21.4	5	17.2	38	30.2
Not much	404	20.2	328	20.2	38	17.0	9	31.0	29	23.0
None	90	4.5	74	4.5	10	4.4	1	3.6	5	4.0
Time spent with friends in the neighbourhood	**2000**		**1621**	***	**224**	***	**29**	***	**126**	
Never	312	15.6	249	15.4	33	14.7	3	10.3	27	21.4
Less than once a week	232	11.6	188	11.6	16	7.1	1	3.5	27	21.4
Once a week	276	13.8	226	13.9	32	14.3	3	10.3	15	12.0
2-6 times a week	452	22.6	371	22.9	34	15.2	7	24.1	40	31.7
Daily	728	36.4	587	36.2	109	48.7	15	51.8	17	13.5
Liveliness in the neighbourhood	**2000**		**1621**	***	**224**	**	**29**		**126**	
Not very lively	362	18.2	279	17.2	40	17.9	8	27.6	35	27.8
Average	805	40.2	657	40.5	85	37.9	6	20.7	57	45.2
Lively	833	41.6	685	42.3	99	44.2	15	51.7	34	27.0
Community spirit	**1997**		**1621**	***	**221**	***	**29**	*	**126**	
Weak	546	27.3	413	25.5	67	30.3	7	24.1	59	46.8
Average	731	36.6	585	36.1	76	34.4	15	51.8	55	43.6
Strong	720	36.1	623	38.4	78	35.3	7	24.1	12	9.6
Security measures										
Dogs	1561	79.0	1244	77.6**	179	81.7*	24	85.7	114	90.5
Weapons	888	61.4	709	60.1	116	67.8	16	64.0	47	66.2
Security guards	640	33.0	469	29.8***	59	27.2***	13	44.8***	99	81.1
High walls/fences/gates	1631	81.8	1314	81.3***	171	77.4***	24	82.8**	122	96.8
Electric fences	774	39.2	552	34.6***	87	38.8***	18	62.1***	117	93.6
Alarms/panic buttons	732	39.2	482	32.1***	110	51.2***	21	75.0**	119	96.0
Security doors	1108	58.4	861	56.2***	111	50.9***	18	64.3***	118	99.2
Barred windows	1594	81	1289	80.8**	163	73.4***	20	71.4***	122	99.2
Security lights	872	46.1	654	43.0***	89	40.8***	18	64.3**	111	90.2

Significance values are for trends from logistic or ordered logistic regression using whites as reference category

*p<0.05, **p <0.01, *** p<0.001

Table 16. Descriptive statistics (overall and by population groups) related to the neighbourhood socio-economic and school environment reported by urban South African adolescents aged 18 years (continued)

	Total		Black Africans		Mixed Ancestry		Indians		Whites	
	n	%	n	%	n	%	n	%	n	%
Safety at school	**1243**		**1056**		**76**		**16**		**95**	
Unsafe	72	5.8	69	6.5	2	2.6	_	_	1	1.0
Moderate	166	13.4	140	13.3	11	14.5	2	12.5	13	13.7
Safe	1005	80.8	847	80.2	63	82.9	14	87.5	81	85.3
Problems at school										
Smoking	1045	84.5	906	86.1**	57	77	11	73.3	71	74.7
Bunking off	806	65.2	688	65.4	47	63.5	9	60.0	62	65.3
Teenage pregnancy	792	64.1	718	68.3***	48	64.9***	5	33.3	21	22.1
Learners under the influence of alcohol during teaching hours	558	45.1	491	46.7**	29	39.2	7	46.7	31	32.6
Overcrowding	496	40.2	428	40.7	29	39.2	7	46.7	32	33.7
Lack of discipline	471	38.1	414	39.3***	34	46.6***	5	33.3	18	18.9
Violence	449	36.4	398	37.9***	36	48.7***	6	40**	9	9.5
Bullying	420	34.0	377	35.9***	33	44.6***	2	13.3	8	8.4
Teachers who cannot teach well	402	32.5	340	32.3**	28	37.8**	7	46.7	27	28.4
Drugs	382	31.1	328	31.4	24	32.4	5	33.3	25	26.6
Weapons	332	27.0	291	27.9***	29	39.2***	5	33.3**	7	7.4
Lack of dedicated teachers	304	24.6	264	25.1**	25	33.8**	3	20.0	12	12.6
Poor academic standards	281	22.7	244	23.2**	24	32.4***	4	26.7	9	9.5
Sexual relationships between learners and teachers	260	21.5	245	23.9***	9	12.5	2	14.3	4	4.2
Teachers under the influence of alcohol during teaching hours	166	13.5	149	14.2**	13	17.6**	2	13.3	2	2.1
Rape	55	4.5	46	4.4	4	5.5	2	13.3	3	3.2

Significance values are for trends from logistic or ordered logistic regression using whites as reference category
*p<0.05, **p <0.01, *** p<0.001

5.2 Univariate and multivariate analyses

5.2.1 Self-perceived neighbourhood economic environment

5.2.1.1 Total sample

Highly significant associations were found between population group and the three neighbourhood economic indices (neighbourhood economic index (p<0.0001), neighbourhood availability of service index (p<0.0001), and neighbourhood problem index (p<0.0001)) in the adjusted models (Table 17). Being Black African in comparison to White reduced the odds of having a higher economic index by 91% (OR=0.09 [0.03-0.24]). Being Mixed Ancestry also reduced the odds of having a higher economic index (OR=0.08 [0.03-0.22]. Being Black African also reduced the odds of having a high neighbourhood availability of services by 72% (OR=0.28 [0.17-0.47]). The same association was seen in Mixed Ancestry adolescents (OR=0.30 [0.17-0.51]). Finally, being Black African or Mixed Ancestry vs. White reduced the odds of low neighbourhood problems (OR=0.25 [0.15-0.42] and (OR=0.17 [0.09-0.29]) respectively).

Significant associations were also found between the caregiver's education and the three neighbourhood economic indices (p≤0.0001). Living with a non-educated caregiver or a caregiver who achieved primary school in comparison to a higher educated caregiver reduced the odds of 1) having a higher neighbourhood economic index by 79% (OR=0.21 [0.13-0.34]), 2) having a high availability of services by 56% (OR=0.44 [0.30-0.63]) and 3) experiencing low neighbourhood problems by 48% (OR=0.52 [0.36-0.75]. The same tendency was found when comparing a caregiver who achieved secondary school in comparison to a higher educated caregiver.

Place of residence was associated with the neighbourhood economic index (p=0.035). Living in metropolitan Johannesburg in comparison to Soweto increased the odds of having a higher neighbourhood economic index (OR=1.54 [1.03-2.29]).

Sex differences were seen in the perception of the neighbourhood economic environment. Being female vs. male reduced the odds of having a higher neighbourhood economic index by 18% (OR=0.82 [0.68-0.99]) (data not shown).

5.2.1.2 Black African adolescent subsample

The same patterns were observed in the subsample of only Black African adolescents. Strong associations were found between the caregiver's education and the three neighbourhood economic indices (Table 17). Living in metropolitan Johannesburg rather than Soweto increased the odds of having a higher economic index (OR=1.74 [1.02-2.95]). After adjustment, there was no significant difference in neighbourhood availability of services and problems between Black Africans living in metropolitan Johannesburg and those living in Soweto.

Perceptions regarding the neighbourhood problem environment differed by sex. Black African females had higher odds of reporting less problems in comparison to Black African males (OR=1.24 [1.02-1.52]) (data not shown).

Table 17. Self-perceived neighbourhood economic environment for urban South African adolescents aged 18 years

	Neighbourhood economic index (tertiles)						**Neighbourhood availability of services index (tertiles)**						**Neighbourhood problem index (tertiles)**					
			Unadjusted		**Adjusted**				**Unadjusted**		**Adjusted**				**Unadjusted**		**Adjusted**	
	n	**%**	**OR**	**CI**	**OR**	**CI**	**n**	**%**	**OR**	**CI**	**OR**	**CI**	**n**	**%**	**OR**	**CI**	**OR**	**CI**
Total sample*																		
Population group			p<0.0001		p<0.0001				p<0.0001		p<0.0001				p<0.0001		p<0.0001	
White	114	6.4	1	-	1	-	113	6.4	1	-	1	-	114	6.5	1	-	1	-
Black African	1446	81.4	0.10	0.06-0.15	0.09	0.03-0.24	1441	81.4	0.18	0.12-0.27	0.28	0.17-0.47	1428	81.4	0.21	0.14-0.31	0.25	0.15-0.42
Mixed Ancestry	217	12.2	0.09	0.05-0.15	0.08	0.03-0.22	217	12.2	0.23	0.14-0.36	0.30	0.17-0.51	213	12.1	0.14	0.09-0.23	0.17	0.09-0.29
Caregiver education			p<0.0001		p<0.0001				p<0.0001		p=0.0001				p<0.0001		p<0.0001	
Higher education	211	13.1	1	-	1	-	212	13.2	1	-	1	-	207	13.0	1	-	1	-
Secondary school	1157	71.9	0.21	0.16-0.28	0.28	0.20-0.39	1153	71.9	0.41	0.31-0.55	0.57	0.42-0.77	1143	71.8	0.34	0.26-0.45	0.46	0.34-0.63
≤ Primary school	241	15.0	0.15	0.10-0.23	0.21	0.13-0.34	239	14.9	0.30	0.21-0.43	0.44	0.30-0.63	241	15.2	0.37	0.26-0.53	0.52	0.36-0.75
Place of residence			p<0.0001		p=0.035				p<0.0001		p=0.081				p<0.0001		p=0.63	
Soweto	1379	78.0	1	-	1	-	1375	78.1	1	-	1	-	1364	78.1	1	-	1	-
Johannesburg	388	22.0	3.51	2.36-5.23	1.54	1.03-2.29	386	21.9	1.97	1.59-2.44	1.26	0.97-1.64	382	21.9	1.85	1.42-2.40	1.07	0.82-1.40
Sample of black African adolescents**																		
Caregiver education			p<0.0001		p<0.0001				p<0.0001		p=0.0001				p<0.0001		p=0.0001	
Higher education	133	10.1	1	-	1	-	133	10.1	1	-	1	-	128	9.8	1	-	1	-
Secondary school	969	73.6	0.29	0.20-0.41	0.30	0.21-0.45	965	73.6	0.50	0.35-0.70	0.52	0.37-0.74	959	73.7	0.44	0.31-0.63	0.46	0.32-0.65
≤ Primary school	215	16.3	0.21	0.12-0.35	0.22	0.13-0.38	214	16.3	0.39	0.26-0.59	0.41	0.27-0.62	215	16.5	0.51	0.34-0.78	0.53	0.35-0.80
Place of residence			p=0.038		p=0.042				p=0.041		p=0.071				p=0.123		p=0.530	
Soweto	1243	86.6	1	-	1	-	1240	86.7	1	-	1	-	1231	86.8	1	-	1	-
Johannesburg	193	13.4	1.75	1.03-2.97	1.74	1.02-2.95	191	13.3	1.34	1.01-1.77	1.32	0.98-1.78	188	13.2	1.35	0.92-1.98	1.10	0.81-1.51

*Adjusted for sex, population group, caregiver education and place of residence

** Adjusted for sex, caregiver education and place of residence

5.2.2 Self-perceived neighbourhood social environment

5.2.2.1 Total sample

Table 18 shows a relationship between population group and the neighbourhood social support index (p=0.007). Being Black African in comparison to White reduced the odds of reporting a positive social support environment by 51% (OR=0.49 [0.31-0.77]). Being Mixed Ancestry reduced the odds by 41% (OR=0.59 [0.36-0.96] compared to the White adolescents. There was no significant difference between metropolitan Johannesburg and Soweto in terms of social environment (p=0.24).

Perceptions of the neighbourhood security environment differed by population group, caregiver education and place of residence. Being Black African or Mixed Ancestry compared to White reduced the odds of reporting a higher neighbourhood security index by 89% (OR=0.11 [0.04-0.32]). Living with a caregiver who completed no education or primary school vs. higher education reduced the odds of having a higher neighbourhood security index by 74% (OR=0.26 [0.16-0.42]). Living with a caregiver who completed secondary school vs. higher education reduced the odds by 60% (OR=0.40 [0.27-0.60]). Adolescents living in metropolitan Johannesburg reported having a higher neighbourhood security index compared with those living in Soweto (OR=2.48 [1.77-3.47]).

Perceptions of the neighbourhood social support and security environment differed by sex (data not shown). Females displayed lower odds of having a positive social support environment (OR=0.83 [0.69-0.99]) and a higher neighbourhood security index (OR=0.73 [0.58-0.92]) compared to males.

5.2.2.2 Black African adolescent subsample

There was no significant difference between Black Africans living in metropolitan Johannesburg and those living in Soweto in terms of perceptions of their neighbourhood social support environment (Table 18). Living with a caregiver that completed no education or primary school vs. higher education reduced the odds of having a higher neighbourhood security index by 66% (OR=0.34 [0.20-0.56]). Living with a caregiver who completed secondary school vs. higher education reduced the odds by 55% (OR=0.45 [0.29-0.70]). Living in metropolitan Johannesburg increased the odds of having a higher neighbourhood security index compared to living in Soweto (OR=2.93 [1.96-4.36]).

Perceptions of the neighbourhood security environment differed by sex. Black African females displayed lower odds of having a higher neighbourhood security environment compared to Black African males (OR=0.72 [0.56-0.92]) (data not shown).

Table 18. Self-perceived neighbourhood social environment for urban South African adolescents aged 18 years

	Neighbourhood social support index (tertiles)						Neighbourhood security index (tertiles)					
			Unadjusted		Adjusted				Unadjusted		Adjusted	
	n	%	OR	CI	OR	CI	n	%	OR	CI	OR	CI
Total sample*												
Population group			p=0.0037		p=0.007				p<0.0001		p=0.0003	
White	114	6.5	1	-	1	-	63	5.3	1	-	1	-
Black African	1441	81.5	0.55	0.39-0.78	0.49	0.31-0.77	971	81.8	0.03	0.01-0.07	0.11	0.04-0.32
Mixed Ancestry	213	12.0	0.59	0.39-0.90	0.59	0.36-0.96	153	12.9	0.04	0.01-0.10	0.11	0.04-0.34
Caregiver education			p=0.22		p=0.34				p<0.0001		p<0.0001	
Higher education	210	13.1	1	-	1	-	131	12.1	1	-	1	-
Secondary school	1152	71.8	0.82	0.62-1.08	0.92	0.69-1.23	776	71.9	0.27	0.19-0.39	0.40	0.27-0.60
≤ Primary school	242	15.1	0.96	0.68-1.35	1.10	0.77-1.59	173	16.0	0.17	0.11-0.26	0.26	0.16-0.42
Place of residence			p=0.48		p=0.243				p<0.0001		p<0.0001	
Soweto	1379	78.2	1	-	1	-	943	79.6	1	-	1	-
Johannesburg	384	21.8	1.08	0.88-1.33	0.85	0.66-1.11	242	20.4	5.25	3.33-8.28	2.48	1.77-3.47
Sample of black African adolescents**												
Caregiver education			p=0.29		p=0.32				p=0.0001		p=0.0001	
Higher education	132	10.0	1	-	1	-	82	9.2	1	-	1	-
Secondary school	966	73.5	1.06	0.76-1.49	1.01	0.72-1.43	656	73.8	0.42	0.27-0.65	0.45	0.29-0.70
≤ Primary school	217	16.5	1.30	0.87-1.95	1.25	0.83-1.87	151	17.0	0.32	0.19-0.54	0.34	0.20-0.56
Place of residence			p=0.155		p=0.227				p<0.0001		p<0.0001	
Soweto	1244	86.7	1	-	1	-	847	87.6	1	-	1	-
Johannesburg	191	13.3	0.81	0.61-1.08	0.83	0.61-1.12	120	12.4	2.86	1.97-4.13	2.93	1.96-4.36

*Adjusted for sex, population group, caregiver education and place of residence

** Adjusted for sex, caregiver education and place of residence

5.2.3 Self-perceived neighbourhood school environment

5.2.3.1 Total sample

Perceptions of the neighbourhood school environment differed by population group and caregiver education (Table 19). Adjusted results show that being Black African reduced the odds of having a higher neighbourhood school economic environment by 88% (OR=0.12 [0.05-0.28]) and being Mixed Ancestry reduced the odds by 92% (OR=0.08 [0.03-0.21]) compared to whites. Living with a caregiver who completed no education or primary school vs. higher education reduced the odds by 74% (OR=0.26 [0.16-0.42]. There was no significant difference between adolescents living in metropolitan Johannesburg and the ones living in Soweto regarding their school environment perceptions (p=0.06).

Perceptions of the school problem environment differed by population group, caregiver education and place of residence. Being Black African and Mixed Ancestry reduced the odds of reporting fewer problems at school by 46% and 58% respectively in comparison to White adolescents. Living with a caregiver who completed no education or primary school education reduced the odds by 54% (OR=0.46 [0.29-0.75]). The odds of reporting fewer problems at school are greater when living in metropolitan Johannesburg (increase by 53% (OR=1.53 [1.06-2.19]) in comparison to adolescents living in Soweto.

Perceptions of the school problem environment also differed by sex, with females displaying higher odds of reporting fewer problems at school in comparison to males (OR=1.55 [1.22-1.97]) (data not shown).

5.2.3.2 Black African adolescent subsample

In Black Africans, a lower caregiver education was associated with perceptions of a lower school economic environment (Table 19). Living with a caregiver who completed no education or primary school vs. higher education reduced the odds of having a higher economic school environment (e.g. high availability of facilities such as library, swimming pool, computer rooms, science labs)) by 81% (OR=0.19 [0.10-0.37]).

There were no significant economic differences in school environments between metropolitan Johannesburg and Soweto after adjusting for caregiver education.

The neighbourhood school problem index was associated with caregiver's education and place of residence. A lower caregiver education was associated with perceptions of more problems at school. Living with a caregiver who completed no education or primary school reduced the odds of reporting less problems at school by 55% (OR=0.45 [0.27-0.76]). The odds of reporting less neighbourhood school problems were greater when living in metropolitan Johannesburg (increase by 52% (OR=1.52 [1.03-2.23]) compared to living in Soweto and for Black African females compared to Black African males (OR=1.53 [1.19-1.98].

Table 19. Self-perceived neighbourhood school environment for urban South African adolescents aged 18 years

	Neighbourhood school economic index (tertiles)						Neighbourhood school problem index (tertiles)					
			Unadjusted		Adjusted				Unadjusted		Adjusted	
	n	**%**	**OR**	**CI**	**OR**	**CI**	**n**	**%**	**OR**	**CI**	**OR**	**CI**
Total sample*												
Population group			p<0.0001		p<0.0001				p<0.0001		p=0.042	
White	80	7.7	1	-	1	-	84	8.1	1	-	1	-
Black African	891	85.8	0.16	0.09-0.31	0.12	0.05-0.28	884	85.3	0.13	0.06-0.28	0.54	0.31-0.96
Mixed Ancestry	67	6.5	0.16	0.09-0.30	0.08	0.03-0.21	68	6.6	0.09	0.02-0.32	0.42	0.21-0.83
Caregiver education			p<0.0001		p<0.0001				p<0.0001		p=0.0077	
Higher education	150	15.8	1	-	1	-	142	15.1	1	-	1	-
Secondary school	674	71.2	0.26	0.17-0.38	0.33	0.22-0.49	672	71.3	0.46	0.33-0.64	0.66	0.45-0.96
≤ Primary school	123	13.0	0.22	0.14-0.33	0.26	0.16-0.42	129	13.7	0.32	0.20-0.49	0.46	0.29-0.75
Place of residence			p<0.0001		p=0.06				p<0.0001		p=0.021	
Soweto	811	78.4	1	-	1	-	805	78.0	1	-	1	-
Johannesburg	223	21.6	5.60	2.90-10.80	1.42	0.98-2.06	227	22.0	2.36	1.79-3.10	1.53	1.06-2.19
Sample of black African adolescents**												
Caregiver education			p<0.0001		p<0.0001				p=0.0040		p=0.011	
Higher education	92	11.3	1	-	1	-	84	10.4	1	-	1	-
Secondary school	610	74.7	0.31	0.21-0.48	0.25	0.14-0.44	605	74.8	0.60	0.40-0.91	0.66	0.43-1.02
≤ Primary school	115	14.0	0.25	0.16-0.41	0.19	0.10-0.37	120	14.8	0.41	0.25-0.70	0.45	0.27-0.76
Place of residence			p=0.039		p=0.137				p=0.005		p=0.035	
Soweto	767	86.5	1	-	1	-	762	86.6	1	-	1	-
Johannesburg	120	13.5	1.80	1.03-3.15	1.60	0.86-2.99	118	13.4	1.66	1.16-2.37	1.52	1.03-2.23

*Adjusted for sex, population group, caregiver education and place of residence

** Adjusted for sex, caregiver education and place of residence

5.3 Summary of results

This study shows that the adolescents' responses to questions on neighbourhood socio-economic and school environments are statistically significantly different according to population group, gender, place of residence and level of caregiver education.

Black African and Mixed Ancestry participants reported living in more deprived SES environments. Black African and Mixed Ancestry adolescents reported a poorer overall neighbourhood economic environment (i.e., they were less likely to have a higher neighbourhood economic index, high availability of services, and low neighbourhood problems) as well as a less favourable social support environment in comparison to Whites.

Black African and Mixed Ancestry adolescents also reported studying in less favourable schools compared to Whites. The neighbourhood socio-economic findings of this study are strongly suggestive of underlying inequalities among adolescents living in this area, with the Black African and Mixed Ancestry groups still being the most disadvantaged.

Among the Black African group, adolescents living in Soweto reported more deprived economic and school environments than those living in Johannesburg. However, no differences were seen between the two places in terms of social support environment, neighbourhood availability of services or level of neighbourhood problems.

Chapter 6: Neighbourhood and household socio-economic influences on dietary intake

6. Neighbourhood and household socio-economic influences on dietary intake

This chapter will firstly describe the characteristics of the analysis sample. Secondly, the daily energy and macronutrient (fat, carbohydrate and protein) intakes will be presented for the overall sample and stratified by sex. The daily macronutrient intakes will then be compared to the international recommendations (WHO/FAO 2003). Thirdly, a description of the food items consumed by the sample will be given, both in terms of the proportion of daily grams and energy intake. Dietary patterns of the sample will then be discussed. Finally, the univariate and step-wise multivariate analysis of the effect of food environment, neighbourhood and household SES on total energy and macronutrients as a proportion of total energy intake will be reported.

6.1 Sample characteristics

Table 20 below shows the socio-demographic characteristics of the sample used for the dietary analysis, after the removal of outliers. The overall sample size was 631 (46.7% males, 84.6% mixed ancestry). The mean age was 17.95 years (Table 20). 73.2% of the adolescents' caregivers had achieved an educational level up to the completion of secondary school, with only 12.7% attaining a higher education (11.3% males vs. 14.0% females). In terms of household wealth index, 37.6% of the sample was in the medium tertile (40.8% males vs. 34.9% females). Adolescents lived mainly in government housing (37% in government housing and 33.5% in improved government housing). When asked to describe their neighbourhood in terms of wealth, 72.2% of adolescents reported their neighbourhood to be average. 36.0% of the sample was in the 1st tertile of the neighbourhood economic index (34.5% males vs. 37.3% females). With regards to the food environment, approximately half of the sample lived within 20 minutes of either a shopping mall (53.3%) or restaurant (50.9%). More than two thirds (68.3%) of the sample had a fast food outlet in their neighbourhood.

Table 20. Sample characteristics

	Total		Males		Females	
Number of participants (n)	**631**		**295**		**336**	
Population group	**n**	%	**n**	%	**n**	%
Black	534	84.6	252	85.4	282	83.9
Mixed Ancestry	97	15.4	43	14.6	54	16.1
Caregiver education	**574**		**273**		**301**	
Primary school	81	14.1	42	15.4	39	12.9
Secondary school	420	73.2	200	73.3	220	73.1
Higher education	73	12.7	31	11.3	41	14
Household wealth index	**558**		**260**		**298**	
1st tertile	182	32.6	83	31.9	99	33.2
2nd tertile	210	37.6	106	40.8	104	34.9
3rd tertile (wealthy)	166	29.8	71	27.3	95	31.9
Type of home	**600**		**277**		**323**	
Shacks	24	4.0	10	3.6	14	4.3
Government housing/flats	222	37.0	103	37.2	119	36.8
Improved government housing/flats	201	33.5	97	35	104	32.2
Bond housing/flats/townhouses	147	25.7	64	23.1	83	25.7
Other	6	0.9	3	1.1	3	0.9
Perception of neighbourhood wealth	**601**		**277**		**324**	
Very poor	17	2.8	5	1.8	12	3.7
Poor	54	9.0	24	8.7	30	9.3
Average	434	72.2	200	72.2	234	72.2
Wealthy	81	13.5	39	14.1	42	12.9
Very wealthy	15	2.5	9	3.2	6	1.9
Neighbourhood economic index	**597**		**275**		**322**	
1st tertile	215	36	95	34.5	120	37.3
2nd tertile	190	31.8	88	32	102	31.7
3rd tertile (wealthy)	192	32.2	92	33.5	100	31.1
Fast food in neighbourhood (≤20 minutes)	**596**		**274**		**322**	
No	189	31.7	67	24.4	122	37.9
Yes	407	68.3	207	75.7	200	62.1
Food outlets in neighbourhood (≤20 minutes)	**598**		**276**		**322**	
No	17	2.8	8	2.9	9	2.8
Yes	581	97.2	268	97.1	313	97.2
Shopping mall in neighbourhood (≤20 minutes)	**596**		**274**		**322**	
No	301	50.5	128	46.7	173	53.7
Yes	295	49.5	146	53.3	149	46.3
Restaurant in neighbourhood (≤20 minutes)	**596**		**275**		**321**	
No	327	54.9	135	49.1	192	59.8
Yes	269	45.1	140	50.9	129	40.2

6.2 Energy, macronutrient intakes and recommended nutrient intakes in the adolescent sample

The overall energy and macronutrient intakes are displayed in Table 21 below. The recommended energy intake for males aged 17-18 years is 3410 kcal/day, with 2503 kcal/day for females (Torun 2001). The recommended macronutrient intakes are shown in Table 22.

In the total sample, the median energy intake was 4053.3 kcal/day (interquartile range (IQR): 2368.9). In males, the median energy intake was significantly greater than in females (4469.6 vs. 3764.2, $p<0.0001$). However, when these energy intakes were reported as percentages of the recommended intake for sex, females consumed significantly higher amounts of energy compared to males, relative to their recommended intakes (150.4% females vs. 131.1% males, $p=0.001$).

The mean protein intake as a percentage of total energy was not significantly different between the sexes (11.8% males vs. 11.4% females, $p=0.07$). Both for males and females, intakes were well within the recommended intake of 10-15%. Males consumed significantly more plant protein than females (5.3% vs. 4.7%, $p<0.0001$).

The fat intake was significantly higher in females than in males (34.4% vs. 32.6%, $p=0.0002$) and for both sexes, exceeded the recommended fat intake (15-30%). Females consumed significantly more saturated fat than males (10.2% vs. 9.6%, $p=0.002$), but close to the recommended intake of less than 10%.

No significant difference between carbohydrate consumption was observed between the sexes (50.2% males vs. 49.6% females, $p=0.26$). These were both below the recommended intake of 55-75% of total energy coming from carbohydrate. Both males and females consumed more added sugar than recommended (<10% of total daily energy intake), with females consuming significantly more than males (12.0% vs. 11.2%, $p=0.01$).

Fibre consumption was on average above the recommended intake of 25g/day, with a significantly higher consumption in males than females (38.4g vs. 29.7g, $p<0.0001$). 20.3% of males and 31.5% of females ($p<0.001$ for difference) were below the recommended fibre intake.

Alcohol contributed a significantly greater amount to total energy intake in males compared to females (1.75% vs. 0.78%, $p=0.0001$).

Fruit consumption was close the recommended intake of 400g/day for both males and females, with a significantly higher consumption in males (478.4g vs. 397.8g, p=0.002). In males 39.0% consumed less than the recommended intake of fruit and vegetables of 400g, compared to 50.6% of females (p=0.003).

Table 21. Mean daily energy (kcal) and macronutrient intakes as percentage of total energy intake by sex

Variables	Total (n=631)		Males (n=295)		Females (n=336)		
	Mean/ Median	SD/IQR	Mean/ Median	SD/IQR	Mean/ Median	SD/IQR	p-value
Age	17.95	0.44	17.94	0.43	17.95	0.45	0.77[1]
Reported energy intake (z-scores)	-0.06	0.82	-0.05	0.78	-0.07	0.85	0.73[1]
Reported energy intake (kcal)	4053.3	3037.6-5406.5	4469.6	3483.0-5883.7	3764.2	2746.4-4848.7	<0.0001***[2]
Percentage of recommended energy intake (%)	138.7	105.9-184.1	131.1	102.1-172.5	150.4	109.7-193.7	0.001**[2]
Protein %	11.6	2.3	11.8	2.3	11.4	2.3	0.07[1]
Animal protein %	6.1	2.5	6.1	2.5	6.1	2.5	0.98[1]
Plant Protein %	5.0	1.2	5.3	1.2	4.7	1.2	<0.0001***[1]
Fat %	33.6	6.2	32.6	6.5	34.4	5.9	0.0002***[1]
Saturated fat %	9.9	2.2	9.6	2.3	10.2	2.1	0.002**[1]
Mono-unsaturated fat%	10.9	2.4	10.8	2.6	11.0	2.2	0.21[1]
Poly-unsaturated fat%	9.1	7.6-11.2	8.8	7.4-10.4	9.5	7.9-11.8	0.0002***[2]
Carbohydrates %	49.9	6.5	50.2	6.8	49.6	6.3	0.26[1]
Added Sugar %	11.5	8.7-14.7	11.2	8.5-14.0	12.0	8.9-15.9	0.01*[2]
Fibres (g)	33.7	24.5-45.9	38.4	27.8-53.6	29.7	22.5-38.5	<0.0001***[2]
Fibres (%)	1.7	0.5	1.8	0.5	1.7	0.5	<0.0001***[1]
Alcohol (%)	1.3	3.3	1.8	3.9	0.8	2.6	0.0001***[2]

Independent t-tests [1] and Mann-Whitney tests [2] were used to test for significant differences between males and females.
*p<0.05 **p<0.01 ***p<0.001

Table 22. Ranges of population nutrient intake goals

Dietary factor	Goal (% of total energy)
Total fat	15-30%
Saturated fatty acids	< 10%
Total carbohydrate	55-75%
Free sugars	< 10%
Protein	10-15%
Fruit and vegetables*	≥ 400 g per day
Total dietary fibre	> 25g

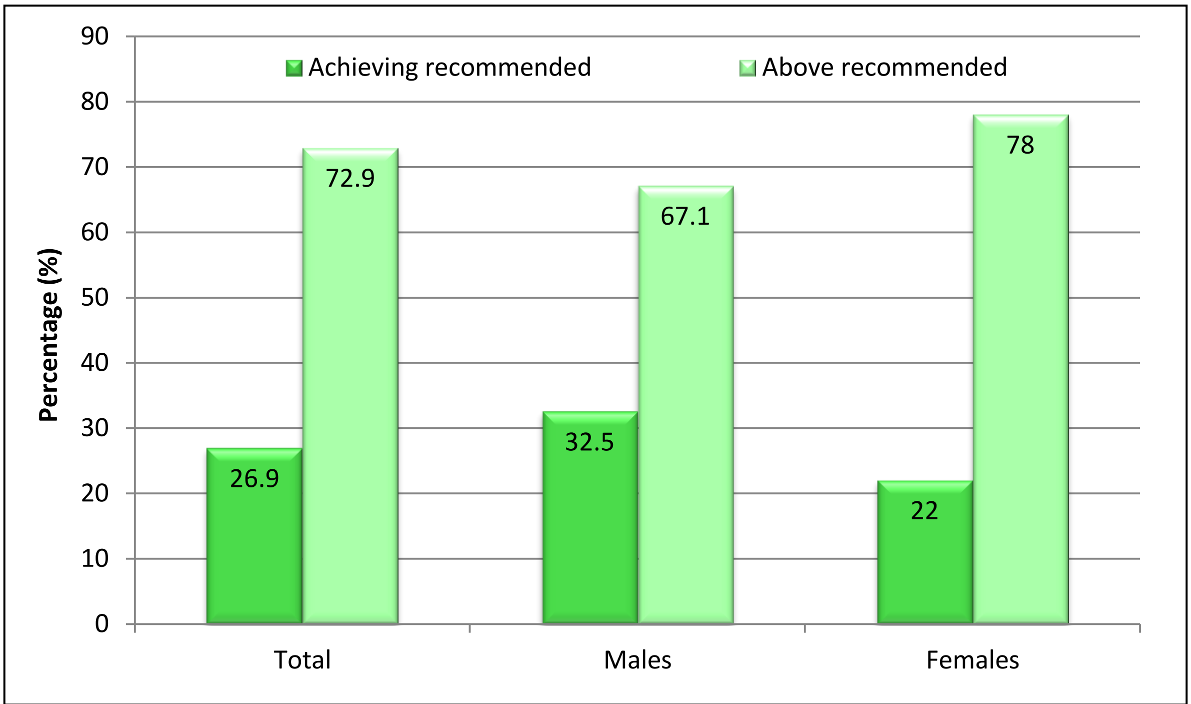
* The fruit and vegetables group includes any fruit, any vegetables, beans and pulses and 100% fruit juices without added sugar
Source: WHO / FAO 2003

Figures 34-38 reveal the proportion of the sample which is below, within and above the recommended intakes for fat, protein, carbohydrates, added sugar and saturated fat, respectively. Results are presented for the overall sample and then stratified by sex.

Fat intake

The majority of the sample was above the recommended fat intake, with significantly more females than males above the recommendation (78.0% vs. 67.1%, p=0.006) (Figure 34). No participants were below the recommended intake.

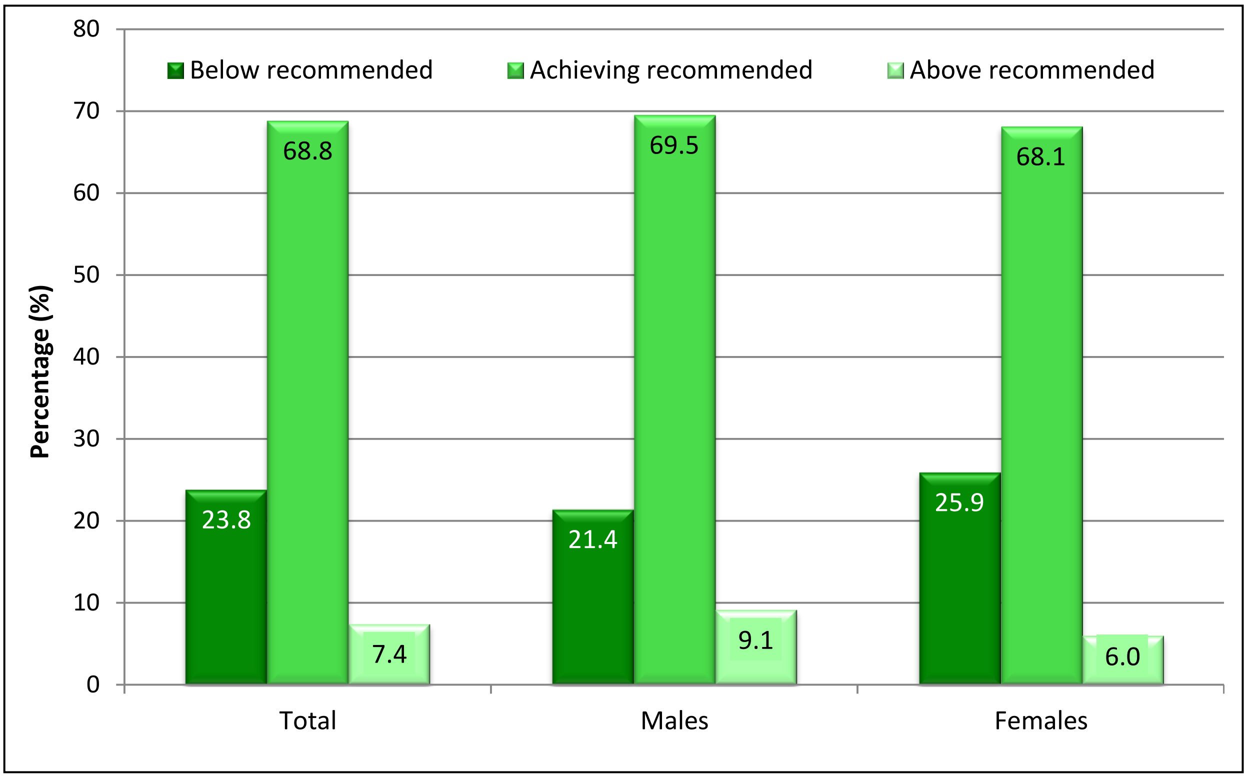
Figure 34. Percentage of the sample achieving WHO/FAO guidelines for fat intake by sex



Protein intake

Approximately one quarter of the total sample was below the recommended daily protein intake (Figure 35). In terms of the proportion below the recommended intake, there was no significant difference between males and females (p=0.18). Approximately two thirds of the population achieved the recommended intake of protein per day, with no differences between the sexes (p=0.72).

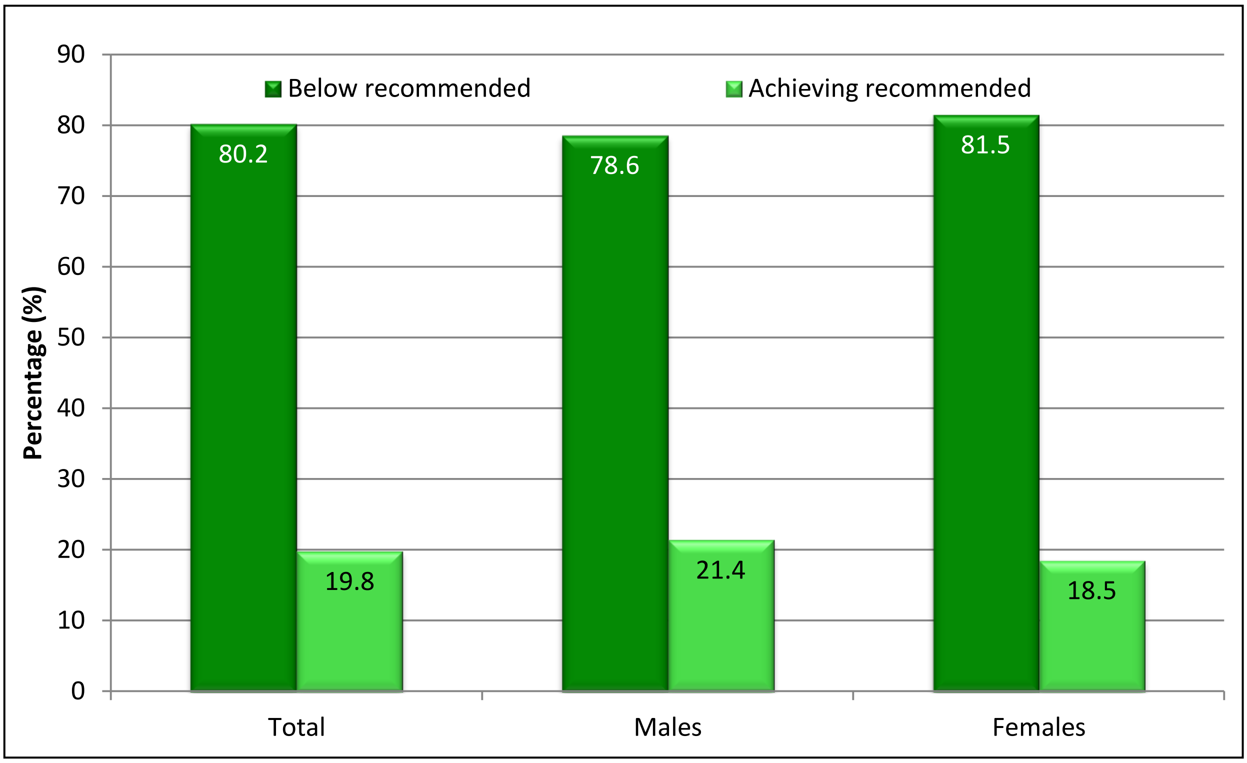
Figure 35. Percentage of the sample achieving WHO/FAO guidelines for protein intake by sex



Carbohydrate intake

Four out of five adolescents consumed less than the recommended intake for carbohydrates (Figure 36). The proportion of males and females achieving the recommended intake was not significantly different (p=0.36). No participants exceeded the recommended intake.

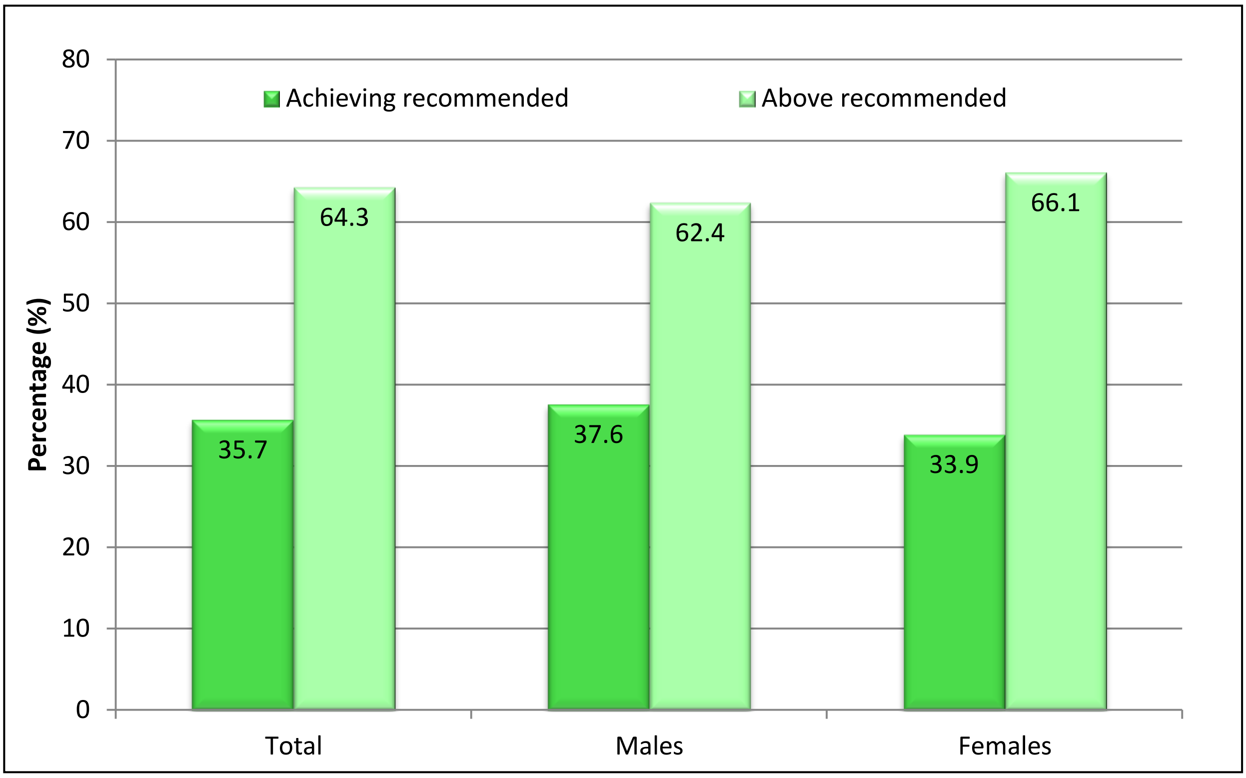
Figure 36. Percentage of the sample achieving WHO/FAO guidelines for carbohydrate intake by sex



Added sugars

The added sugar consumption was above the recommendation for 64.3% of the total sample (Figure 37). In males and females, the proportion above the recommended intake was not significantly different (62.4% vs. 66.1%, p=0.33).

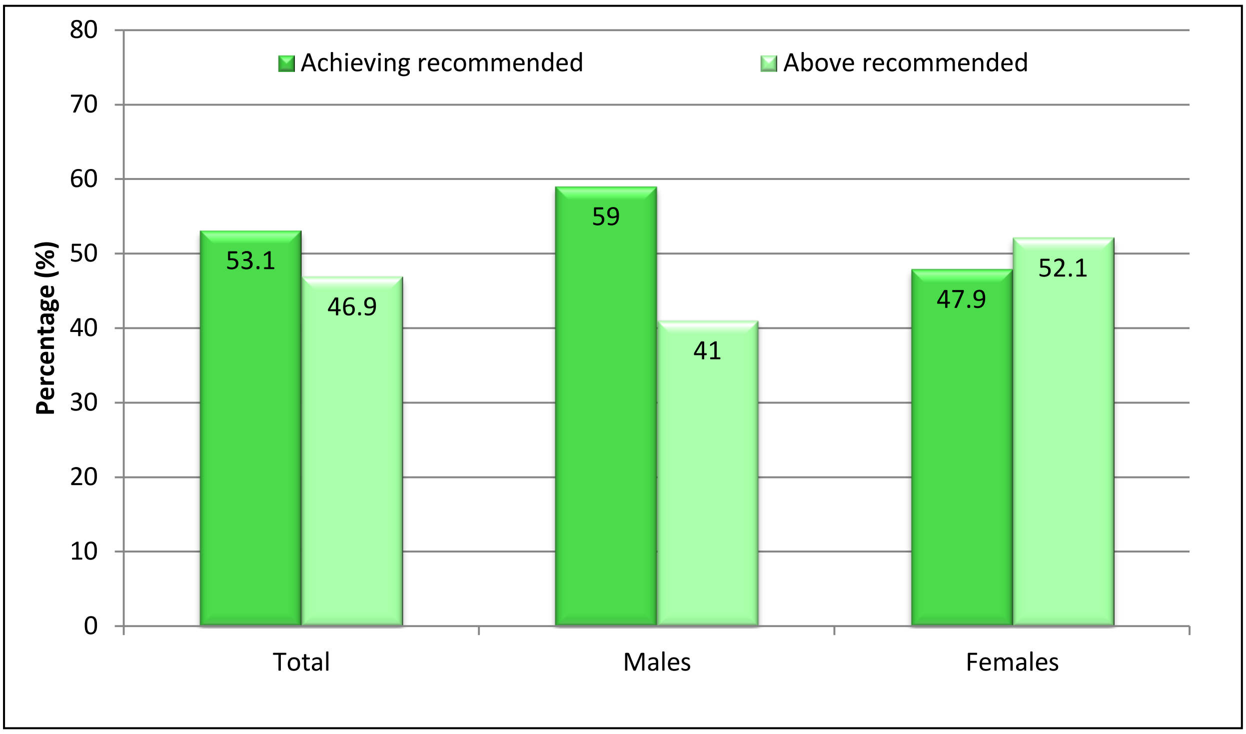
Figure 37. Percentage of the sample achieving WHO/FAO guidelines for added sugars intake by sex



Saturated fat

The proportion of females who consumed above the recommended intake for saturated fats was significantly higher than in males (52.1% vs. 41.0%, p=0.005) (Figure 38).

Figure 38. Percentage of the sample achieving WHO/FAO guidelines for saturated fat intake by sex



6.3 Consumption of food items by the adolescent sample

Table 23 shows the proportion of males and females consuming each different food item (in descending order). In males, the foods consumed by at least 90% of the sample included refined grains, sugar, vegetables, low fat dairy products, fresh fruit, processed meat, soft drinks, oils and dressing, sauces, poultry and chips. In females, the most consumed foods were refined grains, vegetables, low fat dairy products, processed meat, sugar, fresh fruit, oils and dressing, sauces, soft drinks and chips. When comparing the proportions of males and females who consumed each of these most popular food items, slight differences were observed. Sugar, fresh fruit, low fat dairy products, soft drinks and sauces were consumed by a smaller proportion of females than males, whereas vegetables, oils and dressings, processed meats and chips were consumed by a higher proportion of females.

Table 23. Proportion of the sample consuming each of the food item (n=631)

Food items	Males (%) (n=295)	Food items	Females (%) (n=336)
Refined grains (n=294)	99.7	Refined grains (n=335)	99.7
Sugar (n=290)	98.3	Vegetables (n=331)	98.5
Vegetables (n=285)	96.6	Dairy product low fat (n=323)	96.1
Dairy product low fat (n=284)	96.3	Processed meat (n=323)	96.1
Fresh fruit (n=283)	95.9	Sugar (n=322)	95.8
Processed meat (n=280)	94.9	Fresh fruit (n=321)	95.5
Soft drinks (n=278)	94.2	Oils and dressing (n=318)	94.6
Oils and dressing (n=277)	93.9	Sauces (n=316)	94.0
Sauces (n=276)	93.6	Soft drinks (n=316)	94.0
Poultry (n=269)	92.2	Chips (n=310)	92.3
Chips (n=271)	91.9	Poultry (n=299)	89.0
Red meat (n=264)	89.5	Red meat (n=297)	88.4
Biscuits (n=259)	87.8	Snacks (n=292)	86.9
Margarine (n=255)	86.4	Margarine (n=288)	85.7
Snacks (n=244)	82.7	Dairy product high fat (n=336)	85.1
Whole grains (n=239)	81.0	Biscuits (n=282)	83.9
Dairy product high fat (n=239)	81.0	Sweet (n=282)	83.9
Eggs (n=225)	76.3	Whole grains (n=265)	78.9
Sweet (n=225)	76.3	Chocolate (n=260)	77.4
Coffee (n=215)	73.0	Eggs (n=248)	73.8
Nuts and seeds (n=215)	72.9	Dessert (n=242)	72.0
Dessert (n=210)	71.2	Coffee (n=232)	69.0
Tea (n=199)	67.5	Beverages (n=219)	65.2
Chocolate (n=195)	66.1	Tea (n=201)	59.8
Beverages (n=168)	56.9	Soup (n=195)	58.0
Offal (n=166)	56.3	Nuts and seeds (n=193)	57.4
Soup (n=161)	54.6	Offal (n=184)	54.8
Legumes (n=131)	44.4	Legumes (n=140)	41.7
Alcohol (n=122)	41.4	Canned fish (n=129)	38.4
Canned fish (n=113)	38.3	Pizzas (n=125)	37.2
Pizzas (n=94)	31.9	Processed fruit (n=118)	35.1
Processed fish (n=82)	27.8	Alcohol (n=94)	28.0
Processed fruit (n=81)	27.5	Processed fish (n=84)	25.0
Fresh fish (n=46)	15.6	Fresh fish (n=56)	16.7
Savoury tarts (n=40)	13.6	Savoury tarts (n=40)	11.9
Butter and cream (n=25)	8.5	Butter and cream (n=32)	9.5

For each food item, the analysis was conducted with both food intake reported as a weight, in grams, and then in terms of energy provided (kcal). This is because certain food items (e.g. tea/coffee, vegetables and fruits) will be consumed in larger volumes but contribute relatively little to total energy intake. Therefore only looking at food consumption in terms of weight alone may not provide a clear understanding of how food items contribute to the overall diet.

Table 24 below shows the average consumption by weight (g) of each food item and their proportion of total intake per day, for males and females separately (consumers only (i.e. those who reported consuming each particular item)).

In males, the total food intake expressed in grams was 2985.5. Of this, the largest contribution came from refined grains (431.6g, 14.6% of total), followed by fresh fruit (277.1g, 9.4%), soft drinks (257.5, 8.7%), tea (214.3, 7.2%), alcohol (190.5, 6.4%), with low fat dairy products and whole grains both contributing 6.2%. Females consumed around 600g less at 2363.9g. Of this, the predominant food items contributing to total food intake were similar to those identified in males apart from a higher contribution from vegetables (142.2g, 6.0%) and a lower contribution from alcohol (71.4g, 3.0%).

Males had a significantly higher proportion of their total food intake coming from alcohol (6.4% vs. 3.0%, p=0.03), biscuits (2.3% vs. 1.8%, p=0.01), nuts and seeds (0.6% vs. 0.4%, p=0.005), and whole grains (6.2% vs. 4.2%, p<0.00001) compared to females.

Females had a significantly higher proportion of their total food intake compared to males coming from beverages (3.6% vs. 2.4%, p=0.01), chips (2.7% vs. 2.5%, p=0.02), chocolate (0.7% vs. 0.5%, p<0.0001), low fat dairy products (7.2% vs. 6.2%, p=0.03), desserts (2.1% vs. 1.6%, p=0.02), oils and dressings (0.7% vs. 0.5%, p=0.0001), poultry (1.8% vs 1.4%, p=0.001), sauces (1.9% vs. 1.5%, p=0.0002), savoury tarts (0.9% vs. 0.7%, p=0.0001), snacks (0.8% vs. 0.7%, p=0.005) and vegetables (6.0% vs. 4.9%, p=0.01).

It is important to mention that although the percentages differences are statistically significant between males and females, the nutritional relevance of these differences is questionable.

Table 24. Sex differences in the average intakes of consumed food items by weight (g) and their proportion of total intake (%)

		Males			Females		
Food items	**n**	**Average (g/day)**	**% of diet**	**n**	**Average (g/day)**	**% of diet**	**p-value[1]**
Alcohol	122	190.5	6.4	94	71.4	3.0	0.03*
Beverages	168	71.4	2.4	219	85.7	3.6	0.01*
Soft drinks	278	257.5	8.7	316	214.3	9.1	0.65
Tea	199	214.3	7.2	201	178.6	7.6	0.80
Coffee	215	128.6	4.3	232	107.1	4.5	0.14
Fresh fruit	283	277.1	9.4	321	224.6	9.5	0.84
Processed fruit	81	17.1	0.6	118	17.9	0.8	0.16
Vegetables	285	145.7	4.9	331	142.2	6.0	0.01*
Legumes	131	28.6	1.0	140	18.9	0.8	0.70
Nuts and seeds	215	17.1	0.6	193	9.3	0.4	0.005**
High fat dairy product	239	18.6	0.6	286	17.1	0.7	0.39
Low fat dairy product	284	184.8	6.2	323	170.8	7.2	0.03*
Offal	166	33.7	1.1	184	30.0	1.3	0.23
Poultry	269	40.3	1.4	299	42.9	1.8	0.0001***
Processed meat	280	57.7	2.0	323	41.0	1.7	0.19
Red meat	264	90.6	3.1	297	60.7	2.6	0.31
Eggs	225	38.6	1.3	248	28.6	1.2	0.35
Fresh fish	46	17.1	0.6	56	8.6	0.4	0.22
Canned fish	113	19.3	0.7	129	17.1	0.7	0.15
Processed fish	82	20	0.7	84	17.1	0.7	0.29
Butter and cream	25	10.0	0.3	32	8.3	0.4	0.83
Margarine	255	20.0	0.7	288	16.5	0.7	0.84
Oils and dressing	277	15.0	0.5	318	15.6	0.7	0.0001***
Refined grains	294	431.6	14.6	335	338.7	14.3	0.23
Whole grains	239	182.9	6.2	265	99.1	4.2	<0.0001***
Savoury tarts	40	20.0	0.7	40	20.7	0.9	0.0001***
Pizzas	94	47.1	1.6	125	45.7	1.9	0.14
Chips	271	74.3	2.5	310	64.3	2.7	0.02*
Biscuits	259	67.7	2.3	282	42.9	1.8	0.01*
Chocolate	195	15.6	0.5	260	17.7	0.7	<0.0001***
Dessert	210	48.8	1.6	242	50.3	2.1	0.02*
Sugar	290	38.1	1.3	322	30.8	1.3	0.88
Sweet	225	21.4	0.7	282	14.3	0.6	0.61
Sauces	276	43.4	1.5	316	45.8	1.9	0.0002***
Snacks	244	19.7	0.7	292	19.3	0.8	0.005**
Soup	161	34.3	1.2	195	30.0	1.3	0.36
Total		**2958.5**	100.0		**2363.9**	100.0	

Mann-Whitney tests [1] were used to test for significant differences between males and females.
*p<0.05 **p<0.01 ***p<0.001

Table 25 below shows the average consumption of each food item in kcal and their proportion of total energy intake per day, separately for males and females (consumers only (i.e. those who reported consuming each particular item)).

The total daily energy intake was 4432.8 kcal and 3580 kcal for males and females respectively. In males, of the 36 food items, 12 (33.3%) of the food items contributed 66.9% of the total energy intake with refined grains (785.6 kcal, 17.7%), whole grains (414.1kcal, 9.3%), biscuits (267.2kcal, 6.0%), chips (227 kcal, 5.1%), red meat (205.3 kcal, 4.6%), fresh fruit (199.8 kcal, 4.5%), processed meat (188.9 kcal, 4.3%), sugar (145.3 kcal, 3.3%), pizzas (143.5 kcal, 3.2%), margarine (142.3 kcal, 3.2%), low fat dairy products (136.4 kcal, 3.1%) and alcohol (114.1 kcal, 2.6%). In females, 14 (38.9%) of the food items contributed 68.1% of the total energy intake with refined grains (603.1 kcal, 16.8%), chips (196.4 kcal, 5.5%), whole grains (194.7 kcal, 5.4%), biscuits (175.8 kcal, 4.9%); fresh fruit (159.8 kcal, 4.5%), red meat (140.2 kcal, 3.9%), processed meat (135.9 kcal, 3.8%), sauces (131.6 kcal, 3.7%) followed by dessert, pizzas and margarine (each contributing 3.4%), sugar (116.9 kcal, 3.3%), vegetables (3.1%), and oils and dressing (3.0%).

Males had a significantly higher proportion of their energy intake coming from alcohol (2.6% vs. 1.5%, p=0.02), nuts and seeds (2.4% vs. 1.6%, p=0.003), whole grains (9.3% vs. 5.4%, p<0.0001) and biscuits (6.0% vs. 4.9%, p=0.01) in comparison to females.

Females had a significantly higher proportion of their energy intake coming from beverages (1.4% vs. 1.0%, p=0.007), vegetables (3.1% vs. 2.4%, p=0.007), poultry (2.9% vs. 2.1%, p=0.0001), oils and dressing (3.0% vs. 2.4%, p=0.0004), savoury tarts (1.7% vs. 1.2%, p<0.0001), chips (5.5% vs. 5.1% p=0.04), chocolate (2.3% vs. 1.9%, p<0.0001), desserts (3.4% vs. 2.5%, p=0.02), sauces (3.7% vs. 1.3%, p=0.01) and snacks (2.8% vs. 2.3%, p=0.005).

It is important to mention that although the percentages differences are statistically significant between males and females, the nutritional relevance of these differences is questionable.

Table 25. Sex differences in the average intakes of consumed food items (kcal) and their proportion of total energy intake (%)

		Males			Females		
Food items	**n**	**Average (kcal/day)**	**% of dietary energy**	**n**	**Average (kcal/day)**	**% of dietary energy**	**p-value[1]**
Alcohol	122	114.1	2.6	94	53	1.5	0.02*
Beverages	168	43.8	1.0	219	51.7	1.4	0.007**
Soft drinks	278	110.3	2.5	316	96.2	2.7	0.96
Tea	199	2.1	0.0	201	1.9	0.1	0.96
Coffee	215	1.7	0.0	232	1.2	0.0	0.06
Fresh fruit	283	199.8	4.5	321	159.8	4.5	0.95
Vegetables	285	108.1	2.4	331	109.8	3.1	0.007**
Processed fruit	81	21.8	0.5	118	18.2	0.5	0.31
Legumes	131	36.6	0.8	140	25.7	0.7	0.80
Nuts and seeds	215	107.2	2.4	193	57.9	1.6	0.003**
High fat dairy product	239	65.5	1.5	286	56.4	1.6	0.37
Low fat dairy product	284	136.4	3.1	323	128.7	3.6	0.06
Offal	166	65.7	1.5	184	65.8	1.8	0.21
Poultry	269	94.7	2.1	299	102.4	2.9	0.0001***
Processed meat	280	188.9	4.3	323	135.9	3.8	0.19
Red meat	264	205.3	4.6	297	140.2	3.9	0.28
Eggs	225	59.1	1.3	248	46.9	1.3	0.99
Fresh fish	46	20.1	0.5	56	13.6	0.4	0.40
Canned fish	113	21.3	0.5	129	21	0.6	0.32
Processed fish	82	48.3	1.1	84	42.1	1.2	0.42
Butter and cream	25	42.3	1.0	32	38.4	1.1	0.61
Margarine	255	142.3	3.2	288	120.6	3.4	0.71
Oils and dressing	277	105.0	2.4	318	108.7	3.0	0.0004 ***
Refined grains	294	785.6	17.7	335	603.1	16.8	0.33
Whole grains	239	414.1	9.3	265	194.7	5.4	<0.0001***
Savoury tarts	40	53.9	1.2	40	60.9	1.7	<0.0001***
Pizzas	94	143.5	3.2	125	121.1	3.4	0.18
Chips	271	227	5.1	310	196.4	5.5	0.04*
Biscuits	259	267.2	6.0	282	175.8	4.9	0.01*
Chocolate	195	82.8	1.9	260	83.7	2.3	<0.0001***
Dessert	210	109.3	2.5	242	121.3	3.4	0.02*
Sugar	290	145.3	3.3	322	116.9	3.3	0.81
Sweet	225	76.8	1.7	282	54.8	1.5	0.45
Sauces	276	58.4	1.3	316	131.6	3.7	0.01*
Snacks	244	103.6	2.3	292	100.6	2.8	0.005**
Soup	161	24.9	0.6	195	23.0	0.6	0.13
Total		**4432.8**	100.0		**3580.0**	100.0	

Mann-Whitney tests[1] were used to test for significant differences between males and females.
*p<0.05 **p<0.01 ***p<0.001

6.4 Dietary patterns

The PCA of the dietary data led to the identification of four main components (see Chapter 4, section 4.3.6.5.2). PCA was used to detect patterns of food consumption emerging in this cohort of adolescents. The four principal components retained explained 28.9% of the variance in the sample and the eigenvalues were above one for each of the components (Table 26).

The first component explained 13.8% of the variance and had only positive factor loadings. It was characterised by a high consumption of dairy products, poultry, processed meat, red meat, chips, biscuits, vegetables and sauces. This component showed similar features to the "western" pattern (i.e. diet characterized by a high consumption of red meat, processed meat, fast food, refined grains and sugar, alongside a low consumption of vegetables and fruits (Slattery et al. 1998). The Pearson's correlation coefficient between component one and energy intake was high at 0.93 ($p<0.001$) (Table 27). This component was therefore labelled the "high energy" pattern. It was significantly highly positively correlated with fat (mono-saturated and saturated fat) and animal protein and highly negatively correlated with carbohydrates and plant protein (Table 27).

The second component explained 6.3% of the variance and had high positive factor loadings on tea, nuts and seeds, margarine, whole grains, sugar and high negative factor loadings on beverages, high fat dairy products, pizzas and dessert. Component two was highly positively correlated with plant protein, sugar and fibre intakes and highly negatively correlated with saturated fat and animal protein (Table 27). This component seemed to reflect low-cost and filling food options and was therefore termed the "low-cost food" pattern.

The third component explained 4.8% of the variance and had high positive factor loadings on processed fruit, vegetables, legumes, fresh fish, processed fish, canned fish, savoury tarts and high negative factor loadings on soft drinks, refined grains, chips and sweets. This pattern seemed to reflect a balanced, diversified and relatively high-cost diet. It showed similar features to the 'prudent' diet (i.e. diet characterised by a high consumption of fruit and vegetables, fish and poultry alongside a low consumption of red meat, processed meat and sugar (Slattery et al. 1998). It was highly positively correlated with animal protein, fat (mono- and poly-unsaturated) and fibre intakes and highly negatively correlated with starch and added sugar intakes (Table 27). This component was labelled the "healthy" pattern.

The fourth component explained 4.0% of the variance and was characterised by a high consumption of coffee, low fat dairy products, chocolate, dessert, sugar, snacks and a low consumption of alcohol, offal, poultry and eggs. It was highly positively correlated with sugar and added sugar intakes and negatively correlated with animal protein, mono-unsaturated fat and starch (Table 27). This pattern was named the “snacks and sweets” pattern.

Table 26. Dietary patterns retained in the sample (replicate of table in methods)

	Components			
Food items (36)	**1**	**2**	**3**	**4**
Alcohol	0.075	-0.058	-0.161	-0.260
Beverages	0.129	-0.225	-0.071	0.120
Soft drinks	0.191	-0.193	-0.251	-0.055
Tea	0.074	0.334	-0.139	0.189
Coffee	0.065	0.076	-0.019	0.242
Fresh fruit	0.195	0.036	0.169	0.159
Processed fruit	0.075	-0.028	0.259	0.09
Vegetables	0.227	0.187	0.269	-0.073
Legumes	0.102	0.099	0.225	-0.099
Nuts and seeds	0.124	0.231	0.036	0.138
High fat dairy product	0.210	-0.242	0.041	0.086
Low fat dairy product	0.200	0.046	-0.096	0.266
Offal	0.184	0.126	0.039	-0.239
Poultry	0.235	-0.111	0.016	-0.232
Processed meat	0.290	-0.082	-0.104	-0.171
Red meat	0.262	-0.081	0.136	-0.177
Eggs	0.157	0.106	-0.117	-0.204
Fresh fish	0.091	-0.055	0.367	0.050
Canned fish	0.079	0.139	0.257	-0.175
Processed fish	0.104	-0.126	0.245	-0.107
Butter and cream	0.046	-0.019	0.117	0.192
Margarine	0.107	0.221	-0.161	-0.046
Oils and dressing	0.122	-0.006	0.156	0.096
Refined grains	0.197	0.159	-0.247	-0.124
Whole grains	0.152	0.282	0.046	0.119
Savoury tarts	0.058	-0.146	0.231	0.152
Pizzas	0.105	-0.296	0.089	-0.038
Potato chips	0.237	-0.113	-0.238	-0.119
Biscuits	0.255	0.018	-0.035	0.091
Chocolate	0.116	-0.196	-0.094	0.327
Dessert	0.193	-0.293	0.014	0.243
Sugar	0.179	0.344	-0.092	0.206
Sweet	0.138	-0.047	-0.226	0.068
Sauces	0.258	0.010	0.017	-0.112
Snacks	0.143	0.029	-0.044	0.234
Soup	0.138	0.128	0.182	-0.096
Eigenvalue	4.98	2.26	1.73	1.42
Variance explained (%)	13.8	6.3	4.8	4.0
Total variance explained (%)	**28.9**			

Factor loadings with magnitude 0.2 or greater were retained

High factor loading   Negative factor loading

Table 27. Association between dietary patterns and energy and macronutrient intakes

	Patterns			
Nutrient intake	High energy	Low-cost food	Healthy	Snack and sweets
Energy (z-score)	0.93***	0.003	-0.05	0.05
Fat (%)	0.25***	-0.15***	0.15***	-0.09*
Saturated fat (%)	0.31***	-0.42***	0.09*	0.06
Mono-unsaturated fat (%)	0.25***	-0.12**	0.11**	-0.18***
Poly-unsaturated fat (%)	0.02	0.11**	0.11**	-0.08
Protein (%)	0.24***	-0.06	0.27***	-0.37***
Animal protein (%)	0.28***	-0.23***	0.26***	-0.31***
Plant protein (%)	-0.18***	0.48***	-0.06	0.01
Carbohydrates (%)	-0.30***	0.15***	-0.21***	0.29***
Starch (%)	-0.12**	-0.008	-0.33***	-0.20***
Sugars (%)	-0.11**	0.17***	0.12**	0.30***
Added sugars (%)	-0.08*	-0.10*	-0.24***	0.29***
Fibres (%)	-0.09*	0.38***	0.30***	0.12**

Pearson's correlation between energy and macronutrients and principal components
*p<0.05; **p<0.01; ***p<0.001:

The overall diet of adolescents was assessed in a comprehensive manner, analysing macronutrients, food items and dietary patterns. Food environment, neighbourhood and household SES influences on dietary intake (energy and macronutrients) will now be examined.

6.5 Food environment, neighbourhood and household SES influences on dietary intake

This section will present the results of the neighbourhood and household SES influences on dietary outcomes namely energy intake and macronutrients intake. The univariate and step-wise multivariate results for total energy, protein, fat, and carbohydrate intake as a proportion of total energy intake are presented for males followed by females. Results are stratified by sex due to different dietary patterns between males and females. The variables shown in the fully adjusted models were retained based on their significance in the univariate models (p<0.10). Variables were entered in the following order: intrinsic level variables (population group) followed by the main variables of interest (neighbourhood SES variables, neighbourhood food environment variables (distance to fast food outlets, food outlets, restaurants and shopping mall) and finally the household level variables (caregiver education and household wealth index).

6.5.1 Food environment, neighbourhood and household SES influences on dietary intake in males.

6.5.1.1 Energy intake

None of the intrinsic, household or neighbourhood factors was significant in the unadjusted linear regression models (Table 28). None of the food environment variables (distance to fast food, restaurant, shopping mall and food outlets) was associated with energy intake in the univariate analysis (data not shown). As no variables were significant in the univariate analysis, no multivariate model was built.

6.5.1.2 Protein intake

Univariate linear regression models of protein intake showed that living in a household of low SES relative to a high SES resulted in a significantly lower protein intake (β=-0.97% [-1.57/-0.22] for the 1st tertile of the index vs. the 3rd tertile) (Table 28). None of the food environment variables (distance to fast food, restaurant, shopping mall and food outlets) was associated with protein intake in the univariate analysis (data not shown). As only one variable was significantly associated with protein intake in the univariate analysis, no multivariate model was built.

6.5.1.3 Fat intake

Univariate linear regression models of fat intake showed that reporting medium availability of services in the neighbourhood vs. high availability of services was associated with increased consumption of fat (β=+1.93% [0.07-3.79]) (Table 28). None of the food environment variables (distance to fast food, restaurant, shopping mall and food outlets) was associated with fat intake in the univariate analysis (data not shown). As only one variable was significantly associated with fat intake in the univariate analysis, no multivariate model was built.

6.5.1.4 Carbohydrates intake

None of the intrinsic, household or neighbourhood factors was significantly associated with carbohydrates intake in the unadjusted models (Table 28). None of the food environment variables (distance to fast food, restaurant, shopping mall and food outlets) was associated with carbohydrate intake in the univariate analysis (data not shown). As no variables were significant in the univariate analysis, no multivariate model was built.

6.5.1.5 Added sugars

Univariate analysis revealed that the predictors of added sugar intake were population group, the neighbourhood social support index and the distance to restaurant (data not shown). Being Mixed Ancestry in comparison to Black African resulted in a higher consumption of added sugars (β=+2.68% [0.93-4.43]). Living within 20 min of a restaurant was associated with a higher consumption of added sugar (β=+1.14% [0.18-2.47]). Being in the second tertile of the neighbourhood social support index (i.e. medium support/neutral social environment) resulted in a higher consumption of added sugars (β=+1.62% [0.05-3.20] for the second tertile vs. the third tertile).

Table 29 shows the stepwise multivariate regression models for the predictors of added sugar intake in males for variables which achieved statistical significance ($p<0.1$) in the univariate analyses. The predictors of added sugar intake in the fully adjusted model (step 1) were population group and the neighbourhood social support index. Indeed, the direction and strength of the association between the second tertile of the neighbourhood social support index and added sugar intake remained the same (β=+1.58, $p<0.05$). Living within 20 min of a restaurant no longer influenced added sugar intake in the fully adjusted model.

The fully adjusted model (step 1) explained around 6.9% of the variance in added sugar intake compared to 2.7% of variance explained when the model included only population group as a predictor (step 0).

Table 28. Predictors of dietary intake (energy and macronutrients) from univariate linear regression analyses for 18 year old males (n = 295)

	z-scores of energy intake					**Protein intake (%)**					**Fat intake (%)**					**Carbohydrates intake (%)**				
Variables	**n**	**mean (kcal)**	**s.e.**	**Coef Ŧ**	**CI**	**n**	**mean**	**s.e.**	**Coef Ŧ**	**CI**	**n**	**mean**	**s.e.**	**Coef Ŧ**	**CI**	**n**	**mean**	**s.e.**	**Coef Ŧ**	**CI**
Intrinsic factors																				
Population group				p=0.59					p=0.86					p=0.25					p=0.71	
Black	252	4770	124	**0**	_	252	11.8	0.14	0	_	252	32.75	0.40	**0**	_	252	50.1	0.42	**0**	_
Mixed Ancestry	43	4949	328	0.07	-0.18-0.32	43	11.7	0.34	-0.06	-0.79-0.67	43	31.52	1.10	-1.23	-3.33-0.87	43	50.5	1.16	0.42	-1.80-2.64
Household socio-economic factors																				
Caregiver education				p=0.11					p=0.31					p=0.26					p=0.39	
≤ Primary school	42	4250	298	-0.18	-0.55-0.19	42	11.8	0.34	-0.41	-1.44-0.62	42	31.13	1.03	-0.97	-4.0-2.0	42	51.2	1.14	2.24	-0.95-5.43
Secondary school	200	4968	147	0.09	-0.22-0.38	200	11.6	0.16	-0.63	-1.48-0.20	200	32.9	0.45	0.78	-1.7-3.2	200	50.2	0.47	1.29	-1.25-3.94
Higher education	31	4720	338	**0**	_	31	12.2	0.35	**0**	_	31	32.1	1.17	**0**	_	31	49.0	1.36	**0**	_
Household wealth index				p=0.34					p=0.02*					p=0.51					p=0.15	
1st tertile	83	4586	233	-0.18	-0.37-0.11	83	11.4	0.25	-0.97	-1.57/-0.22	83	31.87	0.70	-1.19	-3.2-0.9	83	51.3	0.72	2.13	-0.23-4.02
2nd tertile	106	4811	174	-0.09	-0.27-0.19	106	11.7	0.19	-0.68	-1.25-0.02	106	32.6	0.60	-0.48	-2.3-1.5	106	50.0	0.61	0.87	-1.38-2.65
3rd tertile (wealthy)	71	5058	255	**0**	_	71	12.4	0.26	**0**	_	71	33.1	0.84	**0**	_	71	49.2	0.92	**0**	_
Neighbourhood socio-economic factors																				
Neighbourhood economic index				p=0.45					p=0.22					p=0.80					p=0.35	
1st tertile	95	4526	193	-0.13	-0.34-0.09	95	11.5	0.23	-0.57	-1.21-0.07	95	32.1	0.70	-0.46	-2.3-1.5	95	51.1	0.75	1.37	-0.67-3.29
2nd tertile	88	4821	215	-0.01	-0.22-0.22	88	11.7	0.25	-0.34	-0.99-0.32	88	32.72	0.67	0.17	-1.7-2.2	88	49.9	0.67	0.27	-1.85-2.20
3rd tertile (wealthy)	92	4858	205	**0**	_	92	12.1	0.23	**0**	_	92	32.55	0.69	**0**	_	92	49.7	0.74	**0**	_
Neighbourhood availability of services index				p=0.82					p=0.90					p=0.05†					p=0.25	
1st tertile	90	4693	227	0.01	-0.20-0.24	90	11.8	0.21	-0.05	-0.69-0.59	90	31.75	0.67	-0.03	-1.88-1.87	90	51.0	0.65	0.38	-1.63-2.32
2nd tertile	92	4833	181	0.06	-0.16-0.28	92	11.7	0.24	-0.15	-0.77-0.49	92	33.78	0.61	1.93	0.07-3.79	92	49.4	0.65	-1.22	-3.12-0.79
3rd tertile (high)	93	4666	204	**0**	_	93	11.8	0.25	**0**	_	93	31.78	0.74	**0**	_	93	50.6	0.82	**0**	_
Neighbourhood problem index				p=0.68					p=0.18					p=0.53					p=0.28	
1st tertile	91	4549	176	-0.08	-0.30-0.14	91	11.4	0.22	-0.61	-1.28-0.07	91	32.4	0.69	0.55	-1.4-2.5	91	51.0	0.69	0.38	-1.72-2.39
2nd tertile	98	4759	206	-0.01	-0.23-0.21	98	11.9	0.25	-0.17	-0.82-0.49	98	33.0	0.68	1.04	-0.9-3.0	98	49.4	0.71	-1.15	-3.12-0.92
3rd tertile (low)	83	4775	224	**0**	_	83	12.0	0.24	**0**	_	83	31.9	0.70	**0**	_	83	50.6	0.78	**0**	_
Neighbourhood social support index				p=0.87					p=0.15					p=0.95					p=0.48	
1st tertile	85	4797	215	0.03	-0.20-0.24	85	11.7	0.22	-0.39	-1.05-0.25	85	32.43	0.72	-0.12	-2.1-1.7	85	50.1	0.75	0.19	-1.70-2.28
2nd tertile	92	4644	212	-0.02	-0.25-0.18	92	11.5	0.22	-0.62	-1.26-0.01	92	32.25	0.67	-0.33	-2.2-1.5	92	51.0	0.71	1.14	-0.78-3.12
3rd tertile (favourable)	99	4298	183	**0**	_	99	12.1	0.25	**0**	_	99	32.55	0.65	**0**	_	99	49.9	0.70	**0**	_

Ŧ Linear regression unstandardised coefficient

*p<0.05; **p<0.01; ***p<0.001; † p<0.10

Table 29. Adjusted unstandardised parameter estimates for added sugar intake intake in 18 year old males (n=295)

	n	Step 0 Adjusted parameter estimate (SE) [a]	Step 1 Adjusted parameter estimate (SE) [a]
Constant		11.19 (0.339)	10.55 (0.671)
Intrinsic factors			
Population group (Ref [b] Black African)	252		
Mixed ancestry	43	2.68 (0.889) **	2.69 (0.937) **
Neighbourhood factors			
Neighbourhood social support index (Ref [b] 3rd tertile (favourable))	99		
1st tertile	85		-0.75 (0.814)
2nd tertile	92		1.58 (0.792)*
Distance to restaurant (Ref > 20 min) [b]	135		
≤20 min	140		0.84 (0.664)
Adjusted R^2		0.027	0.069

*p<0.05; **p<0.01; ***p<0.001; † p<0.10

[a] Multivariate regression models were built in two steps: 0-Population group1- Population group, neighbourhood social support index, distance to restaurant

[b] Ref=reference category

6.5.2 Food environment, neighbourhood and household SES influences on dietary intake in females.

6.5.2.1 Energy intake

Univariate linear regression models in females at year 18 showed that population group, caregiver education, household wealth index, neighbourhood economic index and neighbourhood problem index were predictors of energy intake (Table 30).

Being Mixed Ancestry resulted in a significantly lower energy intake in comparison to the Black African group (β=-0.50 zscore [-0.74/-0.25]. Living with a low educated caregiver (less than primary school or secondary school vs. higher education) resulted in a significantly higher energy intake (β=+0.51 zscore [0.14-0.87] for primary school vs. higher education and β=+0.51 zscore [0.23-0.79] for secondary school vs. higher education). Living in a low household SES (1^{st} tertile vs. 3^{rd} tertile (wealthy)) also resulted in a significantly higher energy intake (β=+0.46 zscore [0.23-0.70]). At the neighbourhood level, being in the first tertile of the neighbourhood economic index resulted in a higher energy intake (β=+0.25 zscore [0.03-0.47] for the first tertile vs. the third tertile). The neighbourhood problem index was positively associated with energy intake (p=0.03), such that adolescent females reporting a high level of problems in their neighbourhood (1^{st} tertile vs. 3^{rd} tertile) had a significantly higher energy intake (Table 30).

Table 31 shows the stepwise multivariate regression models for the predictors of energy intake in females for variables which achieved statistical significance (p<0.1) in the univariate analyses. The predictors of energy intake in the fully adjusted model were population group and the neighbourhood problem index. Being Mixed Ancestry resulted in a lower consumption of energy in comparison to Black African participants. Being in the first tertile of the neighbourhood problem index (high perception of problems) resulted in a higher consumption of energy in comparison to females in the third tertile of the index. Household level factors did not influence energy intake in females in the fully adjusted model.

The first step of the adjusted model showed that after adjusting on population group, being in the first tertile of the neighbourhood problem index (i.e. high perception of problems) was a significant predictor of energy intake (β= + 0.32 zscore for the 1^{st} tertile vs. the 3^{rd} tertile, p<0.01).

The fully adjusted model showed that after adjusting on household level factors (caregiver education and household wealth index), the association between the neighbourhood problem index and energy intake remained in the same direction and significant, although the strength of association was reduced (β=+ 0.30 zscore for the 1st tertile vs. the 3rd tertile, $p<0.05$).

The fully adjusted model (step 2) explained around 9% of the variance in energy intake compared to 4.3% of variance explained when the model included only population group as a predictor (step 0).

6.5.2.2 Protein intake

None of the intrinsic or household socio-economic factors were associated with protein intake in females in the univariate analysis. Univariate linear regression models showed that adolescents reporting lower neighbourhood availability of services had a lower intake of protein compared with those reporting high availability of services ($p=0.09$) (Table 30). No multivariate regression model was built for the predictors of protein intake as only one variable was significant in the univariate analysis.

6.5.2.3 Fat intake

None of the intrinsic or household socio-economic factors were associated with fat intake in females in the univariate analysis. Univariate linear regression models revealed an association between the neighbourhood social support index and fat intake. Adolescents reporting an unfavourable social support environment (1st tertile) in comparison to those reporting a favourable one (3rd tertile) had a higher consumption of fat (β =+1.81% [0.29-3.32] for 1st vs. 3rd tertile) (Table 30). A significant association was also found between the availability of food outlets and fat intake, such that females who lived within 20 minutes of a food outlet had higher fat intake (β=+3.94% [0.18-7.69]) (data not shown in table).

Only neighbourhood level factors were included in the multivariate linear regression model.

Table 32 shows the stepwise multivariate regression models for the predictors of fat intake in females for variables which achieved statistical significance ($p<0.1$) in the univariate analyses. The only predictor of fat intake in the fully adjusted model was the neighbourhood social support index. This showed that females in the 1st tertile of the neighbourhood social support index (i.e. less support/unfavourable social environment) had a significantly higher fat intake than those in the 3rd tertile (β =+1.89%; $p<0.05$). The availability of food outlets in the neighbourhood no longer influenced fat intake in the fully adjusted model. The fully adjusted model (step 2) explained 2.4% of the variance in fat intake.

6.5.2.4 Carbohydrates intake

The neighbourhood availability of services index was significantly associated with carbohydrate intake ($p=0.03$) (Table 30). Females reporting medium availability of services consumed more carbohydrates than those reporting high availability of services ($\beta=+2.20\%$ [0.56-3.86]). An association was also found between the neighbourhood social support index and carbohydrate intake ($p=0.06$). Adolescents reporting living in an unfavourable social environment (1st tertile) had a lower consumption of carbohydrates than those living in a favourable one (3rd tertile) ($\beta=-1.94\%$ [-3.56/-0.32]) (Table 30). Finally, the availability of food outlets was associated with carbohydrate intake, such that females living within 20 minutes of a food outlet had lower carbohydrate intake ($\beta=-4.72\%$ [-8.68/-0.77]).

Table 33 shows the stepwise multivariate regression models for the predictors of carbohydrate intake in females for variables which achieved statistical significance ($p<0.1$) in the univariate analyses. The predictors of carbohydrate intake in the fully adjusted model were the neighbourhood availability of services index, the neighbourhood social support index and the distance to food outlet. Being in the second tertile of the neighbourhood availability of services index in comparison to the third tertile of the index resulted in a significantly higher consumption of carbohydrate ($\beta=+2.44\%$, $p<0.01$) whilst being in the first tertile of the neighbourhood social support index was associated with a lower consumption of carbohydrate ($\beta=-1.85\%$, $p<0.05$). Living within 20 min of a food outlet remained significant in the fully adjusted model, such that females living within 20 min of a food outlet had a reduced consumption of carbohydrate ($\beta=-4.58\%$, $p<0.05$). The fully adjusted model explained 4.3% of the variance in carbohydrate intake.

6.5.2.5 Added sugar

Univariate linear regression models in females showed that population group, caregiver education, household wealth index, neighbourhood economic index, distance to fast food outlets, distance to food outlets and distance to restaurants were predictors of added sugar intake (data not shown in table).

Mixed Ancestry female participants had a higher added sugar intake in comparison to Black African participants (β=+1.78% [0.22-3.34]). At the household level, low caregiver education and low household SES index resulted in a lower consumption of added sugar. Females living with a low educated caregiver had a lower added sugar intake (β=-3.00% [-5.25/-0.75]) than those living with a high educated caregiver and females living in a low household SES index had a reduced added sugar consumption (β=-2.48% [-3.98/-0.97] than those living in a high household SES index. At the neighbourhood level, being in the first tertile of the neighbourhood economic index vs. the third tertile (wealthy) resulted in a reduced consumption of added sugar (β=-1.54% [-2.94/-0.13]. The food environment variables were also associated with added sugar intake, such that females living within 20 min of a fast food outlet and of a restaurant had increased consumption of added sugar (β=+1.12% [-0.07-2.32] and β=+2.07% [0.91-3.25] respectively). However, living within 20 min of a food outlet resulted in a lower consumption of added sugar (β=-5.27% [-8.76/-1.77]).

Table 34 shows the stepwise multivariate regression models for the predictors of added sugar intake in females for variables which achieved statistical significance ($p<0.1$) in the univariate analyses. The only predictor of added sugar intake in the fully adjusted model was the availability of restaurants in the neighbourhood.

The first step of the adjusted model showed that after adjusting on population group, living within 20 min of a food outlet or restaurant was associated with added sugar intake. The neighbourhood economic index and distance to fast food no longer influenced added sugar intake after adjusting on population group.

The fully adjusted model (step 2) showed that after adjusting on household level factors (caregiver education and household wealth index), the association between the distance to food outlet variable and added sugar intake was weaker and no longer significant although it remained in the same direction. This implies that the relationship was driven by household SES level variables. The strength of the association between the distance to restaurant and added sugar intake was reduced but remained in the same direction and significant. Indeed, a significantly higher consumption of added sugar was seen amongst females living within 20 min of a restaurant (+1.55%, $p<0.05$). .

The fully adjusted model (step 2) explained around 4.5% of the variance in added sugar intake compared to 1.2% of variance explained when the model included only population group as a predictor (step 0).

Table 30. Predictors of dietary intake (energy and macronutrients) from univariate linear regression analyses for 18 year old females (n = 336)

	z-scores of energy intake					**Protein intake (%)**					**Fat intake (%)**					**Carbohydrates intake (%)**				
	n	**mean (kcal)**	**s.e.**	**Coef Ŧ**	**CI**	**n**	**mean**	**s.e.**	**Coef Ŧ**	**CI**	**n**	**mean**	**s.e.**	**Coef Ŧ**	**CI**	**n**	**mean**	**s.e.**	**Coef Ŧ**	**CI**
Intrinsic factors																				
Population group					p<0.0001***					p=0.19					p=0.73					p=0.89
Black	282	4085	94.6	**0**	_	282	11.5	0.14	**0**	_	282	34.4	0.35	**0**	_	282	49.7	0.37	**0**	_
Mixed Ancestry	54	3141	206	-0.50	-0.74/-0.25	54	11.0	0.26	-0.46	-1.14-0.22	54	34.7	0.82	0.29	-1.42-2.01	54	49.5	0.91	-0.12	-1.96-1.71
Household socio-economic factors																				
Caregiver education					p=0.002**					p=0.39					p=0.74					p=0.61
≤ Primary school	39	4101	267	0.51	0.14-0.87	39	12	0.43	0.14	-0.89-1.18	39	34.6	0.85	-0.50	-3.02-2.01	39	48.6	0.98	-0.29	-3.01-2.43
Secondary school	220	4102	111	0.51	0.23-0.79	220	11.5	0.16	-0.34	-1.12-0.43	220	34.4	0.41	-0.74	-2.65-1.17	220	49.6	0.43	0.84	-1.42-2.71
Higher education	42	3134	185	**0**	_	42	11.8	0.32	**0**	_	42	35.1	0.72	**0**	_	42	48.9	0.85	**0**	_
Household wealth index					p=0.0006***					p=0.82					p=0.94					p=0.69
1st tertile	99	4366	169	0.46	0.23-0.70	99	11.6	0.27	0.16	-0.21-0.84	99	34.5	0.61	0.25	-1.41-1.91	99	49.8	0.68	-0.19	-1.99-1.61
2nd tertile	104	3830	155	0.18	-0.05-0.42	104	11.3	0.23	-0.03	-0.69-0.63	104	34.5	0.58	0.25	-1.39-1.89	104	49.2	0.64	-0.74	-2.52-1.04
3rd tertile (wealthy)	95	3480	155	**0**	_	95	11.4	0.21	**0**	_	95	33.3	0.60	**0**	_	95	49.9	0.60	**0**	_
Neighbourhood socio-economic factors																				
Neighbourhood economic index					p=0.09†					p=0.51					p=0.59					p=0.67
1st tertile	120	4162	154	0.25	0.03-0.47	120	11.5	0.22	0.31	-0.32-0.94	120	34.6	0.53	0.63	-0.89-2.17	120	49.4	0.57	-0.63	-2.27-1.00
2nd tertile	102	3919	148	0.12	-0.11-0.35	102	11.6	0.25	0.35	-0.31-1.00	102	34.8	0.55	0.77	-0.82-2.36	102	49.3	0.60	-0.69	-2.40-1.00
3rd tertile (wealthy)	100	3685	157.0	**0**	_	100	11.2	0.22	**0**	_	100	34.1	0.59	**0**	_	100	50.0	0.61	**0**	_
Neighbourhood availability of services index					p=0.63					p=0.09†					p=0.33					p=0.03*
1st tertile	113	4063	159	0.08	-0.15-0.30	113	11.3	0.24	-0.60	-1.24-0.03	113	34.7	0.60	-0.43	-1.97-1.11	113	49.3	0.64	0.77	-0.86-2.40
2nd tertile	108	3861	156	-0.03	-0.26/-0.20	108	11.2	0.21	-0.62	-1.26-0.02	108	33.9	0.55	-1.16	-2.71-0.39	108	50.8	0.59	2.20	0.56-3.86
3rd tertile (high)	101	3919	146	**0**	_	101	11.9	0.23	**0**	_	101	35.1	0.49	**0**	_	101	48.5	0.51	**0**	_
Neighbourhood problem index					p=0.03*					p=0.46					p=0.46					p=0.36
1st tertile	109	4263	157	0.29	0.07-0.52	109	11.3	0.22	-0.04	-0.67-0.59	109	35	0.59	0.74	-0.79-2.27	109	48.9	0.65	-1.04	-2.68-0.60
2nd tertile	100	3898	159	0.10	-0.12-0.33	100	11.7	0.26	0.33	-0.31-0.98	100	34.1	0.50	-0.18	-1.75-1.39	100	50.0	0.57	-0.01	-1.69-1.66
3rd tertile (low)	108	3703	146	**0**	_	108	11.3	0.22	**0**	_	108	34.3	0.58	**0**	_	108	49.9	0.56	**0**	_
Neighbourhood social support index					p=0.50					p=0.91					p=0.06†					p=0.06†
1st tertile	113	4064	163.0	0.13	-0.09-0.36	113	11.4	0.20	-0.11	-0.73-0.52	113	35.5	0.56	1.81	0.29-3.32	113	48.5	0.58	-1.94	-3.56/-0.32
2nd tertile	100	3962	156.0	0.08	-0.15-0.31	100	11.5	0.28	0.02	-0.62-0.67	100	34.3	0.57	0.59	-0.97-2.16	100	49.7	0.62	-0.83	-2.50-0.83
3rd tertile (favourable)	107	3810	145.3	**0**	_	107	11.5	0.21	**0**	_	107	33.7	0.54	**0**	_	107	50.5	0.57	**0**	_

Ŧ Linear regression unstandardised coefficient
*p<0.05; **p<0.01; ***p<0.001;† p<0.10

Table 31. Adjusted unstandardised parameter estimates for energy intake in 18 year old females (n=336)

	n	Step 0 Adjusted parameter estimate (SE) [a]	Step 1 Adjusted parameter estimate (SE) [a]	Step 2 Adjusted parameter estimate (SE) [a]
Constant		0.008 (0.049)	-0.195 (0.095)	-0.537 (0.157)
Intrinsic factors				
Population group (Ref [b] Black African)	282			
Mixed ancestry	54	-0.50 (0.123) ***	-0.59 (0.131) ***	-0.52 (0.156) **
Neighbourhood factors				
Neighbourhood economic index (Ref [b] 3rd tertile (wealthy))	100			
1st tertile	120		0.15 (0.118)	0.03 (0.146)
2nd tertile	102		0.05 (0.117)	0.06 (0.137)
Neighbourhood problem index (Ref [b] 3rd tertile (low))	108			
1st tertile	109		0.32 (0.118) **	0.30 (0.135) *
2nd tertile	100		0.12 (0.115)	0.11 (0.133)
Household factors				
Caregiver education (Ref [b] higher education)	42			
≤ Primary school	39			0.37 (0.222)
Secondary school	220			0.32 (0.165) †
Household wealth index (Ref [b] 3rd tertile (wealthy))	95			
1st tertile	99			0.20 (0.158)
2nd tertile	104			0.02 (0.143)
Adjusted R^2		0.043	0.073	0.09

*p<0.05; **p<0.01; ***p<0.001; † p<0.10

[a] Multivariate regression models were built in three steps: 0-Population group 1-Population group, neighbourhood economic index, neighbourhood problem index 2-Population group, neighbourhood economic index, neighbourhood problem index, caregiver education, household wealth index

[b] Ref=reference category

Table 32. Adjusted unstandardised parameter estimates for fat intake in 18 year old females (n=336)

	n	Step 0 Adjusted parameter estimate (SE) [a]
Constant		30.16 (1.908)
Neighbourhood factors		
Neighbourhood social support index (Ref [b] 3rd tertile (favourable))	107	
1st tertile	113	1.89 (0.758)*
2nd tertile	100	0.56 (0.783)
Distance to food outlet (Ref [b] > 20 min)	9	
≤20 min	313	3.70 (1.90)†
Adjusted R^2		0.024

*p<0.05; **p<0.01; ***p<0.001; † p<0.10

[a] Multivariate regression models were built in one step: 0-neighbourhood social support index, distance to food outlet

[b] Ref=reference category

Table 33. Adjusted unstandardised parameter estimates for carbohydrate intake in 18 year old females (n=336)

	n	Step 0 Adjusted parameter estimate (SE) [a]
Constant		53.76 (2.027)
Neighbourhood factors		
Neighbourhood availability of services index (Ref [b] 3rd tertile (high))	101	
1st tertile	113	1.06 (0.809)
2nd tertile	108	2.44 (0.816) **
Neighbourhood social support index (Ref [b] 3rd tertile (favourable))	107	
1st tertile	113	-1.85 (0.793) *
2nd tertile	100	-0.97 (0.823)
Distance to food outlet (Ref [b] > 20 min)	9	
≤20 min	313	-4.58 (1.973) *
Adjusted R^2		0.043

*p<0.05; **p<0.01; ***p<0.001; † p<0.10

[a] Multivariate regression models were built in one step: 0-Neighbourhood availability of services index, neighbourhood social support index, distance to food outlet

[b] Ref=reference category

Table 34. Adjusted unstandardised parameter estimates for added sugar intake in 18 year old females (n=336)

	n	Step 0 Adjusted parameter estimate (SE) [a]	Step 1 Adjusted parameter estimate (SE) [a]	Step 2 Adjusted parameter estimate (SE) [a]
Constant		12.33 (0.317)	16.46 (1.79)	14.19 (2.163)
Intrinsic factors				
Population group (Ref [b] Black African)	282			
Mixed ancestry	54	1.78 (0.792)*	2.19 (0.824) **	1.31 (0.979)
Neighbourhood factors				
Neighbourhood economic index (Ref [b] 3rd tertile (wealthy))	100			
1st tertile	120		-1.06 (0.716)	-1.18 (0.886)
2nd tertile	102		0.25 (0.735)	0.22 (0.853)
Distance to food outlet (Ref [b] > 20 min)	9			
≤20 min	313		-4.81 (1.75) **	-1.22 (2.027)
Distance to restaurant (Ref [b] > 20 min)	192			
≤20 min	129		1.69 (0.656)*	1.55 (0.725)*
Distance to fast food (Ref [b] > 20 min)	122			
≤20 min	200		0.17 (0.657)	-0.11 (0.743)
Household factors				
Caregiver education (Ref [b] higher education)	42			
≤ Primary school	39			-0.52 (1.397)
Secondary school	220			-0.28 (1.038)
Household wealth index (Ref [b] 3rd tertile (wealthy))	95			
1st tertile	99			-1.34 (0.993)
2nd tertile	104			-0.567 (0.889)
Adjusted R^2		0.012	0.076	0.045

*p<0.05; **p<0.01; ***p<0.001; † p<0.10

[a] Multivariate regression models were built in three steps: 0-Population group 1-Population group, neighbourhood economic index, distance to food outlet, distance to restaurant, distance to fast food 2- Population group, neighbourhood economic index, distance to food outlet, distance to restaurant, distance to fast food, caregiver education, household wealth index [b] Ref=reference category

6.6 Summary of results

In the total sample, the median reported energy intake was 4053.3 kcal/day. Females consumed more energy, sugar and fat compared to males, relative to their recommended intakes. Both males and females consumed more added sugar than recommended. In complement to the macronutrient analysis, the current study also explored the contribution of the different food items to the total energy intake. In males, the food items which contributed the most to the total energy intake were refined grains, whole grains, biscuits, chips, red meat, fresh fruit, processed meat, sugar, pizzas, margarine, low fat dairy products and alcohol. In females, food items contributing the most to the total energy intake included refined grains, chips, whole grains, biscuits, fresh fruit, red meat, processed meat, sauces, dessert, pizzas, margarine, sugar, vegetables, and oils and dressing. These findings highlight that the diets of the adolescents in this sample include refined products and processed foods both of which are markers of the nutrition transition. The consumption of highly refined and processed foods can explain the greater than recommended fat and added sugar intakes found in the macronutrient analysis. Finally, the PCA of the dietary data revealed four main components: “high energy”; “low-cost food”; “healthy”; and “snacks and sweets” patterns. These findings suggest that adolescents in this sample are transitioning to a “western” / “modern” diet.

No significant associations were observed between SES (household and neighbourhood) and energy, protein, fat, or carbohydrate intakes in males. Household and neighbourhood SES also had little influence on dietary intake in females. Neighbourhood social support was associated with fat intake in females with those in the lowest tertile (with less support) having a significantly higher fat intake than those in the highest tertile.

Chapter 7: Neighbourhood and household SES influences on anthropometric measures

7. Neighbourhood and household SES influences on anthropometric measures

This chapter will present the results of the neighbourhood and household SES influences on three measures outcomes of body fatness namely body mass index; waist-to-height ratio and percent fat mass. For each of the three outcomes, results are presented separately for males and females with the sample characteristics firstly described. Following this, the results of the univariate analysis and the step-wise multivariate analysis are presented. The variables shown in the fully adjusted models were retained based on their significance in the univariate models (p<0.10). Variables were entered in the following order: intrinsic level variables (age, age of entry into menarche, Tanner stage of pubertal development, population group, low birth weight) followed by the main variables of interest (neighbourhood SES variables) and finally the household level variables (caregiver education, household wealth index, smoking status). Due to a greatly reduced sample size of those with dietary data, adjusting for diet would mean that a large proportion of the adolescents would have been excluded in the complete case analysis, thus affecting the reliability of the estimates. Therefore, it was decided that models in this analysis would not be adjusted for diet but have been included in the appendix for reference (Appendix VIII). Furthermore, anthropometric statistics (weight, height, BMI, waist circumference, waist-to-height ratio, percent fat) in boys and girls, stratified by age (17-17.99; 18-18.99; 19-19.99) can be found in the appendix for reference (Appendix VII).

7.1BMI

7.1.1 Sample characteristics for BMI

Table 35 shows the sample characteristics (overall and stratified by sex) for all adolescents with a BMI value recorded in the database. The sample was composed mainly of Black African adolescents (81.1%), with 10.8% of the sample being of Mixed Ancestry, 6.7% White and 1.3% Indian. 82.1% of the sample lived in Soweto. Relative to each sex's specific reference, males were shorter (-0.45 vs. -0.29 zscores, p=0.0003), lighter (-0.19 vs. 0.004 zscores, p<0.0001) and with a lower BMI than girls (-0.41 vs. 0.16 zscores, p<0.0001). Compared to their reference, males were thinner and shorter whilst females were shorter. A significant difference in birth weight was observed between the sexes, with males approximately 100g heavier, however the prevalence of low birth weight was not significantly different. The prevalence of thinness at 18 years was 22.2% in males, as opposed to 10.6% in females (p<0.0001). The proportion of overweight was approximately three times higher in females than in males (17.9% vs. 6.1%, p<0.0001), with a similar pattern observed for obesity (8.3% vs.2.2%, p<0.0001).

In terms of pubertal development, 86% of males had achieved Tanner stages 4 or 5 at age 18. In females, the mean age of entry into menarche was 12.7 years. In terms of household SES variables, the majority (71.4%) of the adolescents' caregivers achieved a secondary school education, with no significant differences between the sexes. The proportion of current smokers was higher in males than females (45.2% vs. 23.2% respectively, p<0.0001).

Different sex distributions were observed between Johannesburg and Soweto, with significantly more males living in Soweto and vice versa for Johannesburg. The distribution of people in each tertile of the household and neighbourhood SES indices was similar between the sexes apart from for the neighbourhood social support index where the proportion of people in the first tertile (unfavourable social environment) was higher in women than in men because of the small range of scores generated from the PCA, which limited the designation of the sample into even tertiles.

Table 35. Sample characteristics for BMI categories

	Total group (n=2019)		Males (n=974 (48.2%))		Females (n=1045 (51.8%)		Tests
Anthropometric variables							
	mean	**SD**	**mean**	**SD**	**mean**	**SD**	
Height (z-scores) ¥	-0.37	0.96	-0.45	0.97	-0.29	0.94	p=0.0003***[1]
Weight (z-scores) ¥	-0.09	0.77	-0.19	0.68	0.004	0.83	p<0.0001***[1]
BMI (z-scores) ¥	-0.12	0.84	-0.41	0.77	0.16	0.82	p<0.0001***[1]
Birthweight (kg)	3.11	0.51	3.11	0.52	3.01	0.49	p<0.0001***[1]
	n	**%**	**n**	**%**	**n**	**%**	
BMI in four classes†							
Underweight	327	16.2	216	22.2	111	10.6	
Normal	1338	66.3	678	69.6	660	63.2	p<0.0001***[3]
Overweight	246	12.2	59	6.1	187	17.9	
Obese	108	5.3	21	2.2	87	8.3	
Overweight (%)	354	17.5	80	8.2	274	26.2	p<0.0001***[3]
Overweight only (%)	246	12.2	59	6.1	187	17.9	p<0.0001***[3]
Obese (%)	108	5.3	21	2.2	87	8.3	p<0.0001***[3]
Intrinsic variables							
	mean	**SD**	**mean**	**SD**	**mean**	**SD**	
Age (years)	18.21	0.57	18.24	0.58	18.18	0.57	p=0.03*[1]
Age of entry into menarche (years)					12.7	1.25	_
	n	**%**	**n**	**%**	**n**	**%**	
Population group							
White	136	6.7	65	6.7	71	6.8	
Black African	1638	81.1	792	81.3	846	80.9	p=0.85[3]
Mixed Ancestry	218	10.8	102	10.5	116	11.1	
Indian	27	1.3	15	1.5	12	1.2	
Physical maturation (tanner stages)							
Early stages (2-3) (late maturers)	_	_	111	14.1	_	_	
Later stages (4-5) (early maturers)	_	_	676	85.9	_	_	_

*p<0.05; **p<0.01; ***p<0.001 [1] t-tests, [2] Mann Whitney tests, [3] Chi square

¥ z-scores for weight, height and BMI were derived using the comprehensive Frisancho age and sex specific reference (Frisancho 2008)

† Categories of BMI were defined using age and sex specific international cut-offs for BMI for <18 years and ≥18 years) (Cole et al. 2000; 2007 and WHO, 2000 respectively)

Table 35. Sample characteristics for BMI categories (continued)

	Total group (n=2019)		Males (n=974 (48.2%)		Females (n=1045 (51.8%)		Tests
Intrinsic variables							
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Age of entry into menarche							
<13 years (early)	_	_	_	_	397	43.1	_
≥13 years (late)	_	_	_	_	523	56.8	
Low birth weight (<2500 g)							
No	1674	89.0	818	90.2	856	87.9	p=0.11[3]
Yes	207	11.0	89	9.8	118	12.1	
Household SES variables							
	n	**%**	**n**	**%**	**n**	**%**	
Household wealth index							
1st tertile	612	34.3	305	35.4	307	33.3	
2nd tertile	612	34.3	299	34.7	313	34.0	p=0.41[3]
3rd tertile	558	31.4	257	29.9	301	32.7	
Caregiver education							
Less than or primary school	265	14.6	131	14.9	134	14.3	
Secondary school	1296	71.4	629	71.6	667	71.2	p=0.78[3]
Higher education	254	14.0	118	13.5	136	14.5	
Smoking status							
None	485	32.0	176	24.6	309	38.6	
Yes but not in last month	521	34.4	215	30.1	306	38.2	p<0.0001***[3]
Yes in last month	509	33.6	323	45.2	186	23.2	

*p<0.05; **p<0.01; ***p<0.001
[1] t-tests, [2] Mann Whitney tests, [3] chi square

Table 35. Sample characteristics for BMI categories (continued)

	Total group (n=2019)		Males (n=974 (48.2%)		Females (n=1045 (51.8%)		Tests
Neighbourhood SES variables							
	n	%	n	%	n	%	
Place of residence							
Soweto	1338	82.1	664	84.4	674	80.0	$p=0.02^{*3}$
Metropolitan Johannesburg	291	17.9	123	15.6	168	20.0	
Neighbourhood economic index							
1st tertile	663	35.2	293	32.5	370	37.7	
2nd tertile	590	31.3	296	32.9	294	29.9	$p=0.06^{3}$
3rd tertile (high)	630	33.5	312	34.6	318	32.4	
Neighbourhood availability of services index							
1st tertile	627	33.4	297	33.1	330	33.6	
2nd tertile	641	34.1	297	33.1	344	35.0	$p=0.50^{3}$
3rd tertile (high)	611	32.5	303	33.8	308	31.4	
Neighbourhood problem index							
1st tertile	623	33.5	307	34.3	316	32.6	
2nd tertile	617	33.1	306	34.2	311	32.1	$p=0.22^{3}$
3rd tertile (low)	622	33.4	281	31.5	341	35.3	
Neighbourhood social support index							
1st tertile	622	33.1	270	29.9	352	35.9	
2nd tertile	629	33.4	308	34.2	321	32.8	$p=0.02^{*3}$
3rd tertile (favourable)	631	33.5	324	35.9	307	31.3	

p<0.05; **p<0.01; ***p<0.001

[1] t-test, [2] Mann Whitney test, [3] Chi square

7.1.2 Predictors of overweight and thinness according to BMI in 18 year old adolescents

Table 36 displays the results from the univariate logistic regression analysis identifying predictors of overweight and thinness in males. Significant predictors of overweight in males were population group, caregiver education and household wealth index. The odds of being overweight were higher in white (OR=3.12 [1.6 – 6.1]) and Mixed Ancestry (OR=2.14 [1.06 – 4.35]) groups, compared to the black African group. Compared to male adolescents whose caregivers had attained a higher level of education, the odds of being overweight were lower in adolescents whose caregivers had either attained an educational level less than or equal to primary school education (OR=0.32 [0.13 – 0.77]) or a secondary education (OR=0.35 [0.20 – 0.62]). A similar pattern was observed for household wealth index, with the poor and medium households having lower odds of being overweight in comparison to the wealthy households (OR=0.30 [0.16-0.58] and OR=0.41 [0.23-0.75] respectively). Adolescents living in Johannesburg had higher odds of being overweight than those living in Soweto (OR=1.94 [1.06 – 3.52]).

The predictors of thinness were population group, low birth weight and household SES index. Mixed Ancestry adolescents had higher odds of being thin (OR=2.06 [1.31-3.25]), whereas white adolescents had lower odds (OR=0.13 [0.03-0.56]) in comparison to black Africans. Adolescents born with a low birth weight had higher odds of being thin (OR=1.98 [1.24-3.16]). Poor and medium SES households had higher odds of being thin in comparison to the wealthy group (OR=1.81 [1.16-2.84] and OR=1.94 [1.24-3.03] respectively).

Table 36. Predictors of overweight and thinness from univariate logistic regression analyses for 18 year old males

	Maximum sample size							
	Overweight				**Thinness**			
	n	**%**	**OR** [a]	**95% CI**	**n**	**%**	**OR** [a]	**95% CI**
Intrinsic factors								
Age	**758**		p=0.201		**894**		p=0.48	
<18 years [b]	267	8.6	1	_	316	22.8	1	_
≥ 18 years	491	11.6	1.39	0.84-2.32	578	24.9	1.12	0.81-1.55
Population group	**750**		p=0.001**		**882**		p=0.0001***	
Black African [b]	620	8.4	1	_	740	23.2	1	_
White	63	22.2	3.12	1.61-6.03	51	3.9	0.13	0.03-0.56
Mixed Ancestry	67	16.4	2.14	1.06-4.35	91	38.5	2.06	1.31-3.25
Low birth weight (<2500 g)	**706**		p=0.08†		**831**		p=0.004**	
No [b]	649	11.4	1	_	744	22.7	1	_
Yes	57	3.5	0.28	0.07-1.18	87	36.8	1.98	1.24-3.16
Tanner stages	**622**		p=0.489		**724**		p=0.94	
Early stages (2-3) [b] (late maturers)	87	8.1	1	_	104	23.1	1	_
Late stages (4-5) (early maturers)	535	10.5	1.34	0.59-3.03	620	22.7	0.98	0.60-1.61
Household socio-economic factors								
Caregiver education	**683**		p=0.001**		**805**		p=0.61	
≤ Primary school	97	8.3	0.32	0.13-0.77	123	27.6	1.3	0.70-2.42
Secondary school	490	9.0	0.35	0.20-0.62	585	23.8	1.06	0.64-1.77
Higher education [b]	96	21.9	1	_	97	22.7	1	_
Household wealth index	**675**		p=0.0002***		**790**		p=0.009**	
1st tertile	230	6.1	0.30	0.16-0.58	291	25.8	1.81	1.16-2.84
2nd tertile	223	8.1	0.41	0.23-0.75	281	27.0	1.94	1.24-3.03
3rd tertile (wealthy) [b]	222	17.6	1	_	218	16.1	1	_
Smoking status	**558**		p=0.435		**652**		p=0.68	
Never [b]	138	11.6	1	_	160	23.8	1	_
Occasionally	173	13.3	1.17	0.59-2.31	192	21.9	0.89	0.54-1.48
Regularly	247	9.3	0.78	0.40-1.54	300	25.3	1.09	0.69-1.70

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

[a] Logistic regression unadjusted odds ratio

[b] Reference category

Table 36. Predictors of overweight and thinness from univariate logistic regression analysis for 18 year old males (continued)

	Maximum sample size							
	Overweight				**Thinness**			
	n	**%**	**OR [a]**	**95% CI**	**n**	**%**	**OR [a]**	**95% CI**
Neighbourhood socio-economic factors								
Neighbourhood economic index	**709**		p=0.085†		**826**		p=0.47	
1st tertile	233	10.7	0.77	0.4-1.34	268	22.4	1.05	0.70-1.57
2nd tertile	224	7.1	0.49	0.26-0.92	280	25.7	1.26	0.85-1.86
3rd tertile (wealthy) [b]	252	13.5	1	_	278	21.6	1	_
Neighbourhood availability of services index	**706**		p=0.34		**822**		p=0.36	
1st tertile	228	8.3	0.74	0.40-1.37	278	24.8	1.3	0.87-1.93
2nd tertile	231	12.5	1.17	0.67-2.04	268	24.6	1.28	0.86-1.92
3rd tertile (high) [b]	247	10.9	1	_	276	20.3	1	_
Neighbourhood problem index	**704**		p=0.082†		**819**		p=0.09†	
1st tertile	228	7.9	0.52	0.28-0.95	289	27.3	1.53	1.02-2.29
2nd tertile	244	9.8	0.66	0.37-1.15	282	22.0	1.14	0.75-1.74
3rd tertile (low) [b]	232	14.2	1	_	248	19.8	1	_
Neighbourhood social support index	**710**		p=0.99		**826**		p=0.18	
1st tertile	217	10.6	0.99	0.55-1.79	247	21.5	0.74	0.50-1.10
2nd tertile	249	10.8	1.02	0.58-1.80	281	21.0	0.72	0.49-1.06
3rd tertile (favourable) [b]	244	10.7	1	_	298	26.9	1	_
Place of residence	**623**		p=0.031*		**723**		p=0.13	
Soweto [b]	518	9.1	1	_	617	23.7	1	_
Johannesburg	105	16.2	1.94	1.06-3.52	106	17.0	0.66	0.38-1.13

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression unadjusted odds ratio
[b] Reference category

Table 37 shows the stepwise multivariate logistic regression analysis for the predictors of overweight in males for variables which achieved statistical significance ($p<0.1$) in the univariate analyses.

In the first step of the adjusted model, whites were 3.6 times more likely to be overweight compared to black Africans (OR=3.59 [1.61-8.04]. In step 2, there were no significant associations between the neighbourhood SES variables and overweight. The increased odds of overweight observed for adolescents living in metropolitan Johannesburg in the univariate analysis (OR=1.94 [1.06-3.52]), was no longer significant in the adjusted analysis (OR=0.94 [0.30-2.93]). In the fully adjusted model, the variables remaining significant were the secondary school education level of caregiver and the first tertile of the household wealth index. Attaining a secondary school educational level compared to a higher level (OR=0.39 [0.17-0.88]) and being in the lowest tertile of the household wealth index compared to the highest tertile (OR=0.31 [0.12-0.76] decreased the odds of being overweight. The neighbourhood economic index became significantly associated with overweight in the fully adjusted model. Being in the first tertile of the neighbourhood economic index (least wealthy) increased the odds for being overweight (OR=3.00 [1.25-7.20]).

Table 38 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 6.1% and 12.2% of the variation in overweight status in males and the model was significant ($p=0.003$). The Hosmer and Lemeshow's goodness of fit test statistic indicated no significant differences between the predicted and observed values and 89.1% of the participants were correctly classified.

Table 37. Odds ratios and 95% confidence intervals for overweight from the adjusted logistic regression analyses in 18 year old males

	n	Step 1 Adjusted odds ratio (CI) [a]	Step 2 Adjusted odds ratio (CI) [a]	Step 3 Adjusted odds ratio (CI) [a]
Intrinsic factors				
Population group (Ref [b] Black African)	396			
White	37	3.59 (1.61-8.04)**	3.97 (0.98-16.1)†	1.98 (0.48-8.24)
Mixed Ancestry	42	1.68 (0.66-4.27)	1.67 (0.63-4.44)	1.25 (0.45-3.46)
Low birth weight (<2500 g) (Ref [b] no)	438			
Yes	37	0.48 (0.11-2.08)	0.49 (0.11-2.14)	0.46 (0.10-2.06)
Neighbourhood socio-economic factors				
Neighbourhood economic index (Ref [b] 3rd tertile (wealthy))	156			
1st tertile	157		1.89 (0.85-4.18)	3.00 (1.25-7.20) *
2nd tertile	162		0.93 (0.40-2.20)	1.23 (0.50-3.02)
Neighbourhood problem index (Ref [b] 3rd tertile (low))	160			
1st tertile	156		0.63 (0.28-1.39)	0.75 (0.33-1.70)
2nd tertile	159		0.78 (0.38-1.60)	0.87 (0.0.41-1.82)
Place of residence (Ref [b] Soweto)	399			
Johannesburg	76		0.94 (0.30-2.93)	0.77 (0.24-2.47)
Household socio-economic factors				
Caregiver education (Ref [b] higher education)	70			
≤ Primary school	69			0.50 (0.15-1.63)
Secondary school	336			0.39 (0.17-0.88) *
Household wealth index (Ref [b] 3rd tertile (wealthy))	144			
1st tertile	176			0.31 (0.12-0.76) *
2nd tertile	155			0.45 (0.20-1.02) †

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression adjusted odds ratio
[b] Reference category

Table 38. Overweight logistic regression model parameters in males

Parameter	Model 1	Model 2	Model 3
Deviance	317.74	312.78	298.4
Model significance (p value)	0.015	0.053	0.003
Cox and Snell R square	0.022	0.032	0.061
Nagelkerke R square	0.043	0.064	0.122
Correctly classified cases (%)	89.1	89.1	89.1
Hosmer and Lemeshow p-value	0.70	0.57	0.71

Table 39 shows the stepwise multivariate logistic regression analysis for the predictors of thinness in males for variables which achieved statistical significance ($p<0.1$) in the univariate analyses. The first step of the adjusted model revealed that being Mixed Ancestry and being born with a low birth weight significantly increased the odds of thinness, whereas being White decreased the odds. The second step revealed no significant association between the neighbourhood problem index and thinness in males. The final step identified Mixed Ancestry, being born low birth weight and being in the first or second tertile of the household wealth index as significant predictors of thinness. In men, the final step identified Mixed Ancestry (OR=2.33 [1.33-4.07]), being born low birthweight (OR=1.91 [1.12-3.26]) and being in the lowest (OR=1.90 [1.09-3.31]) or middle tertile (OR=1.80 [1.03-3.15]) of the household wealth index as significant predictors of thinness.

Table 40 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 4.5% and 6.9% of the variation in thinness status in males and the model was significant ($p<0.0001$). The Hosmer and Lemeshow's goodness of fit test statistic indicated no significant differences between the predicted and observed values and 78.1% of the participants were correctly classified.

Table 39. Odds ratios and 95% confidence intervals for thinness from the adjusted logistic regression analyses in 18 year old males

	n	Step 1 Adjusted odds ratio (CI) [a]	Step 2 Adjusted odds ratio (CI) [a]	Step 3 Adjusted odds ratio (CI) [a]
Intrinsic factors				
Population group (Ref [b] Black African)	569			
White	34	0.11 (0.01-0.83) *	0.12 (0.02-0.90) *	0.20 (0.02-1.53)
Mixed Ancestry	64	2.15 (1.24-3.71) **	2.17 (1.25-3.76) **	2.33 (1.33-4.07) **
Low birth weight (<2500 g) (Ref [b] no)	593			
Yes	74	1.87 (1.10-3.18) *	1.86 (1.09-3.17) *	1.91 (1.12-3.26) *
Neighbourhood socio-economic factors				
Neighbourhood problem index (Ref [b] 3rd tertile (low))	212			
1st tertile	234		1.22 (0.77-1.93)	1.12 (0.71-1.80)
2nd tertile	221		1.00 (0.62-1.61)	0.96 (0.59-1.55)
Household socio-economic factors				
Household wealth index (Ref [b] 3rd tertile (wealthy))	169			
1st tertile	262			1.90 (1.09-3.31) *
2nd tertile	236			1.80 (1.03-3.15) *

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression adjusted odds ratio
[b] Reference category

Table 40. Thinness logistic regression model parameters in males

Parameter	Model 1	Model 2	Model 3
Deviance	682.61	681.55	675.43
Model significance (p value)	<0.0001	<0.0001	<0.0001
Cox and Snell R square	0.035	0.036	0.045
Nagelkerke R square	0.053	0.055	0.069
Correctly classified cases	77.9	77.8	78.1
Hosmer and Lemeshow p-value	0.89	0.05	0.28

Table 41 shows the predictors of overweight and thinness from the univariate logistic regression analysis in females. The only factor that was significantly associated with overweight was age of entry into menarche, with the late menarche group (after 13 years) displaying lower odds of being overweight than the early menarche group (OR=0.56 [0.42-0.76]).

The predictors of thinness were population group and household wealth index. Mixed Ancestry females displayed higher odds of being thin compared to black African females (OR=2.85 [1.71 – 4.72]). Being in the first tertile of the household wealth index reduced the odds of being thin (OR=0.48 [0.27 – 0.84]).

It is worth mentioning that none of the neighbourhood SES variables were significantly associated with either overweight or thinness in females.

Table 41. Predictors of overweight and thinness from univariate logistic regression analysis for 18 year old females

	Maximum sample size							
	Overweight				Thinness			
	n	%	OR [a]	95% CI	n	%	OR [a]	95% CI
Intrinsic factors								
Age	**934**		p=0.30		**771**		p=0.80	
<18 years [b]	385	31.2	1	_	311	14.8	1	_
≥ 18 years	549	28.0	0.86	0.65-1.14	460	14.1	0.95	0.63-1.43
Population group	**924**		p=0.14		**761**		p=0.0002***	
Black African [b]	774	30.4	1	_	611	11.8	1	_
White	61	31.1	1.04	0.59-1.82	52	19.2	1.78	0.86-3.71
Mixed Ancestry	89	20.2	0.58	0.34-0.99	98	27.5	2.85	1.71-4.72
Low birth weight (<2500 g)	**869**		p=0.17		**714**		p=0.19	
No [b]	769	30.7	1	_	620	14	1	_
Yes	100	24.0	0.71	0.44-1.16	94	19.1	1.45	0.83-2.54
Age of entry into menarche	**825**		p<0.0001***		**674**		p=0.11	
<13 years [b] *(early)*	367	36.5	1	_	263	11.4	1	_
≥13 years (late)	458	24.5	0.56	0.42-0.76	411	15.8	1.46	0.92-2.32
Household socio-economic factors								
Caregiver education	**837**		p=0.67		**696**		p=0.93	
≤ Primary school	119	29.4	1.22	0.69-2.16	99	15.1	1.16	0.53-2.55
Secondary school	596	29.4	1.22	0.78-1.90	492	14.4	1.09	0.59-2.03
Higher education [b]	122	25.4	1	_	105	13.3	1	_
Household wealth index	**821**		p=0.25		**681**		p=0.021*	
1st tertile	285	25.6	0.77	0.53-1.12	234	9.4	0.48	0.27-0.84
2nd tertile	274	31.4	1.02	0.71-1.47	227	17.2	0.96	0.59-1.57
3rd tertile (wealthy) [b]	262	30.9	1	_	220	17.7	1	_
Smoking status	**715**		p=0.44		**586**		p=0.90	
Never [b]	278	32.4	1	_	219	14.2	1	_
Occasionally	270	27.4	0.79	0.55-1.14	232	15.5	1.11	0.66-1.87
Regularly	167	30.5	0.92	0.61-1.39	135	14.1	0.99	0.54-1.84

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

[a] Logistic regression unadjusted odds ratio

[b] Reference category

Table 41. Predictors of overweight and thinness from univariate logistic regression analysis for 18 year old females (continued)

	Maximum sample size							
	Overweight				**Thinness**			
	n	**%**	**OR [a]**	**95% CI**	**n**	**%**	**OR [a]**	**95% CI**
Neighbourhood socio-economic factors								
Neighbourhood economic index	**878**		p=0.29		**721**		p=0.70	
1st tertile	331	31.4	1.01	0.72-1.42	266	14.7	0.92	0.57-1.51
2nd tertile	265	26	0.78	0.53-1.13	225	12.9	0.79	0.47-1.35
3rd tertile (wealthy) [b]	282	31.2	1	_	230	15.6	1	_
Neighbourhood availability of services index	**878**		p=0.50		**723**		p=0.43	
1st tertile	300	32.0	1.19	0.83-1.71	234	12.8	0.73	0.43-1.22
2nd tertile	309	28.2	0.99	0.69-1.43	257	13.6	0.78	0.47-1.28
3rd tertile (high) [b]	269	28.3	1	_	232	16.8	1	_
Neighbourhood problem index	**868**		p=0.93		**714**		p=0.60	
1st tertile	287	30.0	1.07	0.75-1.53	230	12.6	0.77	0.46-1.29
2nd tertile	280	29.3	1.03	0.72-1.48	229	13.5	0.84	0.51-1.40
3rd tertile (low) [b]	301	28.6	1	_	255	15.7	1	_
Neighbourhood social support index	**877**		p=0.69		**720**		p=0.26	
1st tertile	321	28.0	0.86	0.60-1.22	262	11.8	0.65	0.39-1.09
2nd tertile	287	30.0	0.94	0.66-1.35	235	14.5	0.82	0.50-1.36
3rd tertile (favourable) [b]	269	31.2	1	_	223	17.0	1	_
Place of residence	**749**		p=0.80		**626**		p=0.097†	
Soweto [b]	606	29.0	1	_	498	13.6	1	_
Johannesburg	143	28.0	0.95	0.63-1.42	128	19.5	1.53	0.92-2.55

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression unadjusted odds ratio
[b] Reference category

Overweight for women was not examined in multivariate analyses because no univariate association with household or neighbourhood SES was found.

Table 42 shows the stepwise multivariate logistic regression analysis for the predictors of thinness in females for variables which achieved statistical significance ($p<0.1$) in the univariate analyses. The final step of the model (step 3) showed that Mixed Ancestry adolescents had higher odds of thinness compared to the Black African group (OR=2.98 [1.61-5.53]). Being in the lowest tertile of the household wealth index remained a significant predictor of thinness, with those in the lowest tertile of the household wealth index displaying lower odds of thinness (OR=0.49 [0.25-0.96]).

Table 43 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 3.9% and 6.8% of the variation in thinness status in females and the model was significant ($p=0.001$). The Hosmer and Lemeshow's goodness of fit test statistic indicated no significant differences between the predicted and observed values and 84.6% of the participants were correctly classified.

Table 42. Odds ratios and 95% confidence intervals for thinness from the adjusted logistic regression analyses in 18 year old females

	n	Step 1 Adjusted odds ratio (CI) [a]	Step 2 Adjusted odds ratio (CI) [a]	Step 3 Adjusted odds ratio (CI) [a]
Intrinsic factors				
Population group (Ref [b] Black African)	438			
White	34	1.49 (0.59-3.77)	1.93 (0.61-6.08)	1.72 (0.52-5.70)
Mixed Ancestry	79	3.04 (1.74-5.30) ***	3.33 (1.82-6.13) ***	2.98 (1.61-5.53) **
Neighbourhood socio-economic factors				
Place of residence (Ref [b] Soweto)	445			
Johannesburg	106		0.76 (0.36-1.57)	0.68 (0.33-1.43)
Household socio-economic factors				
Household wealth index (Ref [b] 3rd tertile (wealthy))	164			
1st tertile	199			0.49 (0.25-0.96) *
2nd tertile	188			1.08 (0.60-1.92)

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression adjusted odds ratio
[b] Reference category

Table 43. Thinness logistic regression model parameters in females

Parameter	Model 1	Model 2	Model 3
Deviance	459.7	459.15	451.9
Model significance (p value)	0.001	0.002	0.001
Cox and Snell R square	0.025	0.026	0.039
Nagelkerke R square	0.044	0.046	0.068
Correctly classified cases	84.6	84.6	84.6
Hosmer and Lemeshow p-value	_	_	0.16

7.2 Waist-to-height ratio

7.2.1 Sample characteristics for waist-to-height ratio

Table 44 shows the sample characteristics for all adolescents with height and waist circumference data (n=1945). Relative to each sex's specific reference, males displayed a lower waist circumference compared to females (-0.34 vs. 0.05 zscores, p<0.0001). The waist-to-height ratio was significantly lower in males than in females (0.42 vs. 0.46, p<0.0001). 24.4% of males had a low waist-to-height ratio (WHTR<0.40 representing underweight) compared to 10.2% of females (p<0.0001). 5.1% of males had a high waist-to-height ratio (WHTR≥0.50 representing risk of metabolic diseases) whilst the prevalence was approximately five times higher in females (26.0%) (p<0.0001).

In females, the mean age of entry into menarche was 12.7 years. In terms of household SES variables, the majority (71.8%) of the adolescent's caregivers achieved a secondary school education, with no significant differences between the sexes. The proportion of current smokers was higher in males than females (45.2% vs. 23.0% respectively, p<0.0001).

Different sex distributions were observed between Johannesburg and Soweto, with significantly more males living in Soweto and vice versa for Johannesburg. The distribution of people in each tertile of the household and neighbourhood SES indices was similar between sexes apart from for the neighbourhood social support index where the proportion of people in the first tertile (unfavourable social environment) was higher in women than in men because of the small range of scores generated from the PCA, which limited the designation of the sample into even tertiles.

Table 44. Sample characteristics for waist-to-height ratio

	Total group (n=1945)		Males (n=933 (48.0%))		Females (n=1012 (52.0%))		Tests
Anthropometric variables							
	mean/median	**SD/IQR**	**mean/median**	**SD/IQR**	**mean/median**	**SD/IQR**	
Waist circumference (z-scores) ¥	-0.14	0.77	-0.34	0.64	0.05	0.83	p<0.0001***[1]
Waist-to-height ratio	0.44	0.41-0.47	0.42	0.40-0.44	0.46	0.42-0.50	p<0.0001***[2]
Birthweight (kg)	3.07	0.51	3.12	0.52	3.02	0.49	p<0.0001***[1]
	n	**%**	**n**	**%**	**n**	**%**	
Low waist-to-height ratio (WHTR<0.40)	331	17.0	228	24.4	103	10.2	P<0.0001***[3]
Normal waist-to-height ratio (WHTR≥0.40 and WHTR<0.50)	1303	67.0	657	70.4	646	63.8	p=0.002**[3]
High waist-to-height ratio (WHTR≥0.50)	311	16.0	48	5.1	263	26.0	p<0.0001***[3]
Intrinsic variables							
	mean	**SD**	**mean**	**SD**	**mean**	**SD**	
Age (years)	18.21	0.57	18.23	0.58	18.18	0.56	p=0.06[1]
Age entry into menarche (years)					12.7	1.24	_
	n	**%**	**n**	**%**	**n**	**%**	
Physical maturation							
Early stages (2-3) (late maturers)	_	_	108	14.0	_	_	_
Later stages (4-5) (early maturers)	_	_	665	84.0	_	_	
Age of entry into menarche							
<13 years (early)	_	_	_	_	385	42.9	_
≥13 years (late)	_	_	_	_	512	57.1	

*p<0.05; **p<0.01; ***p<0.001

¥ z-scores for waist circumference were derived using the comprehensive Frisancho age and sex specific reference (Frisancho 2008)

[1] t-tests, [2] Mann Whitney tests, [3] chi square

Table 44. Sample characteristics for waist-to-height ratio (continued)

	Total group (n=1945)		Males (n=933 (48.0%))		Females (n=1012 (52.0%))		Tests
Intrinsic variables							
	n	**%**	**n**	**%**	**n**	**%**	
Low birth weight							
No	1616	89.2	785	90.5	831	88.0	$p=0.08^3$
Yes	195	10.8	82	9.5	113	12.0	
Population group							
White	128	6.6	61	6.5	67	6.6	
Black African	1596	82.1	770	82.5	826	81.6	$p=0.95^3$
Mixed Ancestry	201	10.3	93	10.0	108	10.7	
Indian	20	1.0	9	1.0	11	1.1	
Household SES variables							
	n	**%**	**n**	**%**	**n**	**%**	
Household wealth index							
1st tertile	596	34.6	296	35.9	300	33.5	
2nd tertile	592	34.4	286	34.7	306	34.1	$p=0.36^3$
3rd tertile	532	30.9	242	29.4	290	32.4	
Caregiver education							
Less than or primary school	252	14.4	124	14.8	128	14.1	
Secondary school	1255	71.8	606	72.1	649	71.5	$p=0.70^3$
Higher education	241	13.8	110	13.1	131	14.4	
Smoking status							
No	467	31.9	170	24.7	297	38.3	
Yes but not in last month	507	34.6	207	30.1	300	38.7	$p<0.0001***^3$
Yes in last month	490	33.5	311	45.2	179	23.0	

*p<0.05; **p<0.01; ***p<0.001
[1] t-tests, [2] Mann Whitney tests, [3] chi square

Table 44. Sample characteristics for waist-to-height ratio (continued)

	Total group (n=1945)		Males (n=933 (48.0%)		Females (n=1012 (52.0%)		Tests
Neighbourhood SES variables							
	n	%	n	%	n	%	
Place of residence							
Soweto	1305	82.9	649	85.5	656	80.5	p=0.008**³
Metropolitan Johannesburg	269	17.1	110	14.5	159	19.5	
Neighbourhood economic index							
1st tertile	639	35.1	281	32.4	358	37.6	
2nd tertile	573	31.5	290	33.4	283	29.8	p=0.053³
3rd tertile (high)	607	33.4	297	34.2	310	32.6	
Neighbourhood availability of services index							
1st tertile	609	33.5	286	33.0	323	34.0	
2nd tertile	622	34.2	287	33.2	335	35.2	p=0.39³
3rd tertile (high)	585	32.3	292	33.8	293	30.8	
Neighbourhood problem index							
1st tertile	595	33.5	286	33.0	323	34.0	
2nd tertile	602	34.2	287	33.2	335	35.2	p=0.18³
3rd tertile (low)	585	32.2	292	33.8	293	30.8	
Neighbourhood social support index							
1st tertile	598	32.9	257	29.6	341	35.9	
2nd tertile	611	33.6	298	34.3	313	33.0	p=0.01*³
3rd tertile (favourable)	609	33.5	314	36.1	295	31.1	

*p<0.05; **p<0.01; ***p<0.001
¹ t-tests, ² Mann Whitney tests, ³ chi square

7.2.2 Predictors of low and high waist-to-height ratio for 18 year old adolescents

Table 45 shows the predictors of low and high waist-to-height ratio from the univariate logistic regression analysis in males. The predictors of high waist-to-height ratio were population group, household SES index and neighbourhood economic index. White and Mixed Ancestry demonstrated increased odds of having a high waist-to-height ratio in comparison to black African (OR=2.950 [1.22 – 7.12]; OR=3.39 [1.61 – 7.13], respectively). The first and second tertile (poor and medium) of the household SES index displayed lower odds of having a high waist-to-height ratio ($p<0.0001$). The second tertile of the neighbourhood economic index was associated with reduced odds for a high waist-to-height ratio compared to the third tertile.

Table 45. Predictors of low and high waist-to-height ratio from univariate logistic regression analysis for 18 year old males

	Maximum sample size							
	High waist-to-height ratio				Low waist-to-height ratio			
	n	**%**	**OR** [a]	**95% CI**	**n**	**%**	**OR** [a]	**95% CI**
Intrinsic factors								
Age	**705**		p=0.09†		**885**		p=0.056†	
<18 years [b]	241	4.6	1	_	326	29.5	1	_
≥ 18 years	464	8.0	1.81	0.91-3.62	559	23.6	0.74	0.54-1.00
Population group	**698**		p=0.001**		**878**		p=0.14	
Black African [b]	571	4.9	1	_	742	26.8	1	_
White	53	13.2	2.95	1.22-7.12	54	14.8	0.47	0.22-1.02
Mixed Ancestry	74	14.9	3.39	1.61-7.13	82	23.2	0.82	0.48-1.41
Low birth weight	**659**		p=0.60		**821**		p=0.18	
No [b]	602	7.1	1	_	742	24.7	1	_
Yes	57	5.3	0.72	0.22-2.40	79	31.7	1.41	0.85-2.34
Tanner stages	**574**		p=0.70		**737**		p=0.35	
Early stages (2-3) [b] (late maturers)	76	5.3	1	_	104	30.8	1	_
Late stages (4-5) (early maturers)	498	6.4	1.24	0.42-3.60	633	26.4	0.81	0.51-1.27
Household socio-economic factors								
Caregiver education	**633**		p=0.18		**795**		p=0.37	
≤ Primary school	95	4.2	0.35	0.10-1.15	120	24.2	1.19	0.63-2.27
Secondary school	449	6.9	0.58	0.28-1.24	575	27.3	1.41	0.84-2.36
Higher education [b]	89	11.2	1	_	100	21	1	_
Household wealth index	**623**		p<0.0001***		**782**		p=0.71	
1st tertile	222	1.3	0.08	0.02-0.28	293	25.3	1.06	0.70-1.59
2nd tertile	211	5.7	0.36	0.18-0.74	274	27.4	1.18	0.78-1.78
3rd tertile (wealthy) [b]	190	14.2	1	_	215	24.2	1	_
Smoking status	**525**		p=0.96		**652**		p=0.32	
Never [b]	124	6.4	1	_	162	28.4	1	_
Occasionally	165	7.3	1.14	0.45-2.87	195	21.5	0.69	0.43-1.12
Regularly	236	6.8	1.05	0.44-2.54	295	25.4	0.86	0.56-1.32

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

[a] Logistic regression unadjusted odds ratio [b] Reference category

Table 45. Predictors of low and high waist-to-height ratio from univariate logistic regression analysis for 18 year old males (continued)

	Maximum sample size							
	High waist-to-height ratio				Low waist-to-height ratio			
	n	%	OR [a]	95% CI	n	%	OR [a]	95% CI
Neighbourhood socio-economic factors								
Neighbourhood economic index	**653**		p=0.019*		**825**		p=0.33	
1st tertile	218	6.4	0.61	0.30-1.22	267	23.6	0.75	0.51-1.10
2nd tertile	218	3.2	0.29	0.12-0.70	283	25.4	0.83	0.57-1.20
3rd tertile (wealthy) [b]	217	10.1	1	_	275	29.1	1	_
Neighbourhood availability of services index	**651**		p=0.87		**822**		p=0.91	
1st tertile	213	7.0	1.21	0.56-2.61	271	26.9	1.08	0.74-1.58
2nd tertile	217	6.9	1.18	0.55-2.56	272	25.7	1.01	0.69-1.49
3rd tertile (high) [b]	221	5.9	1	_	279	25.5	1	_
Neighbourhood problem index	**647**		p=0.22		**818**		p=0.53	
1st tertile	213	5.2	0.53	0.25-1.14	282	28.4	1.11	0.76-1.63
2nd tertile	230	6.1	0.63	0.31-1.29	285	24.2	0.89	0.60-1.32
3rd tertile (low) [b]	204	9.3	1	_	251	26.3	1	_
Neighbourhood social support index	**654**		p=0.75		**825**		p=0.45	
1st tertile	198	7.1	0.95	0.45-1.98	243	24.3	0.8	0.54-1.18
2nd tertile	227	5.7	0.76	0.36-1.60	285	24.9	0.83	0.57-1.19
3rd tertile (favourable) [b]	229	7.4	1	_	297	28.6	1	_
Place of residence	**566**		p=0.11		**724**		p=0.057†	
Soweto [b]	475	5.5	1	_	623	27.9	1	_
Johannesburg	91	9.9	1.89	0.86-4.19	101	18.8	0.6	0.35-1.01

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression unadjusted odds ratio
[b] Reference category

Table 46 shows the stepwise multivariate logistic regression analysis for the predictors of high waist-to-height ratio in males which achieved statistical significance ($p<0.1$) in the univariate analyses. Step two of the multivariate analysis, which introduced the neighbourhood economic index, showed that the association between being White and having a high waist-to-height ratio was no longer significant. The increased odds observed in Mixed Ancestry adolescent males compared to Black African remained unchanged. The fully adjusted model revealed that the significant predictors of high waist-to-height ratio were being Mixed Ancestry (increased odds (OR=2.65 [1.09-6.40]) and being in the first or second tertile of the household wealth index (decreased odds (OR=0.12 [0.03-0.44] and OR=0.41 [0.18-0.97] respectively).

Table 47 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 5.3% and 14.3% of the variation in high waist-to-height ratio in males and the model was significant ($p<0.0001$). The Hosmer and Lemeshow's goodness of fit test statistic indicated no significant differences between the predicted and observed values and 93.8% of the participants were correctly classified.

Table 48 shows the stepwise multivariate logistic regression analysis for the predictors of low waist-to-height ratio in males for variables which achieved statistical significance ($p<0.1$) in the univariate analyses.

Step 1 of the multivariate analysis showed that none of the factors included in the model were significant predictors of low waist-to-height ratio. Place of residence remained borderline significant in the fully adjusted model, with adolescents living in Johannesburg displaying a tendency towards lower odds of having a low waist-to-height ratio.

Table 49 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 0.7% and 1.0% of the variation in low waist-to-height ratio in males and the model was not significant ($p=0.09$). 73.3% of the participants were correctly classified.

Table 46. Odds ratios and 95% confidence intervals for high waist-to-height ratio from the adjusted logistic regression analyses in 18 year old males

	n	Step 1 Adjusted odds ratio (CI) [a]	Step 2 Adjusted odds ratio (CI) [a]	Step 3 Adjusted odds ratio (CI) [a]
Intrinsic factors				
Age (Ref [b] <18 years)	204			
≥ 18 years	372	1.62 (0.70-3.74)	1.67 (0.72-3.86)	1.46 (0.62-3.45)
Population group (Ref [b] Black African)	477			
White	41	3.16 (1.16-8.59) *	2.35 (0.80-6.87)	1.24 (0.41-3.79)
Mixed Ancestry	58	3.83 (1.66-8.87) **	3.88 (1.67-9.05) **	2.65 (1.09-6.40) *
Neighbourhood socio-economic factors				
Neighbourhood economic index (Ref [b] 3rd tertile (wealthy))	193			
1st tertile	186		0.77 (0.33-1.80)	1.18 (0.49-2.86)
2nd tertile	197		0.41 (0.16-1.06) †	0.58 (0.22-1.53)
Household socio-economic factors				
Household wealth index (Ref [b] 3rd tertile (wealthy))	172			
1st tertile	209			0.12 (0.03-0.44) **
2nd tertile	195			0.41 (0.18-0.97) *

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

[a] Logistic regression adjusted odds ratio

[b] Reference category

Table 47. High waist-to-height ratio logistic regression model parameters in males

Parameter	Model 1	Model 2	Model 3
Deviance	255.08	251.39	237.8
Model significance (p value)	0.003	0.003	<0.0001
Cox and Snell R square	0.024	0.031	0.053
Nagelkerke R square	0.065	0.082	0.143
Correctly classified cases	93.8	93.8	93.8
Hosmer and Lemeshow p-value	_	0.94	0.89

Table 48. Odds ratios and 95% confidence intervals for low waist-to-height ratio from the adjusted logistic regression analyses in 18 year old males

	n	Step 1 Adjusted odds ratio (CI) [a]	Step 2 Adjusted odds ratio (CI) [a]
Intrinsic factors			
Age (Ref [b] <18 years)	258		
≥ 18 years	466	0.80 (0.57-1.13)	0.84 (0.60-1.19)
Neighbourhood socio-economic factors			
Place of residence (Ref [b] Soweto)	623		
Johannesburg	101		0.62 (0.36-1.06) †

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression adjusted odds ratio
[b] Reference category

Table 49. Low waist-to-height ratio logistic regression model parameters in males

Parameter	Model 1	Model 2
Deviance	837.9	834.7
Model significance (p value)	0.207	0.088
Cox and Snell R square	0.002	0.007
Nagelkerke R square	0.003	0.010
Correctly classified cases	73.3	73.3
Hosmer and Lemeshow p-value	_	_

Table 50 shows the predictors of low and high waist-to-height ratio from the univariate logistic regression analysis in females. The only predictor of high waist-to-height ratio was age of entry into menarche. Adolescents who entered menarche after 13 years old showed decreased odds of having a high waist-to-height ratio (OR=0.68 [0.50-0.93]). In terms of low waist-to-height ratio, the only predictor was population group. White females demonstrated higher odds of having a low waist-to-height ratio (OR=2.28 [1.19-4.38]).

Table 50. Predictors of low and high waist-to-height ratio from univariate logistic regression analysis for 18 year old females

	Maximum sample size							
	High waist-to-height ratio				Low waist-to-height ratio			
	n	**%**	**OR** [a]	**95% CI**	**n**	**%**	**OR** [a]	**95% CI**
Intrinsic factors								
Age	**909**		p=0.84		**749**		p=0.094†	
<18 years [b]	372	29.3	1	_	314	16.2	1	_
≥ 18 years	537	28.7	0.97	0.72-1.30	435	12.0	0.7	0.46-1.06
Population group	**898**		p=0.39		**742**		p=0.044*	
Black African [b]	749	29.5	1	_	605	12.7	1	_
White	53	20.8	0.63	0.32-1.24	56	25	2.28	1.19-4.38
Mixed Ancestry	96	28.1	0.93	0.58-1.49	81	14.8	1.19	0.62-2.30
Low birth weight	**847**		p=0.06†		**694**		p=0.58	
No [b]	745	30.6	1	_	603	14.3	1	_
Yes	102	21.6	0.62	0.38-1.02	91	12.1	0.83	0.42-1.61
Age of entry into menarche	**808**		p=0.015*		**660**		p=0.99	
<13 years [b]	349	33.8	1	_	267	13.5	1	_
≥13 years	459	25.9	0.68	0.50-0.93	393	13.5	1	0.63-1.58
Household socio-economic factors								
Caregiver education	**811**		p=0.13		**678**		p=0.24	
≤ Primary school	119	31.9	1.79	0.98-3.27	90	10.0	0.49	0.21-1.13
Secondary school	581	29.1	1.57	0.96-2.67	480	14.2	0.73	0.42-1.26
Higher education [b]	111	20.7	1	_	108	18.5	1	_
Household wealth index	**804**		p=0.42		**664**		p=0.07†	
1st tertile	278	27.0	0.96	0.65-1.41	225	9.8	0.52	0.29-0.91
2nd tertile	274	31.7	1.21	0.8-1.76	219	14.6	0.82	0.49-1.37
3rd tertile (wealthy) [b]	252	27.8	1	_	220	17.3	1	_
Smoking status	**696**		p=0.63		**576**		p=0.11	
Never [b]	259	30.1	1	_	219	17.3	1	_
Occasionally	271	29.1	0.95	0.66-1.38	221	13.1	0.72	0.42-1.21
Regularly	166	25.9	0.81	0.52-1.25	136	9.6	0.5	0.26-0.98

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression unadjusted odds ratio
[b] Reference category

Table 50. Predictors of low and high waist-to-height ratio from univariate logistic regression analysis for 18 year old females (continued)

	Maximum sample size							
	High waist-to-height ratio				**Low waist-to-height ratio**			
	n	**%**	**OR [a]**	**95% CI**	**n**	**%**	**OR [a]**	**95% CI**
Neighbourhood socio-economic factors								
Neighbourhood economic index	**850**		p=0.44		**709**		p=0.077†	
1st tertile	330	30.9	1.18	0.83-1.68	256	10.9	0.75	0.44-1.28
2nd tertile	243	26.3	0.95	0.64-1.39	219	18.3	1.36	0.82-2.25
3rd tertile (wealthy) [b]	277	27.4	1	_	234	14.1	1	_
Neighbourhood availability of services index	**850**		p=0.09†		**710**		p=0.52	
1st tertile	288	33.0	1.46	1.00-2.12	228	15.3	1	0.6-1.66
2nd tertile	304	26.6	1.08	0.74-1.57	254	12.2	0.77	0.45-1.29
3rd tertile (high) [b]	258	25.2	1	_	228	15.3	1	_
Neighbourhood problem index	**838**		p=0.58		**700**		p=0.28	
1st tertile	278	30.2	1.21	0.84-1.75	218	11.0	0.68	0.40-1.18
2nd tertile	267	28.5	1.12	0.77-1.62	227	15.9	1.04	0.64-1.71
3rd tertile (low) [b]	293	26.3	1	_	255	15.3	1	_
Neighbourhood social support index	**850**		p=0.84		**708**		p=0.76	
1st tertile	308	27.3	0.95	0.65-1.36	257	12.8	0.9	0.53-1.52
2nd tertile	278	29.5	1.05	0.73-1.53	231	15.1	1.09	0.64-1.84
3rd tertile (favourable) [b]	264	28.4	1	_	220	14.1	1	_
Place of residence	**729**		p=0.92		**608**		p=0.38	
Soweto [b]	590	28.5	1	_	488	13.5	1	_
Johannesburg	139	28.1	0.98	0.65-1.48	120	16.7	1.28	0.74-2.21

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression unadjusted odds ratio
[b] Reference category

Table 51 shows the stepwise multivariate logistic regression analysis for the predictors of high waist-to-height ratio in females for variables which achieved statistical significance ($p<0.1$) in the univariate analyses. The significant predictors of high waist-to-height ratio in the fully adjusted model (step 1) were age of entry into menarche (≥13 years) (decreased odds (OR=0.69 [0.50-0.94]) and being in the first tertile of the neighbourhood availability of services index (increased odds (OR=1.59 [1.07-2.37]).

Table 52 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 1.9% and 2.8% of the variation in high waist-to-height ratio in females and the model was significant ($p=0.005$). The Hosmer and Lemeshow's goodness of fit test statistic indicated no significant differences between the predicted and observed values and 71.0% of the participants were correctly classified.

Table 51. Odds ratios and 95% confidence intervals for high waist-to-height ratio from the adjusted logistic regression analyses in 18 year old females

	n	Step 1 Adjusted odds ratio (CI) [a]	Step 2 Adjusted odds ratio (CI) [a]
Intrinsic factors			
Low birth weight (<2500 g) (Ref [b] no)	673		
Yes	87	0.60 (0.35-1.04) †	0.58 (0.34-1.00) †
Age of entry into menarche (Ref [b] <13 years)	329		
≥13 years (late)	431	0.69 (0.51-0.96) *	0.69 (0.50-0.94) *
Neighbourhood socio-economic factors			
Neighbourhood availability of services index (Ref [b] 3rd tertile (high))	221		
1st tertile	269		1.59 (1.07-2.37) *
2nd tertile	270		1.08 (0.72-1.63)

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression adjusted odds ratio [b] Reference category

Table 52. High waist-to-height ratio logistic regression model parameters in females

Parameter	Model 1	Model 2
Deviance	906.14	899.6
Model significance (p value)	0.015	0.005
Cox and Snell R square	0.011	0.019
Nagelkerke R square	0.016	0.028
Correctly classified cases	71.05	71.05
Hosmer and Lemeshow p-value	_	0.85

Table 53 shows the stepwise multivariate logistic regression analysis for the predictors of low waist-to-height ratio in females which achieved statistical significance (p<0.1) in the univariate analyses. In step 1 of the multivariate analysis, being aged 18 years or above in comparison to less than 18 years showed reduced odds of having a low waist-to-height ratio (OR=0.47 [0.29-0.77]). Being White increased the odds of having a low waist-to-height ratio (OR=3.86 [1.78-8.40]. Step 2, which introduced the neighbourhood economic index revealed that age, population group and being in the second tertile of the neighbourhood economic index were significant predictors of low waist-to-height ratio. Being in the second tertile of the neighbourhood economic index increased the odds of having a low waist-to-height ratio, compared to the third tertile (wealthy tertile) (OR=1.84 [1.04-3.25]). In the fully adjusted model (step 3), the association found between the second tertile of the neighbourhood economic index and a low waist-to-height ratio remained significant after adjusting for household wealth index. Being aged 18 years or above (OR=0.46 [0.28-0.76]) and being in the first tertile of the household wealth index (OR=0.47 [0.24-0.91]) decreased the odds of having a low waist-to-height ratio, whereas being White (OR=3.55 [1.48-8.52]) and in the second tertile of neighbourhood economic index (OR=2.11 [1.17-3.78]) increased the odds of having a low waist-to-height ratio. Table 54 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 4.2% and 7.5% of the variation in low waist-to-height ratio in females and the model was significant (p<0.0001). The Hosmer and Lemeshow's goodness of fit test statistic indicated significant differences between the predicted and observed values and 85.5% of the participants were correctly classified.

Table 53. Odds ratios and 95% confidence intervals for low waist-to-height ratio from the adjusted logistic regression analyses in 18 year old females

	n	Step 1 Adjusted odds ratio (CI) [a]	Step 2 Adjusted odds ratio (CI) [a]	Step 3 Adjusted odds ratio (CI) [a]
Intrinsic factors				
Age (Ref [b] <18 years)	267			
≥ 18 years	356	0.47 (0.29-0.77) **	0.45 (0.28-0.75) **	0.46 (0.28-0.76) **
Population group (Ref [b] Black African)	511			
White	43	3.86 (1.78-8.40) **	4.30 (1.89-9.77) ***	3.55 (1.48-8.52) **
Mixed Ancestry	69	1.41 (0.70-2.86)	1.40 (0.69-2.86)	1.22 (0.60-2.52)
Neighbourhood socio-economic factors				
Neighbourhood economic index (Ref [b] 3rd tertile (wealthy))	**209**			
1st tertile	217		1.06 (0.57-1.97)	1.34 (0.70-2.60)
2nd tertile	197		1.84 (1.04-3.25) *	2.11 (1.17-3.78) *
Household socio-economic factors				
Household wealth index (Ref [b] 3rd tertile (wealthy))	**198**			
1st tertile	212			0.47 (0.24-0.91) *
2nd tertile	213			0.85 (0.47-1.53)

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression adjusted odds ratio
[b] Reference category

Table 54. Low waist-to-height ratio logistic regression model parameters in females

Parameter	Model 1	Model 2	Model 3
Deviance	499.3	493.5	487.6
Model significance (p value)	0.002	0.001	<0.0001
Cox and Snell R square	0.024	0.033	0.042
Nagelkerke R square	0.043	0.059	0.075
Correctly classified cases	85.5	85.5	85.5
Hosmer and Lemeshow p-value	_	<0.0001	0.003

7.3 Percent fat mass

7.3.1 Sample characteristics for percent fat mass

Table 55 shows the sample characteristics for all adolescents with body fat percentage data (n=1728). Relative to each sex's specific reference, males displayed a lower body fat compared to females (-1.03 vs. 0.23 zscores, p=0.0001). In males, 5.2% had a high percent fat and 59.8% had a low percent fat. In females, 24.0% had a high percent fat and 14.0% had a low percent fat.

In females, the mean age of entry into menarche was 12.7 years. In terms of household SES variables, the majority (70.9%) of the adolescent's caregivers achieved a secondary school education, with no significant differences between the sexes. The proportion of current smokers was higher in males than females (44.8% vs. 22.9% respectively, p<0.0001).

Different sex distributions were observed between Johannesburg and Soweto, with significantly more males living in Soweto and vice versa for Johannesburg. The distribution of people in each tertile of the household and neighbourhood SES indices was similar between sexes apart from for the neighbourhood social support index and neighbourhood economic index where the proportion of people in the first tertile was higher in women than in men because of the small range of scores generated from the PCA, which limited the designation of the sample into even tertiles.

Table 55. Sample characteristics for percent fat mass

	Total group (n=1728)		Males (n=839 (48.5%))		Girls (n=889 (51.5%))		Tests
Anthropometric variables							
	mean	**SD**	**mean**	**SD**	**mean**	**SD**	
Body fat (z-scores) ¥	-0.38	1.25	-1.03	1.00	0.23	1.15	p=0.0001***[1]
Birthweight (kg)	3.06	0.51	3.11	0.52	3.02	0.50	p=0.0001***[1]
	n	**%**	**n**	**%**	**n**	**%**	
Below average body fat (%) (≤15th percentiles)	626	36.2	501	59.8	125	14.0	p<0.0001***[3]
Normal body fat (%) (≥15.01 and ≤85.0th percentiles)	845	48.9	294	35.0	551	62.0	p<0.0001***[3]
Above average body fat (%) (≥85.01th percentiles)	257	14.9	44	5.2	213	24.0	p<0.0001***[3]
Intrinsic variables							
	Mean	**SD**	**mean**	**SD**	**mean**	**SD**	
Age (years)	18.18	0.56	18.22	0.57	18.14	0.56	p=0.005**[1]
Age entry into menarche (years)	_	_	_	_	12.7	1.3	_
	n	**%**	**n**	**%**	**n**	**%**	
Physical maturation							
Early stages (2-3)	_	_	97	13.1	_	_	_
Later stages (4-5)	_	_	641	86.9	_	_	
Age of entry into menarche (years)							
<13	_	_	_	_	359	42.6	_
≥13	_	_	_	_	483	57.4	
Low birth weight							
No	1531	89.1	752	90.3	779	87.9	p=0.12[3]
Yes	188	10.9	81	9.7	107	12.1	

*p<0.05; **p<0.01; ***p<0.001

¥ z-scores for body fat were derived using the comprehensive Frisancho age and sex specific reference (Frisancho 2008)

[1] t-tests, [2] Mann Whitney tests, [3] chi square

Table 55. Sample characteristics for percent fat mass (continued)

	Total group (n=1728)		Males (n=839 (48.5%))		Girls (n=889 (51.5%))		Tests
Intrinsic variables							
	Mean	**SD**	**mean**	**SD**	**mean**	**SD**	
Population group							
White	109	6.3	52	6.2	57	6.4	
Black African	1419	82.1	692	82.5	727	81.8	p=0.67[3]
Mixed Ancestry	180	10.4	83	9.9	97	10.9	
Indian	20	1.2	12	1.4	8	0.9	
Household SES variables							
	n	**%**	**n**	**%**	**n**	**%**	
Household wealth index							
1st tertile	527	34.6	269	36.4	258	32.9	
2nd tertile	535	35.1	265	35.8	270	34.5	p=0.12[3]
3rd tertile	461	30.3	206	27.8	255	32.6	
Caregiver education							
Less than or primary school	235	15.1	115	15.1	120	15.0	
Secondary school	1104	70.9	542	71.4	562	70.4	p=0.82[3]
Higher education	218	14.0	102	13.4	116	14.5	
Smoking status							
No	449	32.4	168	25.8	281	38.4	
Yes but not in last month	475	34.3	192	29.5	283	38.7	p<0.0001***[3]
Yes in last month	460	33.2	292	44.8	168	22.9	

*p<0.05; **p<0.01; ***p<0.001
[1] t-tests, [2] Mann Whitney tests, [3] chi square

Table 55. Sample characteristics for percent fat mass (continued)

	Total group (n=1728)		Males (n=839 (48.5%)		Females (n=889 (51.5%)		Tests
Neighbourhood SES variables							
	n	**%**	**n**	**%**	**n**	**%**	
Place of residence							
Soweto	1149	82.5	571	84.8	578	80.3	p=0.025*[3]
Metropolitan Johannesburg	244	17.5	102	15.2	142	19.7	
Neighbourhood economic index							
1st tertile	576	35.9	255	33.0	321	38.5	
2nd tertile	493	30.7	256	33.2	237	28.5	p=0.042*[3]
3rd tertile (high)	536	33.4	261	33.8	275	33.0	
Neighbourhood availability of services index							
1st tertile	552	34.5	262	34.1	290	34.8	
2nd tertile	532	33.2	248	32.3	284	34.1	p=0.54[3]
3rd tertile (high)	517	32.3	258	33.6	259	31.1	
Neighbourhood problem index							
1st tertile	542	34.2	265	34.7	277	33.8	
2nd tertile	516	32.6	257	33.6	259	31.6	p=0.44[3]
3rd tertile (low)	526	33.2	242	31.7	284	34.6	
Neighbourhood social support index							
1st tertile	529	33.0	226	29.2	303	36.4	
2nd tertile	540	33.7	273	35.4	267	32.1	p=0.01*[3]
3rd tertile (favourable)	535	33.3	273	35.4	262	31.5	

*p<0.05; **p<0.01; ***p<0.001
[1] t-tests, [2] Mann Whitney tests, [3] chi square

7.3.2 Predictors of low and high fat mass for 18 year old adolescents

Table 56 shows the predictors of low and high percent fat mass from the univariate logistic regression analysis in males. The predictors strongly associated with high percent fat mass were population group and household wealth index. None of the neighbourhood SES variables was significantly associated with high percent fat mass. None of the white males had a high percent fat mass therefore the odds ratio could not be calculated. Mixed Ancestry adolescents displayed higher odds of having a high percent fat mass (OR=4.54 [1.85-11.1]) compared to black Africans. Males in the first or second tertile of the household wealth index showed decreased odds of having a high percent fat mass, compared to those in the third tertile of the index (wealthy) (OR=0.24 [0.09-0.62] and OR=0.46 [0.21-0.99] for the first and second tertile respectively).

The predictors of low percent fat mass were age, population group, low birth weight, caregiver education and smoking status. None of the neighbourhood SES variables was significantly associated with low percent fat mass. Adolescents aged 18 years or above had higher odds of low percent fat mass (OR=1.54 [1.15-2.08]). Mixed Ancestry adolescents displayed higher odds of having a low percent fat mass in comparison to the black African group (OR=2.2 [1.24-3.91], p=0.01). Those born with a low birth weight had higher odds of having low percent fat mass (OR=1.70 [1.01-2.87]). Adolescents whose caregivers completed primary school or less (OR=2.36 [1.34-4.15]) or secondary school (OR=1.97 [1.27-3.05]) had higher odds of having a low percent fat mass compared to those who completed higher education. Regular smokers had significantly higher odds of a low percent fat mass in comparison to non-smokers (OR=1.54 [1.03-2.30]).

Table 56. Predictors of low and high fat mass from univariate logistic regression analysis for 18 year old males

	Maximum sample size							
	High fat mass				Low fat mass			
	n	**%**	**OR [a]**	**95% CI**	**n**	**%**	**OR [a]**	**95% CI**
Intrinsic factors								
Age	**338**		p=0.69		**795**		p=0.004**	
<18 years [b]	140	12.1	1	_	282	56.4	1	_
≥ 18 years	198	13.6	1.14	0.60-2.18	513	66.7	1.54	1.15-2.08
Population group	**329**		p=0.001**		**787**		p=0.014*	
Black African [b]	281	11.0	1	_	661	62.2	1	_
White	23	0.0	_	_	52	55.8	0.77	0.43-1.35
Mixed Ancestry	25	36.0	4.54	1.85-11.1	74	78.4	2.20	1.24-3.91
Low birth weight (<2500 g)	**336**		p=0.52		**789**		p=0.045*	
No [b]	313	13.4	1	_	710	61.8	1	_
Yes	23	8.7	0.61	0.14-2.72	79	73.4	1.70	1.01-2.87
Tanner stages	**308**		p=0.36		**703**		p=0.44	
Early stages [b] (2-3) (late maturers)	38	15.8	1	_	91	64.8	1	_
Late stages (4-5) (early maturers)	270	10.7	0.64	0.25-1.66	612	60.6	0.83	0.53-1.32
Household socio-economic factors								
Caregiver education	**795**		p=0.37		**716**		p=0.004**	
≤ Primary school	120	24.2	1.2	0.63-2.27	111	67.6	2.36	1.34-4.15
Secondary school	575	27.3	1.41	0.84-2.36	509	63.5	1.97	1.27-3.05
Higher education [b]	100	21.0	1	_	96	46.9	1	_
Household wealth index	**297**		p=0.007**		**701**		p=0.39	
1st tertile	96	6.2	0.24	0.09-0.62	263	65.8	1.31	0.89-1.93
2nd tertile	105	11.4	0.46	0.21-0.99	253	63.2	1.17	0.79-1.73
3rd tertile (wealthy) [b]	96	21.9	1	_	185	59.5	1	_
Smoking status	**271**		p=0.19		**616**		p=0.035*	
Never [b]	77	11.7	1	_	159	57.2	1	_
Occasionally	92	18.5	1.71	0.72-4.09	175	57.1	0.99	0.64-1.54
Regularly	102	9.8	0.82	0.32-2.13	282	67.4	1.54	1.03-2.30

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

[a] Logistic regression unadjusted odds ratio

[b] Reference category

Table 56. Predictors of low and high fat mass from univariate logistic regression analysis for 18 year old males (continued)

	Maximum sample size							
	High fat mass				Low fat mass			
	n	%	OR [a]	95% CI	n	%	OR [a]	95% CI
Neighbourhood socio-economic factors								
Neighbourhood economic index	**309**			p=0.65	**731**			p=0.94
1st tertile	102	12.8	1.13	0.49-2.61	242	63.2	1.02	0.71-1.48
2nd tertile	102	15.7	1.44	0.64-3.22	240	64.2	1.07	0.74-1.54
3rd tertile (wealthy) [b]	105	11.4	1	_	249	62.6	1	_
Neighbourhood availability of services index	**306**			p=0.92	**728**			p=0.34
1st tertile	95	13.7	1.16	0.51-2.64	249	67.1	1.29	0.89-1.86
2nd tertile	103	13.6	1.15	0.51-2.58	234	62	1.03	0.71-1.49
3rd tertile (high) [b]	108	12.0	1	_	245	61.2	1	_
Neighbourhood problem index	**304**			p=0.97	**723**			p=0.31
1st tertile	99	14.1	1.08	0.49-2.40	251	66.1	1.32	0.91-1.92
2nd tertile	99	13.1	0.99	0.44-2.23	244	64.8	1.24	0.86-1.80
3rd tertile (low) [b]	106	13.2	1	_	228	59.7	1	_
Neighbourhood social support index	**311**			p=0.17	**731**			p=0.78
1st tertile	97	18.6	2.05	0.91-4.59	208	62	0.99	0.68-1.44
2nd tertile	104	11.5	1.17	0.49-2.79	261	64.8	1.11	0.78-1.59
3rd tertile (favourable) [b]	110	10.0	1	_	262	62.2	1	_
Place of residence	**271**			p=0.18	**636**			p=0.42
Soweto	228	14.9	1	_	537	63.9	1	_
Johannesburg	43	7.0	0.43	0.12-1.46	99	59.6	0.83	0.54-1.29

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

[a] Logistic regression unadjusted odds ratio

[b] Reference category

Table 57 shows the stepwise multivariate logistic regression analysis for the predictors of high percent fat mass in males for variables which achieved statistical significance ($p<0.1$) in the univariate analyses. In step one, there was a strong association between being Mixed Ancestry and high percent fat mass (OR=5.13 [2.02-13.0]). The fully adjusted model (step two), which introduced the household wealth index, revealed that the strength of the association between Mixed Ancestry and high percent fat was reduced but remained significant (OR=3.49 [1.29-9.43]). The household wealth index was also significantly associated with high percent fat. Adolescents in the first tertile of the household wealth index (poor) had significantly lower odds of having a high fat mass, compared to the adolescents in the relatively wealthy households (OR=0.28 [0.10-0.78]). However being in the second tertile of the household SES was no longer significantly associated with high percent fat mass in the fully adjusted model (OR=0.52 [0.22-1.21]).

Table 58 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 6.5% and 12.1% of the variation in high fat mass in males and the model was significant ($p=0.001$). The Hosmer and Lemeshow's goodness of fit test statistic indicated no significant differences between the predicted and observed values and 86.8% of the participants were correctly classified.

Table 57. Odds ratios and 95% confidence intervals for high fat mass from the adjusted logistic regression analyses in 18 year old males (n=290)

	n	Step 1 Adjusted odds ratio (CI) [a]	Step 2 Adjusted odds ratio (CI) [a]
		Intrinsic factors	
Height	290	1.03 (0.97-1.09)	1.02 (0.96-1.08)
Population group (Ref [b] Black African)	249		
White	18		
Mixed Ancestry	23	5.13 (2.02-13.0) ***	3.49 (1.29-9.43) *
		Household socio-economic factors	
Household wealth index (Ref [b] 3rd tertile (wealthy))	90		
1st tertile	96		0.28 (0.10-0.78) *
2nd tertile	104		0.52 (0.22-1.21)

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression adjusted odds ratio
[b] Reference category

Table 58. High fat mass logistic regression model parameters in males

Parameter	**Model 1**	**Model 2**
Deviance	200.6	194.2
Model significance (p value)	p=0.002	p=0.001
Cox and Snell R square	0.043	0.065
Nagelkerke R square	0.080	0.121
Correctly classified cases	86.76	86.76
Hosmer and Lemeshow p-value	0.41	0.20

Table 59 shows the stepwise multivariate logistic regression analysis for the predictors of low percent fat mass in males which achieved statistical significance ($p<0.1$) in the univariate analyses. In the first step of the multivariate analysis, being aged 18 or above or Mixed Ancestry increased the odds of having a low fat mass (OR=1.68 [1.17-2.41] and OR=2.34 [1.19-4.60] respectively). However, low birth weight was no longer significant. The fully adjusted model (step two), which introduced the household socio-economic factors (caregiver education and smoking status) revealed that the strength of the relationship between age and population group with low percent fat mass remained unchanged (OR=1.74 [1.20-2.51] and OR=2.38 [1.20-4.72] respectively). However, the association observed between caregiver education and low percent fat mass in the univariate analysis was no longer significant for the secondary education level and for the group with a primary school level education or less, compared to the higher educated group. Being a regular smoker as opposed to a non-smoker remained significant, with increased odds of having a low percent fat mass (OR=1.60 [1.03-2.48]).

Table 60 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 5.7% and 7.8% of the variation in low fat mass in males and the model was significant ($p<0.0001$). The Hosmer and Lemeshow's goodness of fit test statistic indicated no significant differences between the predicted and observed values and 63.1% of the participants were correctly classified.

Table 59. Odds ratios and 95% confidence intervals for low fat mass from the adjusted logistic regression analyses in 18 year old males(n= 550)

	n	Step 1 Adjusted odds ratio (CI) [a]	Step 2 Adjusted odds ratio (CI) [a]
		Intrinsic factors	
Height	550	1.02 (0.99-1.05)	1.03 (0.99-1.06)
Age (Ref [b] <18 years)	217		
≥ 18 years	333	1.68 (1.17-2.41)**	1.74 (1.20-2.51)**
Population group (Ref [b] Black African)	461		
White	35	0.55 (0.26-1.15)	0.66 (0.29-1.52)
Mixed Ancestry	54	2.34 (1.19-4.60)*	2.38 (1.20-4.72)*
Low birthweight (Ref [b] no) (<2500 g)	496		
Yes	54	1.60 (0.84-3.02)	1.60 (0.84-3.02)
		Household socio-economic factors	
Caregiver education (Ref [b] 3rd tertile (higher))	79		
≤ Primary school	79		2.03 (0.99-4.16)†
Secondary school	392		1.54 (0.88-2.71)
Smoking status (Ref [b] never smoked)	143		
Previous smoker	160		0.90 (0.57-1.44)
Current smoker	247		1.60 (1.03-2.48)*

*p<0.05; **p<0.01; ***p<0.001, † p<0.1
[a] Logistic regression adjusted odds ratio
[b] Reference category

Table 60. Low fat mass logistic regression model parameters in males

Parameter	Model 1	Model 2
Deviance	714.8	702.7
Model significance (p value)	0.001	<0.0001
Cox and Snell R square	0.036	0.057
Nagelkerke R square	0.049	0.078
Correctly classified cases	60.0	63.1
Hosmer and Lemeshow p-value	0.38	0.27

Table 61 shows the predictors of low and high percent fat mass from the univariate logistic regression analysis in females. The predictors of high percent fat mass were late menarche and being in the second tertile of the neighbourhood social support index. Females entering menarche after 13 years displayed lower odds of having a high percent fat mass (OR=0.58 [0.42-0.80]). Neighbourhood social support index was also significantly associated with having a high percent fat mass; those in the second tertile displayed higher odds of having a high percent fat mass (OR=1.68 [1.11 - 2.55]) compared to the females in the third tertile (favourable).

Predictors of low percent fat mass were age and population group. Females aged 18 or over had higher odds of having a low percent fat mass (OR=2.10 [1.38-3.22]). White and Mixed Ancestry females both had significantly lower odds of having a low percent fat mass compared to Black Africans (OR=2.39 [1.27 – 4.52]; OR=1.96 [1.13 – 3.41], respectively).

Table 61. Predictors of low and high fat mass from univariate logistic regression analysis for 18 year old females

	Maximum sample size							
	High fat mass				Low fat mass			
	n	%	OR	95% CI	n	%	OR	95% CI
Intrinsic factors								
Age	**764**		p=0.19		**676**		p=0.001**	
<18 years [b]	355	30.1	1	_	283	12.4	1	_
≥ 18 years	409	25.9	0.81	0.59-1.11	393	22.9	2.10	1.38-3.22
Population group	**757**		p=0.16		**671**		p=0.003**	
Black African [b]	640	14.6	1	_	543	16.0	1	_
White	41	28.7	0.42	0.17-1.03	51	31.4	2.39	1.27-4.52
Mixed Ancestry	76	26.3	0.88	0.52-1.52	77	27.3	1.96	1.13-3.41
Low birth weight	**761**		p=0.27		**673**		p=0.99	
No [b]	670	29.7	1	_	587	18.6	1	_
Yes	91	23.1	0.75	0.44-1.25	86	18.6	1.00	0.56-1.79
Age of entry into menarche	**732**		p=0.001**		**635**		p=0.06†	
<13 years [b]	325	34.5	1	_	247	13.8	1	_
≥13 years	407	23.3	0.58	0.42-0.80	388	19.6	1.53	0.98-2.37
Household socio-economic factors								
Caregiver education	**678**		p=0.24		**612**		p=0.29	
≤ Primary school	90	10	0.49	0.21-1.13	89	15.7	0.59	0.28-1.24
Secondary school	480	14.2	0.73	0.42-1.26	427	17.8	0.69	0.40-1.17
Higher education [b]	108	18.5	1	_	96	24.0	1	_
Household wealth index	**674**		p=0.22		**593**		p=0.71	
1st tertile	224	24.1	0.78	0.51-1.18	204	16.7	0.81	0.48-1.35
2nd tertile	233	31.3	1.11	0.74-1.67	197	18.8	0.94	0.57-1.55
3rd tertile (wealthy) [b]	217	29.0	1	_	192	19.8	1	_
Smoking status	**633**		p=0.67		**551**		p=0.96	
Never [b]	242	27.3	1	_	215	18.1	1	_
Occasionally	245	30.6	1.17	0.79-1.74	208	18.3	1.01	0.61-1.65
Regularly	146	27.4	1	0.63-1.59	128	17.2	0.94	0.53-1.66

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

[a] Logistic regression adjusted odds ratio

[b] Reference category

Table 61. Predictors of low and high fat mass from univariate logistic regression analysis for 18 year old females (continued)

	Maximum sample size							
	High fat mass				**Low fat mass**			
	n	**%**	**OR**	**95% CI**	**n**	**%**	**OR**	**95% CI**
Neighbourhood socio-economic factors								
Neighbourhood economic index	**718**			p=0.54	**633**			p=0.38
1st tertile	284	28.9	0.98	0.67-1.44	239	15.5	0.72	0.44-1.17
2nd tertile	201	25.0	0.8	0.52-1.23	187	19.3	0.94	0.57-1.54
3rd tertile (wealthy) [b]	233	29.2	1	_	207	20.3	1	_
Neighbourhood availability of services index	**718**			p=0.75	**636**			p=0.72
1st tertile	254	27.9	0.96	0.65-1.44	219	16.4	0.87	0.52-1.44
2nd tertile	241	25.7	0.86	0.57-1.29	222	19.4	1.06	0.65-1.73
3rd tertile (high) [b]	223	28.7	1	_	195	18.5	1	_
Neighbourhood problem index	**709**			p=0.86	**624**			p=0.29
1st tertile	241	27.8	1.07	0.71-1.60	210	17.1	0.78	0.48-1.28
2nd tertile	230	28.7	1.12	0.74-1.68	193	15	0.67	0.40-1.12
3rd tertile (low) [b]	238	26.5	1	_	221	20.8	1	_
Neighbourhood social support index	**718**			p=0.046*	**633**			p=0.65
1st tertile	265	27.2	1.26	0.84-1.91	231	16.5	0.89	0.55-1.47
2nd tertile	229	33.2	1.68	1.11-2.55	191	19.9	1.13	0.69-1.86
3rd tertile (favourable) [b]	224	22.8	1	_	211	18.0	1	_
Place of residence	**620**			p=0.61	**552**			p=0.075†
Soweto	505	27.5	1	_	439	16.7	1	_
Johannesburg	115	25.2	0.89	0.56-1.41	113	23.9	1.57	0.95-2.59

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

[a] Logistic regression adjusted odds ratio

[b] Reference category

Table 62 shows the stepwise multivariate logistic regression analysis for the predictors of high percent fat mass in females for variables which achieved statistical significance ($p<0.1$) in the univariate analyses. In the fully adjusted model both early menarche and being in the second tertile of the neighbourhood social support index remained significant predictors of having a high percent fat mass, with similar associations to those observed in the univariate analysis (OR= 0.65 [0.46-0.92] for late vs. early menarche and OR=1.59 [1.03-2.44] for the second tertile of the neighbourhood social support index vs. the third tertile).

Table 63 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 3.1% and 4.4% of the variation in high fat mass in females and the model was significant ($p<0.0001$). The Hosmer and Lemeshow's goodness of fit test statistic indicated no significant differences between the predicted and observed values and 71.8% of the participants were correctly classified.

Table 62. Odds ratios and 95% confidence intervals for high fat mass from the adjusted logistic regression analyses in 18 year old females (n=692)

	n	Step 1 Adjusted odds ratio (CI) [a]	Step 2 Adjusted odds ratio (CI) [a]
Intrinsic factors			
Height	692	0.96 (0.93-0.99)**	0.96 (0.93-0.99)**
Age of entry into menarche (Ref [b] <13)	309		
≥13 years (late)	383	0.64 (0.45-0.89) **	0.65(0.46-0.92) **
Neighbourhood socio-economic factors			
Neighbourhood social support index (Ref b 3rd tertile (favourable))	213		
1st tertile	259		1.20 (0.79-1.84)
2nd tertile	220		1.59 (1.03-2.44) *

† p<0.10, *p<0.05; **p<0.01; ***p<0.001
[a] Logistic regression adjusted odds ratio
[b] Reference category

Table 63. High fat mass logistic regression model parameters in females

Parameter	Model 1	Model 2
Deviance	799.70	795.03
Model significance (p value)	<0.0001	<0.0001
Cox and Snell R square	0.024	0.031
Nagelkerke R square	0.035	0.044
Correctly classified cases	71.9	71.8
Hosmer and Lemeshow p-value	0.29	0.37

Table 64 shows the stepwise multivariate logistic regression analysis for the predictors of low percent fat mass in females which achieved statistical significance (p<0.1) in the univariate analyses. The fully adjusted model (step 2) revealed that age and population group remained significant. Being 18 years or above was significantly associated with increased odds of low percent fat (OR=2.21 [1.31-3.74]). Mixed Ancestry adolescents had significantly higher odds of having a low percent fat in comparison to black African adolescents (OR=2.48 [1.29-4.76]).

Table 65 shows the deviance, the significance of each model, the amount of variation explained, the percentage of participants correctly classified by each model and finally the significance of the goodness of fit test. The final model explained between 6.1% and 10.1% of the variation in low fat mass in females and the model was significant (p<0.0001). The Hosmer and Lemeshow's goodness of fit test statistic indicated no significant differences between the predicted and observed values and 82.4% of the participants were correctly classified.

Table 64. Odds ratios and 95% confidence intervals for low fat mass from the adjusted logistic regression analyses in 18 year old females (n=520)

	n	Step 1 Adjusted odds ratio (CI)[a]	Step 2 Adjusted odds ratio (CI)[a]
		Intrinsic factors	
Height	520	1.04 (0.99-1.08) †	1.04 (0.99-1.08) †
Age (Ref[b] <18 years)	219		
≥ 18 years	301	2.20 (1.30-3.73) **	2.21 (1.31-3.74) **
Population group (Ref[b] Black African)	439		
White	17	2.84 (1.00-8.08) †	3.10 (0.92-10.5) †
Mixed Ancestry	64	2.40 (1.30-4.41) **	2.48 (1.29-4.76) **
Age of entry into menarche (Ref[b] <13)	203		
≥13 years (late)	317	1.64 (0.98-2.73) †	1.63 (0.98-2.72) †
		Neighbourhood socio-economic factors	
Place of residence (Ref[b] Soweto)	435		
Johannesburg	85		0.90 (0.44-1.86)

† p<0.10, *p<0.05; **p<0.01; ***p<0.001

[a] Logistic regression adjusted odds ratio

[b] Reference category

Table 65. Low fat mass logistic regression model parameters in females

Parameter	Model 1	Model 2
Deviance	448.6	448.5
Model significance (p value)	<0.0001	<0.0001
Cox and Snell R square	0.061	0.061
Nagelkerke R square	0.101	0.101
Correctly classified cases	82.2	82.4
Hosmer and Lemeshow p-value	0.86	0.81

7.4 Summary of results

Females had a significantly higher combined prevalence of overweight and obesity than males (26.2% vs. 8.2% respectively) whereas the prevalence of thinness was significantly higher in males than females (22.2% vs. 10.6%). Similar results were found with WHTR and percent fat. 24.4% of males had a low waist-to-height ratio (WHTR<0.40 representing underweight) compared to 10.2% of females. 5.1% of males had a high waist-to-height ratio (WHTR ≥0.50 representing overweight) whilst the prevalence was approximately five times higher in females (26.0%). In males, 5.2% had a high percent fat compared to 24.0% in females. 59.8% of males had a low percent fat compared to 14.0% of females.

The pattern of association between SES and anthropometric status also showed clear differences between sexes. Results for overweight, fatness and high WHTR for males reveal the neighbourhood SES environment not to be a significant factor. However, poor household SES level was associated with lower odds of overweight, fatness and high WHTR in males. For females the household SES level was not significantly associated with overweight, fatness and high WHTR. However, having a relatively less favourable neighbourhood social support environment was associated with higher odds of fatness and high WHTR. Results for thinness and low fatness for males and females revealed the neighbourhood SES environment not to be a significant factor. However, poor or middle household SES level was associated with higher odds of being thin in males. For females, poor household SES level was associated with lower odds of being thin.

Chapter 8: Religious leaders' role in adolescent obesity interventions

8. Religious leaders' role in adolescent obesity interventions

The aim of this chapter was to evaluate the potential for religious groups such as Churches to be used as community-based organisations for obesity intervention by assessing the readiness of leaders from religious groups to engage in such interventions.

This chapter includes results from the CRM survey and six FGDs conducted with religious leaders in the area of Johannesburg and Soweto.

Socio-demographic characteristics of the sample will first be presented and information on the composition of the six focus groups will be given. Descriptive statistics on the level of concern towards overweight and obesity will then be presented. The overall community readiness scores and stratified scores by Church will then be discussed. Information from the FGDs will be used to provide insight into the CRM scores in the six different dimensions (community efforts and knowledge of efforts, leadership, community climate, knowledge of the issue, resources).

8.1 Socio-demographic characteristics of focus group participants

Prior to the beginning of the FGDs, all participants completed some socio-demographic questions part of the CRM survey (see Chapter 4, section 4.4.6 for more information on the recruitment and data collection process). These data allowed the examination of the composition of each focus group. Table 66 shows the socio-demographic information of the participants overall but also stratified by religious institution. Overall results will only be discussed here.

Six focus groups were conducted. A total of 51 participants attended the FGDs and completed the CRM survey which included socio-demographic questions (62.8% males) (Table 66). Five focus groups were mixed males and females and one focus group included only male participants. In terms of population group, five focus groups included only Black African participants and one focus group included a mix of Black African, Mixed Ancestry and White participants. Table 66 shows that the sample was relatively young with 60.7% of the sample aged between 20-39 years old. More than half of the sample completed a higher education degree (53.0%). An almost equal proportion of participants were single (45.1%) or married (47.1%). Most commonly, the leaders who attended the FGDs were either pastors (26.0%) or youth leaders (32.0%) such as youth pastor, sports coach, etc. The other leaders represented in the sample were teachers, elders and other members of the Church. More than two thirds of the sample had been associated with the Church for more than ten years.

Table 66. Socio-demographic characteristics of focus group and survey participants

	Overall		Congregational Church (Soweto)		Methodist Church (Johannesburg)		Roman Catholic Church (Soweto)		Methodist Church (Soweto)		Evangelical Church (Johannesburg)		Pentecostal Church (Johannesburg)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Sex														
Male	32	62.8	7	53.9	5	55.6	4	57.1	7	63.6	4	66.7	5	100
Female	19	37.2	6	46.1	4	44.4	3	42.9	4	36.4	2	33.3	0	0
Population group														
White	4	7.8	_	_	_	_	_	_	_	_	4	66.7	_	_
Black	46	90.2	13	100	9	100	7	100	11	100	1	16.7	5	100
Mixed Ancestry	1	2	_	_	_	_	_	_	_	_	1	16.6	_	_
Age														
<20 years old	1	2	_	_	1	11.1	_	_	_	_	_	_	_	_
20-29 years old	15	29.4	_	_	3	33.3	5	71.4	5	45.5	2	33.3	_	_
30-39 years old	16	31.3	5	38.5	3	33.3	2	28.6	6	54.5	_	_	_	_
40-49 years old	10	19.6	4	30.8	2	22.3	_	_	_	_	2	33.3	2	40
50-59 years old	8	15.7	3	23.1	_	_	_	_	_	_	2	33.4	3	60
> 60 years old	1	2	1	7.6	_	_	_	_	_	_	_	_	_	_
Level of education														
Never went to school	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Some primary school	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Primary school completed	2	3.9	_	_	1	11.1	_	_	_	_			1	20
Some secondary school	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Secondary school completed	5	9.8	2	15.4	_		1	14.3	1	9.1	1	16.7	_	
Some high school	4	7.8	4	30.8	_	_	_	_	_	_	_	_	_	_
High school completed	13	25.5	6	46.1	_		1	14.3	3	27.3	2	33.3	1	20
More than high school	27	53	1	7.7	8	88.9	5	71.4	7	63.6	3	50	3	60

Table 66. Socio-demographic characteristics of focus group and survey participants (continued)

	Overall		Congregational Church (Soweto)		Methodist Church (Johannesburg)		Roman Catholic Church (Soweto)		Methodist Church (Soweto)		Evangelical Church (Johannesburg)		Pentecostal Church (Johannesburg)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Marital status														
Single	23	45.1	_	_	6	66.7	6	85.7	11	100	_	_	_	_
Married	24	47.1	12	92.3	2	22.2	1	14.3	_	_	6	100	3	60
Widow	2	3.9	1	7.7	1	11.1	_	_	_	_	_	_	_	_
Divorced	2	3.9	_	_	_	_	_	_	_	_	_	_	2	40
Cohabiting	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Role in the institution														
Pastor	13	26	2	15.4	1	11.1	1	14.3	_	_	4	66.7	5	100
Teacher	5	10	1	7.7	2	22.2	_	_	_	_	2	33.3	_	_
Elder	8	16	5	38.5	1	11.1	1	14.3	1	10	_	_	_	_
Health professional	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Youth worker/youth leader	16	32	2	15.4	3	33.3	5	71.4	6	60	_	_	_	_
Other	8	16	3	23	2	22.3	_	_	3	30	_	_	_	_
How long have you been associated with the Church														
Less than a year	2	4	1	7.7	1	11.1	_	_	_	_	_	_	_	_
1-5 years	7	14	_	_	3	33.3	1	14.3	1	9.1	2	33.3	_	_
5-10 years	8	16	3	23.1	3	33.3	_	_	_	_	1	16.7	1	20
More than 10 years	33	66	8	61.5	2	22.3	6	85.7	10	90.9	3	50	4	80

8.2 Level of concern towards overweight and obesity

The CRM included some closed questions and Likert scales questions to assess the level of concern towards overweight and obesity in the different congregations. The data allowed the quantitative examination of the level of concern towards this issue (Table 67). Results are shown on the overall sample and stratified by congregation. Questions using Likert scales to assess opinions (scale of 1 to 10) were put into three categories: not at all (responses from 1-3 on Likert scale); somewhat of a concern (responses from 4-7 on Likert scale) and a very great concern (responses from 8-10 on Likert scale).

Overall, 43.1% of the sample declared that overweight or obesity is somewhat of a concern and 19.6% reported that this issue represents a very great concern in adolescents (Table 67). The Methodist Churches in Johannesburg and Soweto had the highest percent thinking overweight and obesity are a concern in adolescents in their congregation. The Roman Catholic Church in Soweto and the Pentecostal Church in Johannesburg had the lowest percent thinking overweight and obesity are a concern in adolescents in their congregation.

Although it was recognised as a potential issue for adolescents in the congregation, 53.1% of the sample stated that adolescents' overweight or obesity was not a concern for the leadership. This percentage was ranging from 100% (Pentecostal Church in Johannesburg) to 33% (Methodist Church in Johannesburg) (Table 67).

58% of the leaders declared that overweight or obesity is very much of a problem for adolescents in general. Differences were found between Churches (Table 67).

Table 67. Level of concern towards overweight and obesity

	Overall		Congregational Church (Soweto)		Methodist Church (Johannesburg)		Roman Catholic Church (Soweto)		Methodist Church (Soweto)		Evangelical Church (Johannesburg)		Pentecostal Church (Johannesburg)	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
How much of a concern is overweight or obesity in adolescents in your congregation														
Not at all	19	37.3	5	38.5	2	22.2	4	57.1	2	18.2	3	50	3	60
Somewhat of a concern	22	43.1	4	30.8	6	66.7	3	42.9	5	45.5	2	33.3	2	40
A very great concern	10	19.6	4	30.8	1	11.1	_	_	4	36.4	1	16.7	_	_
How much of a concern is adults overweight or obesity to the leadership in your congregation														
Not at all	26	53.1	5	45.4	4	44.4	3	42.9	5	45.4	4	66.7	5	100
Somewhat of a concern	15	30.6	4	36.4	5	55.6	3	42.9	2	18.2	1	16.7	_	_
A very great concern	8	16.3	2	18.2			1	14.3	4	36.4	1	16.7	_	_
How much of a concern is adolescents overweight or obesity to the leadership in your congregation														
Not at all	26	53.1	4	36.4	3	33.3	4	57.1	6	54.5	4	66.7	5	100
Somewhat of a concern	19	38.8	6	54.5	6	66.7	3	42.9	3	27.3	1	16.7	_	_
A very great concern	4	8.2	1	9.1					2	18.2	1	16.7	_	_
Do you think overweight or obesity is a problem for adolescents in general														
Not at all	6	12	4	33.3							1	16.7	1	20
Somewhat	15	30	3	25	4	44.4	3	42.9	2	18.2	2	33.3	1	20
Very much	29	58	5	41.7	5	55.6	4	57.1	9	81.8	3	50	3	60
Do other people in your congregation think overweight or obesity is a problem for adolescents														
Not at all	6	12	2	16.7			1	14.3			1	16.7	2	40
Somewhat	17	34	3	25	3	33.3	2	28.6	4	36.4	2	33.3	3	60
Very much	12	24	3	25	2	22.2	1	14.3	4	36.4	2	33.3	_	_
Don't know	15	30	4	33.3	4	44.4	3	42.9	3	27.3	1	16.7	_	_

8.3 Community Readiness Model results

The surveys were scored according to the CRM protocol explained in the methods chapter (Chapter 4, section 4.4.8) and the level of readiness of religious leaders to prevent obesity in adolescents was calculated according to the scoring protocol. It is advised to round down the overall score rather than up (Plested et al. 2006).

In this section, the overall community readiness score and scores obtained for each Church will be discussed. Information from the FGDs will be used to interpret the scores obtained in the six different dimensions assessed in the CRM (community efforts and knowledge of efforts, leadership, community climate, knowledge of the issue, resources).

The mean obesity readiness score was 2.67 (i.e. the average readiness score for all six churches, with each church's individual score based on the average score for community efforts, knowledge of community efforts, leadership, community climate, knowledge of the obesity issue and resources mobilised for the obesity issue). This corresponds to the second out of nine stages of the community readiness (Table 68). This stage is called the "denial/resistance stage" and is reached when "at least some community members recognise that it is a concern, but there is little recognition that it might be occurring locally"(Plested et al: 2006; p12).

The readiness scores for resources (i.e. the extent to which people, time, money and space are available to support efforts) were the highest of all the dimensions (3.75), followed by knowledge of the issue (3.18) (i.e. the extent to which community members know about the causes and consequences of the issue). The lowest score was seen for community knowledge of efforts (1.88) (i.e. the extent to which community members know about local efforts and effectiveness) and the second lowest score was community climate (2.16) (i.e. the prevailing attitude of the community towards the issue). The scores for leadership (i.e. the extent to which appointed leaders and influential community members are supportive of the issue) and community efforts (i.e. efforts, programmes and policies in place that address the issue) were 2.59 and 2.47 respectively. These results suggest, in accordance with the CRM handbook, that: 1) no efforts currently exist to address the obesity issue; 2) the community has no knowledge of the need for efforts to address the issue; 3) the leadership believes this is not an issue in their community; 4) the prevailing attitude of the community toward the issue is not one of responsibility and empowerment; 5) a few people in the community have some knowledge about the issue and 6) the community is not sure where the resources would come from to initiate efforts.

It is important to mention that the overall obesity readiness score masks some differences between churches, with some being at a more advanced readiness stage than others. The differences between churches will now be examined.

The congregation church and Methodist church in Johannesburg had the highest obesity readiness scores (3.00 and 3.04 respectively), corresponding to the third out of nine stages of the community readiness. This stage is called the “vague awareness stage”. This stage is reached when “most feel that there is a local concern, but there is no immediate motivation to do anything about it” (Plested et al: 2006; p12). The relatively higher scores observed for the congregational church and Methodist church in Johannesburg can be explained by higher scores in the community efforts, leadership, knowledge of the issue and resources dimensions. The Roman Catholic Church, the evangelical church and Methodist Church in Soweto had intermediary obesity readiness scores (2.33, 2.47 and 2.62 respectively), which corresponds, as described above, to the “denial/resistance stage” (Plested et al: 2006; p12). The Pentecostal church had the lowest obesity readiness score of all churches (1.97), corresponding to the first out of nine stages of the community readiness. This stage is called the “no awareness stage” and is reached when “the issue is not generally recognised by the community or leaders as a problem (or it may truly not be an issue) (Plested et al: 2006; p12). The relatively low score observed for the Pentecostal church can be explained by low scores for the community efforts, knowledge of the efforts, leadership and community climate dimensions. Although the majority of the scores were low for the Pentecostal church, it is worth mentioning that the readiness score for resources was relatively high (4.00) (i.e. the community has individuals, organisations and/or space available that could be used as resources).

The overall and stratified community readiness results suggest that religious leaders in some churches are relatively knowledgeable about the obesity issue and that the resources could be available to support obesity prevention-related initiatives. The low levels of community efforts, knowledge of efforts and community climate, imply that the awareness of the issue and the need to develop initiatives have to be increased.

The following section focuses on interpreting scores within each dimension by using information from the FGDs and also identify potential initiatives which could improve the community readiness scores.

Table 68. Community readiness scores

	Community efforts (A)	Knowledge of community efforts (B)	Leadership (C)	Community climate (D)	Knowledge of the issue (E)	Resources (F)
Congregational Church, Soweto						
Questionnaire 1	1	1	3	1	1	4
Questionnaire 2	1	1	3	1	1	4
Questionnaire 3	3	2	3	4	4	1
Questionnaire 4	3	3	3	4	2	4
Questionnaire 5	7	4	3	5	3	4
Questionnaire 6	7	4	3	4	3	4
Questionnaire 7	7	4	3	4	4	4
Questionnaire 8	2	2	1	1	2	4
Questionnaire 9	7	5	3	4	3	4
Questionnaire 10	1	1	3	1	1	4
Questionnaire 11	2	2	3	5	4	2
Questionnaire 12	6	3	3	1	1	4
Questionnaire 13	1	1	3	1	4	4
Mean score	**3.69**	**2.54**	**2.85**	**2.77**	**2.54**	**3.62**
Readiness score	**3**					
Methodist Church, Johannesburg						
Questionnaire 1	1	1	3	1	4	4
Questionnaire 2	1	1	3	3	4	4
Questionnaire 3	2	2	3	3	4	4
Questionnaire 4	1	1	3	1	3	4
Questionnaire 5	2	2	3	3	3	4
Questionnaire 6	2	2	3	3	3	4
Questionnaire 7	6	4	3	3	5	4
Questionnaire 8	6	5	3	4	4	4
Questionnaire 9	2	2	3	3	4	4
Mean score	**2.56**	**2.22**	**3**	**2.67**	**3.78**	**4**
Readiness score	**3.04**					
Roman Catholic Church, Soweto						
Questionnaire 1	1	1	3	1	3	4
Questionnaire 2	1	1	3	1	3	4
Questionnaire 3	2	2	1	1	4	4
Questionnaire 4	1	1	3	1	3	4
Questionnaire 5	1	1	3	1	3	4
Questionnaire 6	2	2	3	3	5	4
Questionnaire 7	1	1	3	1	3	4
Mean score	**1.29**	**1.29**	**2.71**	**1.29**	**3.43**	**4**
Readiness score	**2.33**					

Table 68. Community readiness scores (continued)

	Community efforts (A)	Knowledge of community efforts (B)	Leadership (C)	Community climate (D)	Knowledge of the issue (E)	Resources (F)
Methodist Church, Soweto						
Questionnaire 1	3	2	3	3	5	4
Questionnaire 2	2	2	2	1	3	3
Questionnaire 3	1	1	3	4	2	4
Questionnaire 4	1	1	3	1	3	4
Questionnaire 5	1	1	3	1	3	4
Questionnaire 6	1	1	3	2	4	4
Questionnaire 7	3	2	3	3	3	4
Questionnaire 8	2	2	3	2	4	4
Questionnaire 9	3	2	3	3	3	4
Questionnaire 10	2	2	3	1	3	4
Questionnaire 11	3	2	3	3	4	1
Mean score	**2**	**1.64**	**2.91**	**2.18**	**3.36**	**3.64**
Readiness score	**2.62**					
Evangelical Church, Johannesburg						
Questionnaire 1	2	2	1	2	2	4
Questionnaire 2	1	1	3	1	3	3
Questionnaire 3	6	2	3	3	5	4
Questionnaire 4	1	1	1	1	3	4
Questionnaire 5	6	2	3	2	5	4
Questionnaire 6	1	1	1	1	3	1
Mean score	**2.83**	**1.5**	**2**	**1.67**	**3.5**	**3.33**
Readiness score	**2.47**					
Pentecostal Church, Johannesburg						
Questionnaire 1	2	2	1	2	3	4
Questionnaire 2	1	1	1	1	1	4
Questionnaire 3	1	1	1	1	3	4
Questionnaire 4	2	2	1	2	3	4
Questionnaire 5	1	1	1	1	3	4
Mean score	**1.4**	**1.4**	**1**	**1.4**	**2.6**	**4**
Readiness score	**1.97**					
Total	126	96	132	110	162	191
Mean (SD)	**2.47** (1.98)	**1.88** (1.07)	**2.59** (0.80)	**2.16** (1.27)	**3.18** (1.05)	**3.75** (0.77)
Overall readiness stage	**2.67**	**(Denial/resistance stage)**				

8.3.1 Community efforts and knowledge of efforts

To what extent are there efforts, programmes, and policies that address the issue? To what extent do community members know about local efforts and their effectiveness, and are the efforts accessible to all segments of the community?

The scores for community efforts and knowledge of efforts were relatively low. The only reported programmes specifically targeting adolescents and related to the obesity issue were football and exercise sessions (only in males), sports day with outdoor activities taking place twice or three times a year and camp days. Blood pressure and diabetes checks were reported to be assessed in elders only.

The low scores can be explained by the fact that adolescents overweight or obesity in the congregation was mainly “not a concern at all” to the leadership although it was recognised to be an issue in the congregation for adults and for adolescents in the wider population. The fact that overweight/obesity was not a concern to the leadership can be explained by the fact that adolescents experience various problems in their daily lives that seem to have greater priority or that the prevalence is perceived as being low.

> *“In our Church, we have challenges like adolescents being raped, physically abused, homeless and poverty stricken, and obesity has in a way been shoved low on the list of priorities relatively.”*
>
> Female leader, Evangelical Church, Johannesburg suburb

> *“I don’t think that obesity is quite as prevalent in our community as it is in the white areas and we don’t see much of it in the Church either”*
>
> Female leader, Roman Catholic Church, Soweto

> *“There is about only 1 in 10 people who might be obese in the congregation. We could attribute this to the fact that kids in our community are very active, they are always playing in the streets and it is very hard to spot an obese kid in our community”*
>
> Female leader, Roman Catholic Church, Soweto

A female leader from the Methodist Church in Soweto added a key element important to take into consideration when designing an intervention. She mentioned that *“yes some* *people are big but it has never been viewed as a problem, we do not discriminate against big people or make them feel uncomfortable in any way."*

Amongst the issues faced by adolescents, both social (peer pressure, depression, technology, change in family structure, loss of identity, environmental change, cultural change, discipline, delinquency and unruliness, unemployment, lack of development activities, lack of empowerment programmes, hopelessness, inequality and poverty, drugs and alcohol) and safety issues (violence) were mentioned along with health issues (teenage pregnancies, obesity, unhealthy dietary habits, access to health care and information).

8.3.1.1 Wider social issues faced by adolescents in their community

The key social issues discussed were poverty and inequalities, cultural change (discipline, family structure, role of parents, etc.), peer pressure, technology and self-esteem. One of the issues discussed by leaders was the lack of social development programmes for adolescents and, the lack of information and financial support for them to pursue their studies. These factors were associated with the high unemployment rate seen in the youth population which in turn impact on their self-esteem level and how they view their future. Adolescents were described as hopeless and disillusioned.

> *"Lack of resources to implement development programmes is also a problem. Our kids are not exposed to what the rest of the world has to offer, there is a serious lack of empowerment programmes. "*
>
> Female leader, Congregational Church, Soweto

> *"It is also because of lack of information and uncertainty about the future after high school".*
>
> Female leader, Roman Catholic Church, Soweto

Leaders reported that the nature of problems that adolescents experience in their communities differs by SES level and that social inequalities are apparent.

"In our Church we have about two groups of adolescents, those that go to model C[1] schools and are well informed and those that do not receive support from anywhere".

Female leader, Roman Catholic Church, Soweto

"There are obvious inequalities between the two groups".

Female leader, Roman Catholic Church, Soweto

"It all depends on the socio-economic environment that they come from (…) we have adolescents from practically all walks of life. There are those from informal settlements and they face issues that are totally different to those faced by adolescents from the more affluent neighbourhoods. Adolescents coming from disadvantaged communities face issues related with day-to-day survival security and a large number of these unfortunate kids are also heads of households as most of them are orphans. On the other hand the adolescents from the affluent areas are not very concerned about their immediate needs but the future rather and that is the major difference."

Male leader, Evangelical Church, Johannesburg suburb

Leaders also highlighted that the problems differ between urban and rural areas and that the urban area enhances all types of risky behaviours.

"The influences and experiences are vastly different in Johannesburg from those in predominantly rural areas. The trends and behavioural patterns would also then differ."

Male leader, Methodist Church, Johannesburg

"… bad information flies and spreads around more. Adolescents in Soweto are easily influences by bad things. It is very unlikely that you would find cases of substance abuse other than just maybe alcohol abuse in the rural areas (…)."

Male leader, Methodist Church, Johannesburg

[1] Model C schools: government schools that are administrated and largely funded by a governing body of parents and alumni. These schools offer exceptional facilities and high academic standards.

Cultural change was discussed broadly across the FGDs. Leaders mentioned that family structure, parental role and relationships between parents and adolescents have evolved. Adolescents living in broken family structures were described as more likely to adopt bad behaviours. Loss of identity (African vs. Western) was also raised as a problem.

> *"…Today single parenthood is the order of the day. A lot of these kids are raised by mostly their mothers. The world today poses a serious challenge that the mother cannot handle alone."*
>
> Male leader, Pentecostal Church, Johannesburg

> *"… I have noticed that there is a very strong link between their behaviour and broken family structures. There tends to be a lot of ill-discipline and a lot of longing for guidance amongst those adolescents that come from broken families. This ultimately leads to a whole lot of other social ills".*
>
> Male leader, Methodist Church, Johannesburg

> *"Cultural behaviour is also a major challenge for us. Information technology has exposed our kids to international behaviour and trends and as a result we now have Africans who live a double life trying to be both African and Western at the same time. This poses a lot of confusion and friction between adults and adolescents".*
>
> Male leader, Pentecostal Church, Johannesburg

There was an agreement around peer pressure and self-esteem being major issues in adolescents. Exposure to media, TV, and social networks put pressure on youth "to keep up with the latest trends in fashion and technology" (Female leader, congregational Church, Soweto).

> *"Everyone wants to belong to or fit into a clique, it is not necessarily a bad thing, it is a phase. My only concern is the pressure and the challenges that befall them or come with this need to belong or fit in"*
>
> Female leader, Roman Catholic Church, Soweto

Although peer pressure was recognised as a transient phenomenon, its consequences on self-esteem and self-confidence were discussed.

> *"Kids struggle to fit in and tend to feel inferior to those other kids who seem to have it all."*
>
> Male leader, Pentecostal Church, Johannesburg

> *"Poverty and lacking in items of clothing that peers have, definitely does affect their confidence as well"*
>
> Male leader, Congregational Church, Soweto

8.3.1.2 Health issues among adolescents

The health issues cited by religious leaders varied from STDs, HIV/AIDS, teenage pregnancies, unhealthy lifestyles (unhealthy dietary habits, lack of physical activity, stress and depression and substance abuse (alcoholism and drugs).

Sex related issues were seen as problematic in adolescents, although differences in prevalence existed depending *"on the milieu that the kids come from"* (Male leader, Evangelical Church, Johannesburg suburb). Leaders reported that "youths are already sexually active and contracting STDs and other sex related issues is rife" (Male leader, Evangelical Church, Johannesburg suburb). The lack of facilities and resources for these adolescents to engage in community-based extra-curricular activities was described as a contributor of risky sexual behaviours and teenage pregnancies.

> *"…I am worried about young brothers and sisters lacking facilities for extra mural activities and resorting to pre-marital sex as a recreational activity" and teenage pregnancies are rife as a result".*
>
> Male leader, Methodist Church, Johannesburg

> *"…that is the reason why we find such a high number of STIs amongst the youth as well. HIV/AIDS is also prevalent. This is a problem that affects the community at large. Young people have taken to sex for entertainment."*
>
> Male leader, Methodist Church, Johannesburg

"After having interacted with them, I would basically say that it is mostly sexually related issues. When they start being sexually active, they then become susceptible to teenage pregnancies and promiscuity. We don't always get to know about it until there is a problem. There is also a risk of STDs consequently. This is the main issue amongst other things."

Male leader, Pentecostal Church, Johannesburg

Leaders highlighted that inequalities exist in terms of access to health systems and to health-related information in adolescents.

"One of the big issues that I have observed in terms of health issues is that the access to healthcare and information to help them make better choices about their health is limited. A lot of these young people do not have any access to such information and they have erroneous information most of the time (…)."

Male leader, Evangelical Church, Johannesburg suburb

This probably explains the way that people interact with the health systems. Prevention did not seem to be a priority.

"We don't normally go for regular check-ups as black people; we usually wait until we are sick before we take the dreaded trip".

Male leader, Congregational Church, Soweto

Unhealthy lifestyles (unhealthy dietary patterns, lack of physical activity, sedentary behaviour) were also discussed extensively and were seen as detrimental factors for health. Leaders emphasised the change in food culture, cooking and dietary patterns.

"All the above factors considered and all the exposure that adolescents are exposed to, also considering the amount of processed food that they eat, all of this creates a social disaster (…) When I was a kid myself, I had to go buy vegetables at the market every weekend and everyone in the family would gather around to chop up the vegetables

and this gave us quality time as a family. A lot of us are opting for quick-time processed food especially fast food."

Male leader, Methodist Church, Johannesburg

"Life is now fast paced and both parents are working and as a result nobody has the time to prepare a healthy balanced meal for the family and unhealthy eating may cause obesity, heart diseases and hypertension as a result which were never an issue for adolescents in my time."

Male leader, Pentecostal Church, Johannesburg

In contrast to what was said for social and other health issues, in this instance, leaders declared that adolescents' dietary patterns were the same regardless of their SES.

"Nutrition is also another issue and this is not really dependent on background. Well off kids also eat junk food for lunch and it doesn't matter how much we emphasise the importance of eating fruits and drinking water among other good eating habits. The availability of resources and even the information doesn't influence their diet that much."

Female leader, Evangelical Church, Johannesburg suburb

Safety issues in the area of Johannesburg/Soweto were seen as responsible for affecting physical activity patterns and in turn health.

"There is also a safety concern because it is now a risk for the kids to walk or cycle home after school. This is a major contributing factor to the kids' bad health."

Male leader, Congregational Church, Johannesburg suburb

8.3.1.3 Resources and challenges for obesity prevention interventions

The lack of resources and challenges faced by the religious leaders could also explain the low scores for community efforts and community knowledge of efforts.

Some members reported that resources were lacking (information, space and facilities, time, money, and people) and also made mention of perceptions as a barrier for the development of community efforts for the obesity issue. Spiritual satisfaction over physical satisfaction was also discussed.

> *"Time is the scarcest of all resources in this community. It hinders most development (…) I also don't think that we have enough tools to facilitate our activities."*
>
> Male leader, Methodist Church, Johannesburg

> *"I also agree with the pastor that lack of information is an issue (…) Information and education needs to be advanced for us to achieve the desired outcome. "*
>
> Male leader, Methodist Church, Johannesburg

> *"In the Church we do not know who can give us that information (i.e. healthy lifestyle related information). I do however think that once we take an initiative and invite people with information to come forward, then maybe we can get moving."*
>
> Female leader, Roman Catholic Church, Soweto

> *"…we normally lack funds to do most of these projects (…) The space is also a limiting factor when it comes to outdoor activities (…) I think that we do have the structures that can plan and make the resources available but such issues are not priorities within the Church because most people just focus on satisfying their spirituality side of things and the physical being is ignored. Cleanliness and healthiness are line with Godly standards. We just need to identify the needs and plans accordingly."*
>
> Male leader, Methodist Church, Soweto

> *"Perception could also be a major challenge. As Africans we believe that bigger is always better."*
>
> Male leader, Methodist Church, Soweto

Another reason for not having obesity programmes could be the stigmatisation associated with it.

> *"We wouldn't of course have a program for obese people as that would stigmatise them."*
>
> Female leader, Congregational Church, Soweto

One Church had good resources (people, space, money, sports facilities) but declared that *"the opportunities that we have are only limited by the scarcity of time. We have the necessary facilities and we engage in one-on-one conversations with the kids, we just don't have enough time" (*Male leader, Evangelical Church, Johannesburg suburb).

The government was also blamed for the lack of programmes implemented to address obesity.

> *"We think that the government is playing a major role in promoting obesity because they allow companies to distribute foods that cause obesity. There are no outreach programmes in place by the government to teach people on obesity."*
>
> Male leader, Congregational Church, Soweto

Although leaders recognise their role in adolescents' health, they mentioned that other stakeholders such as social workers, family, school and provincial and local councils should all be included in developing programmes.

> *"The schooling system as well should be involved. Some schools have gardens that are also used to nourish the kids and enforce healthy eating habits."*
>
> Female leader, Methodist Church, Johannesburg

> *"The provincial and local councils should also come to the fore and help in identifying and converting idle land into recreational facilities that will function all year round for the benefit of young people. "*
>
> Male leader, Methodist Church, Johannesburg

8.3.2 Leadership and community climate

To what extent are appointed leaders and influential community members supportive of the issue? What is the prevailing attitude of the community toward the issue? Is it one of helplessness or one of responsibility and empowerment?

The scores for leadership and community climate were low. This could be explained by the fact that obesity is not a concern to the leadership and is not a top priority in the agenda for adolescents (see section on community efforts). This translates into the absence of specific programmes towards obesity. Although leadership and community climate were low regarding the obesity issue, a strong sense of leadership and responsibility towards adolescents' health and well-being in general were apparent. Leaders also identified several opportunities that could be implemented to have an impact on adolescents' lifestyles.

8.3.2.1 Church's role in adolescents' life and health

A leader from the Evangelical Church in Johannesburg stated that "mostly Church is about spiritual growth and not personal health and hygiene really". However, leaders from other Churches agreed that their role is important and goes beyond the spiritual guidance and mentoring. They also play a role in physical well-being.

> *"We play the same role as parents would at home towards the adolescents in the Church".*
>
> Male leader, Congregational Church, Soweto

> *"Adolescents in general need direction but this is a joint venture between the parents at home and us the Pastors at Church."*
>
> Male leader, Pentecostal Church, Johannesburg

> *"I think that there is a role that we have. We are responsible for the well-being of the young people that attend at this church, their health is part of our responsibility towards them. It is also our responsibility as a Church to find the information that is to need to understand the different phases that the adolescents go through"*
>
> Male leader, Methodist Church, Johannesburg

> *"The Church plays a very important role in this regard as it has always been a central meeting place for people of different backgrounds coming together for one agenda. The Church is responsible for uplifting and informing people spiritually and otherwise. "*
>
> Female leader, Roman Catholic Church, Soweto

"…In as much as we are feeding their spirits, we also have to take care of the bodies that house the spirit"

Male leader, Pentecostal Church, Johannesburg

Religious leaders described themselves as role models for adolescents but youth leaders (youth pastor, youth coach, etc.) were recognised the most influential people in this working with adolescent members of the congregation.

"Man: All the Church leaders and elders are looked upon by adolescents, and most importantly the youth leader. "

Male leader, Congregational Church, Soweto

"We could inspire them and advise them to lead healthy lifestyles. We should also understand that this is an opportunity to shape the whole country and if we fail as a Church then we would have failed South Africa. "

Male leader, Methodist Church, Johannesburg

"…these kids do look up to us as their role models and if we lead by example then there is a big chance that the next generation after us will be conscious of healthy living options and issues like obesity could be history."

Male leader, Methodist Church, Soweto

"We should be exemplary to elders and the youth alike in all aspects."

Male leader, Methodist Church, Johannesburg

8.3.2.2 Opportunities for obesity prevention interventions

Very little was currently in place regarding the obesity issue within the churches that took part in this study. However, leaders identified opportunities for change and action. Some of the suggestions that emerged from the FGDs were workshops, nutrition education, physical activity programmes (obstacle course, boot camps), counselling, obesity awareness campaigns, and change in the type of food served in Church.

"They (adolescents) believe and accept the information that is distributed by the leaders and this is an opportunity that the Church has to exploit as far as educating people about nutrition is concerned. There will always be a valuable lesson to teach on nutrition not necessarily for the already obese but for those that are healthy to encourage them to stay healthy. "

Male leader, Pentecostal Church, Johannesburg

"We deal with people and we are very influential in their lives, we counsel and teach them and I think the Church must and will support the information on nutrition…"

Male leader, Pentecostal Church, Johannesburg

"We already have youth programmes in place within the congregation and now that we are exposed to something new then perhaps our job would be to educate the young people within the Church to live right and also eat right."

Female leader, Methodist Church, Soweto

"We could also have days when we teach people on how to cook healthy and also emphasize on regular exercise by marking specific days strictly for physical activity."

Female leader, Roman Catholic Church, Soweto

Prevention and intervention at an early age for all were highlighted as being key elements.

"We could perhaps start by having workshops with these adolescents and if we start with this, when they are still young then they would grow with it and it would have an impact when they are older as well. "

Female leader, Methodist Church, Soweto

"… We could enlighten people on the link between good eating habits and general health. There are a lot of people suffering from cholesterol related illnesses and others directly linked to what they eat. It could be beneficial as well if these can be prevented as early as adolescent stage."

Female leader, Roman Catholic Church, Soweto

"…Our role has always been on a corrective basis when the damage has already occurred. If we can embark strongly on dietary education and teach people to eat well and exercise then we could prevent a problem from happening."

Male leader, Pentecostal Church, Johannesburg

"As pastors, we also need to inculcate a new culture by talking about something over and over again until people make it a part of their lives. We need to preach the Gospel of healthy living as much as we preach the gospel of salvation. We should preach this until it becomes engrained in their system and they feel guilty whenever they eat junk food".

Male leader, Pentecostal Church, Johannesburg

These opportunities were also perceived as beneficial not only for the congregation but for the broader community.

"These opportunities will allow us to identify issues in Church and extend the solutions at our homes and the community at large on health issues like obesity. This generation needs intervention immediately".

Male leader, Methodist Church, Soweto

8.3.3 Knowledge of the issue of obesity

To what extent do community members know about the causes of the problem, consequences, and how it impacts your community?

In this first section, religious leaders' knowledge about the obesity issue, its definition, causes and consequences will be discussed. In the second and third sections, an emphasis will be placed on unhealthy dietary and physical activity patterns as the proximal determinants of obesity. In the last section, body image perceptions will be discussed.

8.3.3.1 Definition, causes and consequences of the obesity issue

Religious leaders provided different definitions of obesity: "fat", "excessive body matter", "BMI too big", "fat and unhealthy", "10% in excess of your BMI", "state of weighing more than one should weigh", "overweight", "extremely fat", "someone that doesn't look after themselves", "body weight not proportional to the height and struggle to carry the body".

Obesity was also defined as a factor that impacts on potential and life.

> *"It means somebody that is unable to carry their weight (…) Obesity to me means that a person's weight seems to have debilitating effect on their life"*
>
> Female leader, Methodist Church, Johannesburg

> *"I would rather just say that to me obesity is limited to your weight limiting your potential."*
>
> Female leader, Methodist Church, Johannesburg

However, leaders highlighted the importance of "differentiating between big and healthy and, big and unhealthy".

> *I wouldn't call a big, perfectly healthy person obese."*
>
> Female leader, Methodist Church, Johannesburg

> *"…A woman can be thin and unhealthy and another can be big and healthy and also owing to her genetics, she cannot be a size zero and she maintains a healthy diet and goes to the gym regularly. "*
>
> Female leader, Roman Catholic Church, Soweto

Leaders' perceptions about the causes of obesity have been grouped in accordance with the ecological model of health (individual, household, organisation, neighbourhood and national levels).

At the individual level, leaders reported lifestyle factors (unhealthy dietary and physical activity patterns) to be the main drivers of obesity.

> *"It could be one's diet. A lot of doctors and nutritionists have detected a new trend amongst black people since they have financially developed. They can now afford takeaways like McDonald's and a lot of junk food."*
>
> Male leader, Methodist Church, Soweto

"It is usually the cheap and readily available food that causes obesity"

Male leader, Congregational Church, Soweto

"Judging from the shape of their bodies, it is evident that junk food is not good for them."

Male leader, Pentecostal Church, Johannesburg

"*…Most of these adolescent boys are not active and they are busy stuffing themselves with junk food and they are unhealthy. "*

Male leader, Pentecostal Church, Johannesburg

They have also mentioned causes such as "laziness", "lack of fasting", "genetic", "stress, depression and emotions", "medication or medical condition". There was some debate around genetic causes.

"Some people are just born obese."

Male leader, Congregational Church, Soweto

"At times, it is just a hereditary thing, being big is in the family's genetics. "

Male leader, Congregational Church, Soweto

"From what I know, there is no way that obesity could be caused by bad genes within the family. It could just be because you do not exercise or you do not practice good eating habits."

Male leader, Methodist Church, Soweto

"It is triggered by something but it is genetic to a certain extent."

Male leader, Methodist Church, Soweto

"…Sometimes it is being stressed that causes a person to be fat (…) There isn't necessarily a direct link to obesity and lack of exercise or not healthy eating."

Male leader, Congregational Church, Soweto

"…Adolescents would rather just watch TV or play with the PlayStation or keep busy with mobile phones."

Male leader, Methodist Church, Johannesburg

Perception was also seen as a factor favouring overweight and obesity.

"People unfortunately only see big or thin, they don't really care much about the specifics in between. We are just very accepting as Africans."

Female leader, Roman Catholic Church, Soweto

At the household level, the main factors that were discussed were affordability and cultural change regarding family dynamics (work life balance, working women, etc.). Very little was mentioned about peer influences. These factors were related to dietary patterns.

"Life is now fast paced and both parents are working and as a result nobody has the time to prepare a healthy balanced meal for the family and unhealthy eating may cause obesity, heart diseases, and hypertension as a result which were never an issue for adolescents in my time. "

Male leader, Pentecostal Church, Johannesburg

At the neighbourhood and society levels, leaders discussed the lack of development programs, lack of facilities and information.

"One of the major causes of obesity is lack of exercise and that could also be fuelled by lack of platforms or resources for young people to embark on exercise or even be interested in sports or exercise."

Male leader, Methodist Church, Johannesburg

"… There are no educational programmes in place to teach people on ways to curb obesity."

Male leader, Congregational Church, Soweto

"…The government is playing a major role in promoting obesity because they allow companies to distribute foods that cause obesity. There are no outreach programs in place by the government to teach people on obesity. The government is basically to blame."

Male leader, Congregational Church, Soweto

"It is also because of lack of information as well on what people should eat and how much of it they should eat. "

Female leader, Roman Catholic Church, Soweto

Leaders' perceptions of the consequences of obesity encompassed both health and psycho-social factors.

In terms of health, obesity was associated with proneness to diseases (high blood pressure, diabetes, heart disease, stroke, and high blood cholesterol) and death. It was also related to poor sex life.

"We are in for serious health problems in the long run as a result of these processed foods. Adolescents and adults alike are exposed to the same problem."

Male leader, Methodist Church, Johannesburg

"…They develop knee and ankle problems which limit their mobility and make them even more obese. "

Male leader, Evangelical Church, Johannesburg suburb

"Because of these artificial dietary options, kids actually look way older than their actual age. (…) they certainly didn't look like me when I was a teenager. Consequently 8 or 9 year olds are at the stage of puberty unlike back then where we started at about 13. "

Female leader, Methodist Church, Johannesburg

In relation to psycho-social consequences, low self-esteem, depression and stress, lack of self-confidence, social exclusion and loneliness were mentioned. Low concentration level was also reported as a problem in obese adolescents.

"They are also targets of ridicule, stereotyping and stigmatisation. People tend to almost always make fun of a big person and they call them all sorts of ugly names."

Female leader, Congregational Church, Soweto

"Being overweight depletes one's confidence and an individual lacking in self-confidence cannot add any value to the community. We advocate for healthier and more confident youth that will live long enough to see the changes that they have implemented come to pass. We don't want people that will be too obese to even see outside of the house. We need people to enjoy life to the fullest."

Female leader, Methodist Church, Soweto

"An obese person usually misses out on sporting opportunities"

Male leader, Methodist Church, Johannesburg

"… You might find yourself as a social outcast. Besides the scientific factors; there are also social factors that do not favour being obese. Public transport operators are also not keen on picking up because you take up a lot of space. "

Male leader, Pentecostal Church, Johannesburg

8.3.3.2 Unhealthy dietary patterns

8.3.3.2.1 Definition and patterns in adolescents

Unhealthy dietary patterns were defined as the consumption of unhealthy food items in parallel with a general "over-eating" and consumption of "huge portion sizes". Food items perceived as unhealthy were "full cream milk", "potatoes", "chocolate", "fat cakes" (bread dough deep-fried in oil consumed plain, with butter and jam or with savoury, curried mince, sausages, etc.), "eggs", "mango-atchar" (pickled mango with spices), "fried potato chips", "bunny chows" (South African fast food dish consisting of hollowed loaf of bread filled with curry or sausages, cheese, chips, mince, eggs, chakalaka (vegetable spice relish)), "red meat", "fast food and takeaways", "refined products", "processed foods", "fried foods", "food from restaurants", "non-organic food", "frozen vegetables". Healthy food items listed by leaders were "fruit and vegetables", "non-fatty meat", "white meat", "grain fed chicken vs. hormone induced chicken", "unrefined maize meal", "long grain bread", "Mopane worms"(i.e. large edible caterpillar), "organic foods", "fish", "water", "everything else that doesn't come from a factory", "freshly cooked food", "food fresh out of the soil", "food that has minimal or no processing at all".

Some leaders mentioned that not all fast foods or restaurants are unhealthy as they do differ in the quality of products served. A female leader from the Methodist church in Johannesburg stated that "…not all fast foods are unhealthy. Kauai®[2] sells fast food but the healthy kind". A male leader from the same congregation added that "Kauai® sells healthy food but like most other healthier alternatives, they tend to be more expensive. A wrap is about R45[3], this is more than double the price of a full meal at McDonald's®".

Also, a few leaders highlighted that healthy food items such as salads can be sold in these places and that "what you buy is entirely your choice" (Male leader, Methodist Church, Soweto). Although, consuming junk food was perceived as an individual responsibility, a female leader from the Methodist Church in Soweto stated that "the salads should be advertised more and promoted well instead of the big tastier burgers." The way of cooking the foods was also discussed.

> *"Most food is healthy, it is just the way that it is prepared that makes it unhealthy."*
>
> Male leader, Methodist Church, Johannesburg

> *"I think that all food is healthy but it all depends on the method of preparation. Grilling is less fatty than fried. "*
>
> Female leader, Methodist Church, Soweto

> *"The way you prepare your food also counts. You don't necessarily have to fry the chicken when you prepare it. Boiling food is a healthier way of preparing it."*
>
> Male leader, Methodist Church, Soweto

[2] Food franchise company selling health convenience food
[3] R45 equals 2.43GBP (conversion rate 1ZAR=0.0539135 GBP)

The structure of the meals was also mentioned as a potential problem. “Skipping meals” during the day and consuming “heavy meals in the evening followed by sleep” is a common practice in South Africa and was seen as a negative factor.

> *“…We should avoid starving ourselves all morning only to eat last nights’ leftover food at noon and heavy supper in the evening”*
>
> Male leader, Roman Catholic Church, Soweto

> *“We cannot be skipping meals because a skip meal might just mean double the portion on your next meal. “*
>
> Male leader, Methodist Church, Soweto

The leaders’ definition of “eating well” encompassed the type of food consumed, the structure of the meals and quantity consumed.

> *“It would have to be having a balanced meal regularly. It’s understandable that one may have takeaway food once in a while but it is important to have a balanced breakfast lunch and supper in controlled portions.”*
>
> Female leader, Roman Catholic Church, Soweto

> *“That would be a balanced diet including vegetables, fruit, protein and simple carbohydrates in moderate proportions and a little bit of roughage.”*
>
> Male leader, Evangelical Church, Johannesburg suburb

> *“Eating well involves consuming a meal balanced with most essential nutrients that the body requires. I am talking about protein, carbohydrate, and vitamins amongst other things. “*
>
> Male leader, Pentecostal Church, Johannesburg

Leaders also made a mention of changing dietary patterns from the typical traditional diet to a traditional unhealthy or western unhealthy diet. There was some debate around the healthiness of the typical traditional diet and to which extent the traditional diet is still part of the South African culture.

> *"To most of us, carbohydrate rich maize meal thick porridge meals are a staple food. They are easily accessible and affordable. The maize meal has become too refined in recent times and that is not the healthiest option. "*
>
> Female leader, Congregational Church, Soweto

> *"Most parents are now working and you may find that two minute noodles have now become very popular not because they are a healthier option but because our parents don't have as much time to prepare proper food as they did before."*
>
> Female leader, Roman Catholic Church, Soweto

> *"I think that pap is still the more preferred option to two minute noodles amongst most African families."*
>
> Male leader, Roman Catholic Church, Soweto

> *"On a typical Sunday, everyone cooks pap with gravy and meat, two minute noodles is a less preferred alternative. "*
>
> Male leader, Roman Catholic Church, Soweto

> *"I love my heavy meals. We have pap almost daily and we add more colour to our meals on Sundays by including a lot of salads."*
>
> Male leader, Roman Catholic Church, Soweto

> *"I think that people should not judge pap. Our parents grew up eating pap and they still look thin. The problem lies with all the other alternatives that we now add onto the pap that weren't there before. We have altered our diet by adding all the oily meat and other things that makes us fat. It is also the way in which we now prepare our food that's to blame. "*
>
> Female leader, Roman Catholic Church, Soweto

Leaders discussed the diet adopted by adolescents. They mention that their diet has shifted from a traditional healthy diet to a mix of traditional unhealthy (bunny chow, fat cakes, etc.) and western (chips, soft drinks, burgers, chocolate, snacks, sweets, etc.) unhealthy diet. They consume “a lot of junk food” and “do not relate to traditional food at all”. A lot of them and people in general would opt for “quick time processed food especially fast food” and “easy to prepare and easily accessible food”. Adolescents don’t want to consume fruit and vegetables as they are “simply not interested in them”. They are not interested in healthy foods.

“Adolescents in our congregation and in the city in general practically live off junk food. They do not eat a balanced diet. I have seen a hungry person buying a soda and potato crisps and they expect to be satisfied with that. All that they are doing is stuffing themselves with fried starch and a soda and that right there is of no nutritional value. “

Male leader, Pentecostal Church, Johannesburg

“…Most of these kids do not even want to eat their vegetables as they would rather have fast food. “

Male leader, Pentecostal Church, Johannesburg

“They mostly eat bunny chow for lunch because their parents normally give them R10 with which to buy a bunny chow for lunch. As a result these kids eat a bunny chow all week long.”

Male leader, Methodist Church, Soweto

“…Given a choice, the young people will always avoid healthier options”

Female leader, Methodist Church, Soweto

"I believe that adolescents these days just want everything that they lay their eyes on and they don't believe much in eating good food and vegetables. The adolescents decide what they want to eat (…) the adolescents decide what they want to eat and the parents seem to have lost control over what their children eat."

Female leader, Evangelical Church, Johannesburg Suburb

"It is not an availability or affordability issue; we are simply not interested in them (fruit and vegetables)"

Female leader, Methodist Church, Soweto

8.3.3.2.2 Causes of unhealthy dietary patterns

The causes of unhealthy dietary patterns have been grouped according to the ecological model of obesity from the individual to the societal level.

At the individual level, taste was mentioned as an important determinant of food intake.

"….The nutrition is not taken seriously. People look for tasty food rather than nutritious food"

Male leader, Pentecostal Church, Johannesburg

Fast food was defined as "addictive', "attractive" and "convenient".

"It is a known fact that junk food or most unhealthy foods are addictive and one's whole system including the taste buds, reject any other taste in the long run and want just the junk. It would take some time for an individual to adhere to a healthy diet and forfeit the unhealthy stuff that they are used to. "

Female leader, Methodist Church, Johannesburg

"Takeaways are convenient and tastier than traditional food."

Male leader, Methodist Church, Soweto

"Most people are lazy to cook hence they opt to buy takeaways. Takeaways are instant; they cut out the time that one needs to wait for food to be ready at home. The fact that they are more expensive is not relevant."

Male leader, Methodist Church, Soweto

Feeling "full" after a meal was also an important element.

"People are failing to balance between eating to be full and eating to be nourished. "

Male leader, Pentecostal Church, Johannesburg

Another psycho-social factor seen as a determinant of unhealthy dietary habits was low self-esteem.

"Those with low self-esteem tend to isolate themselves and stay indoors but in the process sit in front of the TV and eat a lot. This would then lead to an unhealthy lifestyle."

Female leader, Methodist Church, Soweto

At the household level, cost was defined as a limiting factor for the consumption of healthy foods.

"Not everyone can afford healthy food"

Male leader, Methodist Church, Soweto

"…Bad foods are cheap and easily accessible. The good stuff and the organic foods are expensive. The good quality food that we ate before has now become out of reach and very expensive and this poses a major challenge for us when we have to choose what to eat. Everything has been refined today and the quality food has been compromised. Fruit has been a luxury and not an everyday readily available commodity. "

Female leader, Congregational Church, Soweto

"It would cost about R150[4] *to cook a decent meal for two people with salads and vegetables but it would cost only R89 to buy two large meals at MacDonald's. It would cost only R50*[5] *at Steers and this would include drinks as well. If we also put into consideration the cost of the electricity, and the time that you need to prepare a proper meal then you would save a lot by buying takeaway food. "*

Female leader, Evangelical Church, Johannesburg suburb

[4] R150 equals to 8.09GBP (conversion rate 1ZAR=0.0539135)
[5] R50 equals to 2.70 GBP (conversion rate 1ZAR=0.0539135)

“Poverty contributes as well. Not everyone has enough money to buy healthy food. A bunny chow is very popular in our area. It is quickly made with bread, chips, polony and vienna[6], eggs, and maybe a Russian sausage. There are usually no veggies in a bunny chow. Looking at the home situation, people hardly have enough to buy healthy food. “

Male leader, Pentecostal Church, Johannesburg

There was some disagreement on the availability and cost of fruit and vegetables. Although fruit and vegetables (non-organic) are available and affordable, the quality of fruit and vegetables seemed to be a key element of their consumption. People would rather not consume fruit and vegetables that are non-organic even if these items are cheap and considered to be healthy.

“Fruit and veg (vegetables) are available and affordable. It is just ignorance and the taste over substance issue”.

Male leader, Pentecostal Church, Johannesburg

“Good quality fruit and veggies are expensive (…) there are cheaper options available but they have no nutritional value. “

Female leader, Evangelical Church, Johannesburg suburb

“…Locally produced good quality fruit and veggies are more expensive to the average man of this country. They would rather buy a loaf and a half of bread for the same money they could have used on 2kg of bananas. “

Male leader, Evangelical Church, Johannesburg suburb

Another reason for the low consumption of fruit and vegetables is the fact that people assimilate fruit and vegetables with negative experiences and periods of difficulties.

[6] Vienna and Polony are different types of sausages commonly consumed in South Africa

"People have this mentality that they have always had to eat fruit and veggies under duress from parents and now that they can afford to buy their own food then they tend to forego the healthy stuff. Takeaways become very popular in the process."

Female leader, Methodist Church, Soweto

Beyond cost, parents' role was extensively discussed. Parents were seen as having a pivotal role in shaping adolescents' diet and leaders stated that they should act as role models.

"I think it has mostly to do with what the parents make them eat. If the parents brought home salad then you would be used to that but if they brought the happy meal from MacDonald's then naturally you would prefer the latter."

Female leader, Roman Catholic Church, Soweto

"We cannot be preaching about a good diet and filling up the fridge with junk food. The food we buy must tally with the message that we are trying to send to the kids as parents."

Male leader, Methodist Church, Soweto

Change in family dynamics with both parents working was perceived as a barrier for providing healthy food to the children and adolescents.

"The time factor also comes into play. People hardly ever have time to cook. I am also guilty because I have Church for most of the day on Sunday and we usually go to a restaurant for a quick, tasty, fat, not so nutritious lunch. Most restaurants are full of Church going people on Sundays. In yester years Sunday used to be family day and proper balanced meals were served on these occasions. "

Male leader, Pentecostal Church, Johannesburg

"A lot of people are pressed for time and they therefore opt for takeaways."

Male leader, Evangelical Church, Johannesburg suburb

"Parents have compromised on the good quality food because their kids prefer junk food or just takeaways and it saves the parents time and money compared to cooking a proper meal."

Male leader, Evangelical Church, Johannesburg suburb

Leaders highlighted that familial values regarding food habits have been lost in the transitioning process.

"It is important that families gather around and eat together as they fellowship at the same time (…) the modern family is however now scattered and a lot of good habits including eating are then broken as well. "

Male leader, Pentecostal Church, Johannesburg

"Looking back, when I was at school we used to sit as a family during mealtime but lately kids are forever in their room on their gadgets or doing homework and the family has now been robbed of quality time. "

Male leader, Pentecostal Church, Johannesburg

Overall, at the individual and household levels, taste, convenience and attractiveness seemed to be the most important factors in driving people's dietary patterns. They also mentioned that junk food is cheaper than healthy food, with the traditional junk food being less expensive than the western junk food. Parental role, lack of time, lack of knowledge and education were also brought up by leaders as potential barriers for healthy eating patterns.

At a higher level, school was not viewed as a positive influence on adolescents' dietary intake. The availability of healthy foods in this setting is low and healthy products are more expensive than unhealthy ones.

"They (children and adolescents) would usually eat buttered bread with a slice of polony or they would be given about R5 with which to buy a bunny chow or some cheap alternatives".

Male leader, Roman Catholic Church, Soweto

> *"Junk food is sold at most schools and there are no healthier alternatives, they tend to be more expensive. A wrap is about R45[7] this is more than double the price of a full meal at MacDonald's. One would therefore opt for the cheaper kind which may not necessarily be healthier"*
>
> Male leader, Methodist Church, Johannesburg

An important factor at the neighbourhood and societal level was culture and perceptions. The fact that unhealthy dietary patterns and overweight are accepted within the community is seen as a limiting factor for the adoption of healthy lifestyles.

> *"We find it acceptable to eat fat cakes in the morning and multi-colour puffed maize corn in the afternoon followed by heavy pap and steak for supper. "*
>
> Female leader, Roman Catholic Church, Soweto

There was disagreement between leaders. Some of them mentioned that "we are however slowly moving away from that, we are now eating salads and healthier options and slowly becoming intolerant towards fat people". (Female leader, Roman Catholic Church, Soweto) However, another leader questioned whether they are moving away from it when opening new shopping malls full of fast food outlets. This move towards western fast food is fuelled by the perception that it is associated with increased wealth. Food and body size seem to be used as indicators of social status and therefore the cycle is going on, with unhealthy dietary patterns and overweight still being accepted.

8.3.3.3 Physical activity patterns

Lack of physical activity and sedentary behaviour were also discussed as determinants of overweight and obesity. However, it is important to mention that physical activity and sedentary behaviour were discussed less than diet overall. According to leaders, physical activity patterns have changed.

> *"Only a few people do exercise" and "people are generally lazy"*
>
> Male leader, Methodist Church, Soweto

[7] R45 equals 2.43 GBP (conversion rate 1ZAR=0.0539135 GBP)

"People are no longer active"

Male leader, Evangelical Church, Johannesburg

"People consume a lot of energy that they do not burn out through necessary activity. If one eats pap and walks about 5kms daily and plays soccer by the road side they won't get fat. My point is that we shouldn't put much blame on our diet but rather all the other factors like eating in front of the TV and not be active at all"

Female leader, Roman Catholic Church, Soweto

The reasons for this lack of physical activity were cost, lack of time, social media and technological advancement, lack of facilities and safety issues.

"It is easier to socialise on the phone than it is to socialise outside. Now we have all the gadgets to keep us entertained and connected to our peers without actually having to go outside to play and interact."

Female leader, Roman Catholic Church, Soweto

"Technology has brought about a lot of convenience and people have become idle in the process"

Male leader, Roman Catholic Church, Soweto

"One of the major causes of obesity is lack of exercise and that could also be fuelled by lack of platforms or resources for young people to embark on exercise or even be interested in sports or exercise."

Male leader, Methodist Church, Johannesburg

"There is also a safety concern because it is now a risk for the kids to walk or cycle home after school. This is a major contributing factor to the kids' bad health."

Male leader, Congregational Church, Johannesburg suburb

However, there was some disagreement regarding cost and time.

"I think that we have a lot of excuses. There are gyms where you only have to pay R30 and free gyms as well. I mean you can just walk".

Female participant, Methodist Church, Soweto

8.3.3.4 Body image perceptions

Religious leaders described fundamental differences in the ways in which they perceived a healthy body. In general, study participants indicated that a healthy body was a larger body, and this was similar for men and women. However, variation of these beliefs varied by sex, age, and geographic location (e.g., urban/rural) of the body type that they were discussing. Age was an important factor raised by leaders.

"There are certain acceptable sizes along with certain ages"

Male leader, Pentecostal Church, Johannesburg

"I think there is a certain look and weight that is acceptable at a certain age so one has to adjust their weight in accordance with their age."

Male leader, Roman Catholic Church, Soweto

The following sections describe the general perceptions to a set of male and female body image silhouettes that were presented to participants during the FGDs.

8.3.3.4.1 Thin woman silhouette

There were positive connotations of thin women, including "slender", "active", "very strong", "looks fit and in great shape", "fine and healthy". Her thinness was associated with negative social attributes, such as "anorexia", "malnourished", "unhealthy", "sick", "under-fed", "no go area", "bottom of the list of attractive women", "un-African". A male pastor from the Pentecostal church in Johannesburg stated that "…there is also a general feeling that when people start losing weight then they are HIV positive". However, when probed about a thin woman further, there was a belief that "if the person is naturally thin around the people that know then there wouldn't be a problem" (Male pastor, Pentecostal church, Johannesburg).

8.3.3.4.2 Thin man silhouette

There were no positive attributes associated with a thin man. Thin men were described as "under average", "too thin", and "skinny". One person said it was "not acceptable for the man of the house to look this tiny." As such, thin men were described in relation to how their health was perceived to the observers, such as "unhealthy", "malnourished", "underfed", "into drugs", "smoker", "sick" and "stressed out". They were also linked with social issues, including "not affluent", "socially excluded", "not successful", "having problems", "doubts on his ability to take care of his wife", "not happy in his marriage", and "his wife is not feeding him enough". A female leader from the Methodist Church in Johannesburg stated "He looks like he's suffering."

In contrast, the respondents suggested that this body, although unacceptable for a married man, would be acceptable for a teenager.

8.3.3.4.3 Normal woman silhouette

The image of the "normal" size woman was met with some discordance, including terms such as "sick person" versus "healthy", "not as attractive as "fuller figured woman" versus "good looking", and "perfect" versus "moderate". Others said that she had "something wrong with her" and that she was "okay, not big just okay". Age played a role in this definition as it was identified as a "typical teenager's ideal body". A male pastor from the Pentecostal church in Johannesburg described the normal woman's silhouette as:

> "In our time she wouldn't be a front runner for marriage. She could be mistaken for a sick person. She looks like there is something wrong with her. She is moderate but not as attractive as a fuller figured woman. She is not really thin however."

8.3.3.4.4 Normal man silhouette

The image of the "normal" size man was addressed with contradictions. While some defined the image as a "modern man" who "looks like he works out", others defined him as "not fit" who could "do with some exercise". The silhouette was also associated with younger people who were "carefree". But it was also linked with social aspects of traditional beliefs about body weight, such as "not affluent",

"not successful", and "there is a bit of hope in comparison to the previous silhouette" (of the underweight image). There was general consensus that this silhouette represented someone on their way "up" in society, as one female leader described:

> "It is normal but generally speaking and looking at the black community at large, I would say that that man is a student. If I can use [participant] as a reference, I would say that he is looking healthy and okay but would bulk up as soon as he starts raking in the money. I think that there is a general progression in our community from thin to big as soon as the money is present, even my own dad was thin at one stage."

8.3.3.4.5 Overweight woman silhouette

The study respondents had more to say about the overweight woman, who they perceived generally to be "healthy", "relaxed", "healthy and happy", "thought to bear many children", and "model of an African woman". One female leader said that the image was of an "African body but also fat"; others said she was "chunky", "big", a "middle-sized person" and at "higher risk of heart diseases and heart problems". Others said she was "full-figured", "well-built", "curvaceous", "voluptuous", and had a "nicely shaped body". Some leaders said the image was of a woman who was "strong" and "went to the "gym".

8.3.3.4.6 Overweight man silhouette

The overweight man was described as an "oversized man", "chubby", "big", "average", "strong, well-built frame, but not muscular" and as someone who "doesn't have a health conscience". However, in most cases, the image was defined by social terms, including: "being well-fed is a sign of affluence", "big and wealthy […] eats well, and lives comfortably", "having a pot-belly is a sign of success", "nobody focuses on the health risks associated with him being big, we just see the big money side of him", "a woman would be proud of this man", "this silhouette says you have achieved your goals, and you are comfortable", "businessman type", "real man", and "BEE recipient" (Black Economic Empowerment recipient[8]). There was also an age component to these comments, including "middle-aged" and "old" men.

8.3.3.4.7 Obese woman silhouette

The obese woman's silhouette was met with contradictions, as well, but there was a majority of support for the idea that the photo represented a woman who was "healthy", "full-of-life", "she looks African", and "strong". In contrast, some said she looked "fat, big, and still nice." Some said she was the "ideal woman" who was "attractive" and the "epitome of dignity". Others described her frame in regard to her family who brought her up, such as "the big frame makes her and her family respected" and "this family reflects that you were well taken care of as a girl." A male pastor from the Evangelical church in Johannesburg stated: "In a black setup, that would be a very sexy woman." However, in one focus group, there was a direct contradiction to this finding, with the belief that "she is huge and might be acceptable in society but she looks like she could really use some exercise."

8.3.3.4.8 Obese man silhouette

This silhouette was described as "obese", "sizeable", "heavy", "really big and unhealthy", "big boned", and "sluggish". There were also some social characteristics of this body, including "protector" and "authoritative". Furthermore, there were some health-related comments, such as "he needs to exercise" and "it's not right for a man to look like that." The following quote demonstrate the general consensus of what the silhouette represents among study participants, including "he is also old", "this would be mostly common in older males", and "it could be a previous BEE experience that should be blamed", indicating that it is social position that causes such large bodies.

[8] BEE (Black Economic Empowerment) refers to a programme implemented by the South African government to address inequalities that resulted from the Apartheid era. Disadvantaged groups were given economic privileges previously not available to them.

8.3.4 Resources for obesity prevention intervention

To what extent are local resources (people, time, money, space, etc.) available to support efforts?

The readiness scores for resources were the highest of all the dimensions (3.75). Availability of resources (people, time, money, space and facilities, and knowledge) differed between the different Churches. For example, leaders from the Congregational Church in Soweto reported lacking “financial support”, “time”, “facilities”, “knowledge” and “information” whereas participants/leaders from the Evangelical Church located in Johannesburg suburb declared *“we are fortunate that we have a lot of good facilities within the congregation. We have a lot of equipment and infrastructure to facilitate sporting activity and most of the teachers and staff at the Church is proactive and sporty.”* Lack of time seemed to be a common factor for all the Churches. Each type of resource is discussed in detail in the following sections. The types of resources have been grouped under people; time; money; space/facilities and religious writings from leaders’ responses.

8.3.4.1 People

Leaders recognised that people within the Church could be used as a resource for obesity prevention/health promotion initiatives.

> *“I think that we do have people within the congregation that are expert in the various fields that are necessary in helping the adolescents and all that we need to do is to initiate the move. Any other information can be outsourced. We can always grab an external person to be a guest speaker. “*
>
> Female leader, Methodist Church, Soweto

> *“We have teachers, social workers and nurses amongst others within the Church”.*
>
> *Female leader, Methodist Church, Soweto*

They mentioned that *“most Churches neglect to collect a database of who attends and everything that pertains to them (…) if we created a platform for everyone to express themselves then we wouldn’t have perhaps to outsource the knowledge” (Male leader, Pentecostal Church, Johannesburg)*.

Leaders also indicated that they have potentially good networks.

"We operate as a youth body in a community within a bigger community. There are various activities like sports and others that we are involved in and there are other networks and resources within the bigger circle".

Female leader, Methodist Church, Johannesburg

Another important resource discussed by leaders was the access to adolescents.

"The fact that we have these kids all in one place is a resource on its own (…)"

Male leader, Pentecostal Church, Johannesburg

8.3.4.2 Time

Time seemed to be a constraint across the six different Churches, from the members' perspective and leaders' perspective. However, some leaders were more positive about it.

"Time is the scarcest of all resources in this community. It hinders most development …".

Male leader, Methodist Church, Johannesburg

"There is not much time really but we always do try and make time."

Male leader, Evangelical Church, Johannesburg suburb

"With proper planning time can be made. We have a good understanding and credibility with the parents and the idea of kids putting in extra time at Church would be most welcome..."

Male leader, Pentecostal Church, Johannesburg

8.3.4.3 Money

Money was not extensively discussed by leaders. It was mainly a problem in Churches located in more deprived areas.

"We normally lack funds to do most projects and we have always had to raise funds for all previous functions"

Male leader, Methodist Church, Soweto

8.3.4.4 Space/facilities

There were mixed messages towards the availability of facilities and space, depending on the type of Church.

> *"The space is also a limiting factor when it comes to outdoor activities and exercising…"*
>
> Male leader, Roman Catholic Church, Soweto

> *"I think we do have the structures that can plan and make the resources available"*
>
> Male leader, Methodist Church, Soweto

> *"We are fortunate that we have a lot of good facilities within the congregation. We have a lot of equipment and infrastructure to facilitate sporting activity"*
>
> Male leader, Evangelical Church, Johannesburg suburb

8.3.4.5 Religious writings

Religious writings were mentioned and discussed largely as a resource that could potentially be used to promote healthy lifestyles.

> *"We have the greatest resource in the word of God as pastors. We teach them through the scriptures to grow up to be responsible members of society".*
>
> Male leader, Pentecostal Church, Johannesburg

> *"The word of God actually guides us to take care of our bodies."*
>
> Male leader, Pentecostal Church, Johannesburg

> *"The bible encourages everything to be done in moderation".*
>
> Male leader, Roman Catholic Church, Soweto

Religious writings in reference to diet are cited below:

> *"There are many things in the bible along those lines. First there is the story on creation which we hardly dwell on as believers and we should instead be stewards of creation*

and never exploit nature whether by over eating or mass production of what we need to survive. Another example is that we need to remember that our bodies are God's Temple and we need to respect them. We need to keep the inside of our bodies very clean as much as we clean the outside. "

Male leader, Methodist Church, Johannesburg

"Over and above the mention of your body being a temple, the bible makes reference to gluttony. It condemns over eating and gives a stern warning that we shouldn't make the stomach our god. We are encouraged to eat to live rather than to live to eat. "

Female leader, Methodist Church, Johannesburg

"The most important of all commandments is love (…) Eating unhealthily does not amount to loving yourself. "

Female leader, Methodist Church, Johannesburg

Reference to religious writings on physical activity were scarce across the groups:

"…there is a verse in the Old Testament, I just can't remember what it is exactly but it encourages physical exercise. It emphasizes that we need to take care of the body as much as we take care of the soul."

Male leader, Roman Catholic Church, Soweto

This resource was seen as valuable when teaching adolescents about healthy lifestyles as "adolescents pay more attention when there is biblical backing on a principle" (Male leader, Pentecostal Church, Johannesburg).

8.3.4.6 Knowledge

Leaders felt that it is their responsibility to be knowledgeable about a wide range of topics as they are in charge of guidance and mentoring people.

"As pastors we have a mandate to keep learning, reading and studying and staying abreast of change and are aware of what is happening in our environment. Our environment is the people in our congregation both young and old. It is almost

compulsory that as a pastor one should always be up to date. From health issues to social and political issues, we do not have to be experts in any particular field but we have to be knowledgeable about most issues."

Male leader, Pentecostal Church, Johannesburg

Although leaders felt that it was their responsibility, some of them mentioned that they lacked information and knowledge about the obesity issue and its determinants. However, they felt that this information could be provided by some members of the church.

"In all honesty, most of our knowledge is media driven"

Male leader, Evangelical Church, Johannesburg suburb

"Information and education need to be advanced for us to achieve the desired outcome".

Male leader, Methodist Church, Johannesburg

"We need an initiative to get started. As a congregation I think that we are big enough to have people with the information amongst us and all we need to do is to invite them to come forth."

Female leader, Roman Catholic Church, Soweto

8.4 Summary of results

This study provides an overall idea of the community readiness to prevent overweight/obesity in adolescents and the necessary actions and strategies required to improve the readiness for addressing this issue. The mean obesity readiness score was 2.67, which corresponds to the "denial/resistance stage". This stage is reached when "at least some community members recognise that it is a concern, but there is little recognition that it might be occurring locally". Our overall score suggests that this community of religious leaders is at an earlier stage of readiness, in which 1) no efforts currently exist to address the obesity issue; 2) the community has no knowledge of the need for efforts addressing the issue; 3) the leadership believes this is not an issue in their community; 4) the prevailing attitude of the community toward the issue is not one of responsibility and empowerment; 5) a few in the community have some knowledge about the issue and 6) the community is not sure where the resources would come from to initiate efforts. The overall obesity readiness score masks some differences between churches, with some being at a more advanced readiness stage than others. The FGDs conducted in this study provided a wide range of opinions which allowed the in-depth interpretation of the CRM scores. The FGDs also scoped out the potential for churches to be used as vehicles for obesity prevention intervention in adolescents. The FGDs also identified some barriers and opportunities for the implementation of obesity prevention interventions. The fact that obesity was not viewed as an issue and that adolescents faced more important issues in their daily lives could be barriers for change. Culture and body image perceptions were also identified as potential barriers for change. Existing resources (mainly people and religious writings), strong leadership and willingness from leaders to improve adolescents' health were perceived as opportunities for change.

Overall, the CRM scores and FGDs results show that the community (of religious leaders from Christian Churches) is ready to move forward the obesity prevention agenda in adolescents and that the first starting point for an intervention in this setting would be to mobilise communities and focus around raising awareness that the problem of overweight/obesity exists in this community.

Chapter 9: Discussion

9. Discussion

This chapter summarises and discusses the key findings of both the quantitative and qualitative part of this study. This research explored the following in relation to South African urban adolescents: 1) Adolescents' perceptions of their socio-economic and school neighbourhood environments; 2) Adolescent dietary patterns; 3) The relationship between neighbourhood and household SES and dietary intake (energy, macronutrients); 4) The relationship between neighbourhood and household SES and anthropometric status (BMI, WHTR, percent fat); and 5) The potential for religious groups such as Churches as community-based organisations for obesity intervention by assessing the readiness of leaders from such organisations to engage in such interventions.

The discussion will be organised into three main sections. The first section will discuss the overall findings from the quantitative and qualitative research. The second section will present the strengths and limitations of the study as a whole. The third section of the discussion collates and integrates the main study findings. Recommendations on how to strengthen the existing health system to deal with overweight, obesity and NCDs are formulated and future directions of research considered.

9.1 Summary and discussion of the key findings

9.1.1 Neighbourhood deprivation

The purpose of this research was to determine adolescents' perceptions of their socio-economic and school neighbourhood environments and to collate experiences of living in a transitioning urban environment. The findings of this study allow the identification of leverage points for the implementation of adequate policies to target the reduction of neighbourhood inequalities for urban South African adolescents (chapter 5).

9.1.1.1 Summary of main findings

- Black African and Mixed Ancestry participants reported living in more deprived SES environments and studying in less favourable schools compared to Whites.
- Among the Black African group, adolescents living in Soweto reported more deprived economic and school environments than those living in Johannesburg.

9.1.1.2 Discussion of main findings

This dataset provided a unique opportunity to examine deprivation at the neighbourhood level in adolescents who were born in 1990 - as Nelson Mandela was being released from prison and Apartheid was ending. While there is evidence of a national collective identity among adolescents living in Johannesburg (Norris et al. 2008), there remain extreme differences in the economic well-being of South Africans with large differences in the socio-economic environment across the population groups. The study shows that the adolescents' responses to questions on neighbourhood socio-economic and school environments are statistically significantly different according to population group, gender, place of residence and level of caregiver education.

The neighbourhood socio-economic findings of this study are strongly suggestive of underlying inequalities among adolescents living in this area, with the Black African and Mixed Ancestry groups still being the most disadvantaged. Black African and Mixed Ancestry adolescents reported a poorer overall neighbourhood economic environment (i.e., they were less likely to have a higher neighbourhood economic index, high availability of services, and low neighbourhood problems) as well as a less favourable social support environment in comparison to Whites. It is important to mention here that population group differences are found in this cohort, even with the highest SES Whites being excluded from the cohort because of recruitment from government facilities. When examining socio-economic differences among Black African adolescents only, differences were seen in terms of perceptions of economic status between those living in metropolitan Johannesburg versus those living in Soweto. Black African adolescents living in metropolitan Johannesburg reported more favourable environments. These perceptions may be associated with the level of development of the place of residence, with Soweto being less economically developed and displaying high rates of poverty compared to metropolitan Johannesburg (City of Johannesburg 2014). However, no differences were seen between the two places in terms of social support environment, neighbourhood availability of services or level of neighbourhood problems.

These results corroborate with the literature on socio-economic inequalities in South Africa, which demonstrates that since 1994 inequality has worsened (Mooney and Gilson 2009) and disparities within specific population groups have widened (May and Govender 1998; Bhorat and Kanbur 2005; Leibbrandt et al. 2011). South Africa is known as being the most unequal society in the world (World Bank 2014a). However, the present study highlights new results in relation to the social environment. Namely, while Black African and Mixed Ancestry adolescents reported a less favourable economic environment, they also experienced a more favourable social environment in terms of community spirit, time spent with friends and liveliness compared to their White peers, although the overall social support environment was lower in Black and Mixed Ancestry adolescents. This might come from the fact that the social support index incorporated dimensions of both trust towards neighbours and community atmosphere (community spirit, liveliness, happiness, etc.), which generated divergent responses. For instance, 28.3 percent of Black African and 24.7 percent of Mixed Ancestry adolescents reported that they trusted nobody in their neighbourhood other than their family, compared to 14.3 percent of White adolescents. 65.5 percent of Black Africans stated that they could ask their neighbours to look after their house compared to 80.2 percent in the White group. In terms of community atmosphere, community spirit was reported to be strong by 38.4 percent and 35.3 percent of Black African and Mixed Ancestry adolescents, respectively, as opposed to 9.5 percent of White adolescents. More than 40 percent of the Black African and Mixed Ancestry sample reported their neighbourhood to be lively as opposed to 27.0 percent of the White group. Finally, Black African and Mixed Ancestry adolescents spent significantly more time with their friends than did White adolescents.

This study also demonstrates perceived inequalities in the school environment. Black African and Mixed Ancestry adolescents reported studying in a less favourable school environment (less likely to have a higher school economic index and low school problems) in comparison to Whites. Black African adolescents living in Soweto reported experiencing more problems at school than those living in metropolitan Johannesburg. The school economic environment, however, was not different between Black Africans living in metropolitan Johannesburg and Soweto after adjusting for caregiver education. This demonstrates that there is no effect of ‘place’ in neighbourhood school economic environment but rather that caregiver education levels are different between the two areas. This fact suggests that adolescents with less educated parents who are living in Soweto are having the likelihood of poor educational outcomes being perpetuated across generations because of the quality of the school environments that they experience.

The school findings discussed above have strong policy implications, particularly as the observed differences are not exclusive to population group. Rather, within the Black African group, living in Soweto is more likely to result in educational disadvantage compared to living in metropolitan Johannesburg. The school environment is an important part of an adolescent's neighbourhood. The current study is in line with previous research showing that the school setting in South Africa can be hostile and unfavourable for education, with a lack of trained teachers, facilities and educational resources (Van der Berg 2002; Barbarin 2003; OECD 2013). However, it also shows that there is varying quality in school environments. Although the abolition of Apartheid led to a decrease in political violence, this was replaced to some extent with community and interpersonal violence (Jenkins 1997; Seekings 2000; Barbarin and Richter 2001b; Seedat et al. 2009). Children in post-Apartheid South Africa were exposed to extreme violence and psychosocial distress (Lockhat and Van Niekerk 2000; Barbarin et al. 2001). A core element of school integration is feeling safe while in the educational environment (McNeely et al. 2002; Brookmeyer et al. 2006). In the present study, around 20 percent of adolescents feel unsafe or moderately safe at school. Furthermore, the school climate is a key determinant of school absenteeism and is inversely related to class and school size (Brookmeyer et al. 2006). In this study, around 65 percent and 40 percent of adolescents reported absenteeism and overcrowding, respectively, as issues in their schools.

Demombynes and Özler (2005) showed that crime and socio-economic inequality are interconnected, and that within-group inequality is a significant predictor of violence (Seedat et al. 2009). The neighbourhood problems (shebeens, alcohol abuse, illegal dumping, lack of park and sports facilities, lack of police officers patrolling the neighbourhood) and school problems (lack of educational resources) reported in the current study corroborate with a previous qualitative participatory study on young adolescents' daily living conditions (Kruger and Chawla 2002). Kruger and Chawla's (2002) study of young adolescents (10-14 years old) residing in low SES neighbourhoods in the Greater Johannesburg region highlighted a multitude of problems in their daily lives. Some problems were ubiquitous (insufficient and unsafe place for play, presence of shebeens, alcohol abuse, harassment, poor waste management) and others were neighbourhood-specific (drug abuse, unemployment, rape, lack of police station, lack of educational resources, etc.). All these problems resulted in a high level of fear towards the outside environment and adolescents felt restrained in the way they interact with their neighbourhoods (Kruger and Chawla 2002). The current study shows that adolescents reporting higher crime are the ones more socio-economically disadvantaged. Furthermore, 81.3 percent of adolescents reported unemployment as an issue and this was mainly found in the Black African and Mixed Ancestry groups. The high level of crime and unemployment in this sample corroborate the findings of previous studies (Seekings 2000; Seedat et al. 2009), who reported that crime and unemployment are the issues predominantly facing South Africa. Around 30 percent of South Africa's population is unemployed (Statistics South Africa 2012) and youth unemployment remains a challenge. The present study adds to the literature by showing that Black Africans living in Soweto are the most vulnerable and experience the highest levels of crime out of all adolescents in the study.

A previous study in the Bt20 cohort revealed that, although housing, water and sanitation conditions have improved, socio-economic inequalities still exist at the household level (Richter et al. 2009). The present study strengthens the evidence for socio-economic inequalities within and between the different population groups at the neighbourhood level based on adolescents' perceptions. It also brings unique information on Black Africans who have moved from Soweto to metropolitan Johannesburg compared to the ones still residing in Soweto and suggests that they have not gained in terms of social provision, availability of services, experiences of neighbourhood problems or school provision. However they do appear to have reduced their economic disadvantage and experience fewer problems at school.

Another key element is that population group differences remain despite controlling for caregiver education, gender and place of residence for all the neighbourhood socio-economic and school environment measures. This reveals that the population group differences are not explained by differences in the education level of the primary caregiver, place of residence or gender.

Finally, although White participants reported more positive neighbourhoods relative to Black African and Mixed Ancestry adolescents, it is important to highlight that they did not report perfect neighbourhoods and improvements could be achieved.

Reducing neighbourhood poverty, inequality and violence remains a challenge and a priority in the area of Johannesburg and Soweto. Improvements in the school environment may be an important means of addressing socio-economic disparities through promoting better education, increasing job opportunities and developing economic empowerment for the disadvantaged groups (Van der Berg 2002). In order to reduce violence and crime and improve social aspects of neighbourhoods, a sense of community spirit should be nurtured (Barbarin 2003). Adolescents are key stakeholders in the community and as such, they contribute to creating a favourable environment that ensures adequate development for themselves and for future generations (Chawla 2002; Chawla and Driskell 2006). In this study, the proportion of adolescents reporting a strong community spirit was relatively low (below 40 percent), suggesting that improvement is needed. Community atmosphere (trust, happiness, liveliness, community spirit) could be improved through grassroots programmes, community engagement and empowerment. Key informants in the community (community leaders, parents, government officials, etc.) could nurture a sense of responsibility among community members and promote collective action to solve common neighbourhood problems (Chawla 2002; Chawla and Driskell 2006).

A willingness from the government to incorporate the views of these adolescents when implementing policy is essential (Chawla and Driskell 2006). The key differences that have been highlighted by adolescents are economic factors both in the neighbourhood and school environments. Thus policy makers need to design initiatives to reduce the economic differences between the different population groups and between Johannesburg and Soweto. The fact that a gradient exists in the scale of problems in the neighbourhoods and schools opens up the possibility for some neighbourhoods to act as role models for others and for policies to draw on pre-existing frameworks.

9.1.2 Neighbourhood and household SES influences on dietary intake and anthropometric status

The purpose of this research was to examine how both household and neighbourhood SES influence dietary intake and the anthropometric status of South African adolescents and whether these associations differ by sex, to better understand the effect of the nutrition transition in this population (chapters 6 and 7).

9.1.2.1 Summary of findings

- In the total sample, the median reported energy intake was 4053.3 kcal/day. Females consumed more energy, sugar and fat compared to males, relative to their recommended intakes. Both males and females consumed more added sugar than recommended. The PCA of the dietary data led to the identification of four main components: “high energy”; “low-cost food”; “healthy”; and “snacks and sweets” patterns. These findings suggest that adolescents in this sample are transitioning to a “western” / “modern” diet.

- No significant associations were observed between SES (household and neighbourhood) and energy, protein, fat, or carbohydrate intakes in males. Household and neighbourhood SES also had little influence on dietary intake in females. Neighbourhood social support was associated with fat intake in females with those in the lowest tertile (with less support) having a significantly higher fat intake than those in the highest tertile.
- Females had a significantly higher combined prevalence of overweight/obesity than males whereas males had a significantly higher prevalence of thinness. Having a relatively less favourable neighbourhood social support environment was associated with higher odds of high percent fat and high WHTR in females. Poor household SES was associated with lower odds of both overweight and high percent fat in males but no associations were observed among females. A poor or middle household SES level was associated with higher odds of being thin in males. For females, poor household SES was associated with lower odds of being thin. These findings highlight that even within a relatively small urban area, the nutrition transition manifests itself differently in males and females and across SES indicators.

9.1.2.2 Discussion of the key findings

9.1.2.3.1 Dietary and anthropometric profile of adolescents

- Dietary profile

In the total sample, the median reported energy intake was 4053.3 kcal/day, with males consuming approximately 700 kcal more per day in comparison to females (4469.6 kcal vs. 3764.2 kcal). Females had a significantly higher energy intake than males, relative to their recommended daily intake (150.4% for females vs. 131.1% for males). In terms of macronutrients, both males and females were within the recommended protein intake of between 10-15% of total energy (WHO/FAO 2003). There was no significant difference in protein intake between the sexes. Carbohydrate consumption in both sexes was below the recommended intake of 55-75% of total energy (WHO/FAO 2003) with no significant difference between the sexes. Both sexes significantly exceeded the recommended fat intake of 15-30% (WHO/FAO 2003). Females' diet contained a significantly higher proportion of fat compared to males (females: 34.4% vs. males: 32.6%). Both males and females were above the recommended added sugar intake of 10% (WHO/FAO 2003) with females having a greater proportion (females: 12% vs. males: 11.2%). However, fibre consumption was on average above the recommended intake of 25g/day for both males and females, with a significantly higher consumption in males (38.4g vs. 29.7g). It is worth noting however that 20.3% of males and 31.5% of females were below the recommended fibre intake. There was also a significant difference in the consumption of fruit and vegetables between males and females (respectively 478.4 g vs. 397.8g). In males 39.0% consumed less than the recommended intake of fruit and vegetables of 400g, compared to 50.6% of females.

Popkin (2006) defines the five patterns of nutrition transition and highlights the fact that the diets in many LMICs are transitioning from a 'receding famine pattern' (i.e. starchy staples, low fat, low variety, water, high fibre) to a 'degenerative disease pattern' (i.e. more fat, sugar, processed food, caloric beverages and less fibre). As such, the lower than recommended intake of carbohydrate, paired with higher than recommended intakes of both fat and added sugar found in this study is indicative of a nutrition transition. In support of this, a recent study by Abrahams et al. (2011b) reported that out of all of the Sub-Saharan countries (n=40), South Africa had the highest nutrition transition score (i.e. the most advanced nutrition transition stage). Indeed, South Africa had the greatest calorie availability at 2999 kcal/capita/day, the seventh highest percentage of energy coming from fat (24.6%) and the third lowest percentage of energy coming from carbohydrates (64.6%). It is important to note however that the tool used to estimate energy and macronutrients intake in the study by Abrahams et al. (2011b) was the Food Balance Sheets from the FAO. Food Balance Sheets can provide an overall understanding of the food supply pattern of a country and an overall idea of how the food supply matches the nutritional requirements of the population. Nonetheless, food balance sheets only provide information regarding the food available for human consumption and do not reflect actual food consumption. Therefore, it is important to corroborate these findings with studies utilising nutrition surveys. As such, Vorster et al. (2011), using data from different studies (Vorster et al. 1997a; MacIntyre 1998; Vorster et al. 2000; Kruger et al. 2001; MacIntyre et al. 2002b; Kruger 2005) analysed the trend in macronutrient intake as a percentage of energy intake in urban South African women from 1975 to 2005. Over this period, fat intake was observed to increase from 21%

of total energy to 30%. This was alongside a reduction in carbohydrate intake from 65% to 57%. Bourne (1996) report a similar change in a sample of both sexes living in Cape Town. They report that an increasing time residing in the city was associated with an approximate 9% reduction in carbohydrate intake, alongside an 8% increase in fat intake. The BRISK study conducted in a sample of urban African adolescents aged 15-18 years residing in the Cape Peninsula in 1990 (Bourne et al. 1993), allows a comparison to be made with our similarly aged sample, 18 years later. The authors found that the adolescents' diet comprise 27% fat, 64% carbohydrates and 13% protein. In our sample, the results showed a consumption of 34% fat, 53% carbohydrates and around 12% protein, which, although in a different sample, suggest that there has been a shift in the diet of South African adolescents. Bourne et al. (2002) define a 'traditional' diet as one composed of more than 60% carbohydrates and less than 25% fat, whilst a 'western' diet was defined as one comprising less than 50% carbohydrates and more than 35% of fat. As such, the results of this study suggest that diets in urban South African adolescents are at an advanced stage of the transition from a 'traditional' to a 'western' diet.

In complement to the macronutrient analysis, this study also investigated the food items consumed most commonly in the cohort. In both males and females, the most consumed foods included refined grains, sugar, vegetables, low fat dairy products, fresh fruit, processed meat, soft drinks, oils and dressing, sauces, poultry and chips. The current study also explored the contribution of the different food items to the total energy intake. In males, the food items which contributed the most to the total energy intake were refined grains, whole grains, biscuits, chips, red meat, fresh fruit, processed meat, sugar, pizzas, margarine, low fat dairy products and alcohol. In females, food items contributing the most to the total energy intake included refined grains, chips, whole grains, biscuits, fresh fruit, red meat, processed meat, sauces, dessert, pizzas, margarine, sugar, vegetables, and oils and dressing. These findings highlight that the diets of the adolescents in this sample include refined products and processed foods which are both markers of the nutrition transition. The consumption of highly refined and processed foods can explain the higher than recommended fat and added sugar intakes found in the macronutrient analysis in this study. The food items analysis provides further evidence that the diets of adolescents in this sample are transitioning to a 'western' diet. These results corroborate the findings of quantitative and qualitative studies conducted in urban areas in South Africa. Feeley et al.

(2009) assessed the fast food consumption of urban Black African adolescents aged 17 year olds residing in the area of Soweto/Johannesburg (adolescents from the Bt20+ study), an area which offers numerous food outlets (i.e. commercial or informal (e.g. tuck shops, street vendors) selling fast food items (Feeley et al. 2009). The study revealed that over a seven day period, around 30% of adolescents (28.4% for males vs. 31.0% for females) consumed 5-7 fast food items and around 44.0% of adolescents (50.0% for males vs. 38.0% for females) consumed 8 fast food items or more. The three most common fast food items consumed were 'quarters' also called 'kota' (i.e. Traditional South African sandwich composed of a quarter loaf of white bread, fried chips, processed cheese and meats/sausages, a fried egg and sauces); chips and vetkoek (i.e. traditional South African fried dough bread (fat cakes) either filled with mincemeat or syrup/honey/jam). Sedibe et al. (2014) found that items such as the 'quarters' and fat cakes were perceived as being affordable, convenient and popular amongst adolescents. Feeley et al. (2009) also reported that 40.3% of the sample visited a fast food outlet 1-3 times in the week and 35.3% visited a fast food outlet 4-10 times in the week. It was found that the frequency of visits to food outlets and the consumption of fast-food items were higher in this South African population compared to the adolescents in the US. The authors argue that adolescents' fast food consumption may have contributed more than 50% to their daily energy intake. Temple et al. (2006) examined the food items consumed by students (12 to 16 years old) at a school in Cape Town, SA. Neither food purchased nor food brought to school contained healthy items, comprising mostly items such as chocolate, French fries, doughnut, and fat cakes (deep-fried dough balls). Two qualitative studies on dietary practices conducted among urban female adolescents (around 18 years old) in South Africa showed that adolescents tend to choose local, energy dense, fast food products instead of food prepared at home, resulting in poor-quality diet (Voorend et al. 2013; Sedibe et al. 2014). A majority of the adolescents reported not eating breakfast as they favoured buying fat cakes from informal vendors before school. Adolescents also did not bring lunchboxes to school and bought food from the school tuck-shop (i.e. food shop) instead. In a study of adolescents aged 10-12 years old residing in the Western Cape in South Africa, Abrahams et al. (2011a) found that around 70% of the children brought a lunchbox to school and around 1 in 2 children consumed at least one item sold in the tuck shop. Feeley et al. (2012) assessed the evolution of dietary habits and eating practices in a sample of adolescents from the Bt20+ cohort study. Dietary habits and eating practices were measured longitudinally at 13, 15 and 17 years. The authors found that over a 5 year period, breakfast consumption and usage of a lunchbox decreased whilst snacking in front of the TV, fast food consumption and number of food items bought in a tuck shop increased.

The findings of the qualitative study (Chapter 8) confirm the evidence presented above and adds further insight into the determinants of unhealthy dietary patterns in adolescence. Religious leaders reported that adolescents' diets are shifting from a traditional healthy diet to a mixture of traditional unhealthy and western unhealthy diets. They also emphasised the fact that adolescents do not relate to traditional food anymore and that they favour processed, easy to prepare and easily accessible food. At the individual and household levels, taste, convenience, attractiveness and cost seemed to be the most important factors in driving adolescents' dietary patterns. Parental role, lack of time, lack of knowledge and education were also brought up by leaders as potential barriers to healthy eating patterns. At a higher level, school was not viewed as a positive influence on adolescents' dietary intake. Culture and perceptions also seemed to influence dietary patterns in adolescence. Overall, the current study and the existing literature on dietary patterns of urban South African adolescents suggest that this group adopts unhealthy eating patterns in their home, school and neighbourhood environments.

A recent paper examined worldwide dietary patterns amongst men and women aged 20 years or above (Imamura et al. 2015). Diet quality was assessed at two time points (1990 and 2010) in 187 countries using representative national surveys, large subnational surveys and the Food Balance Sheets from the FAO. The diet quality results were stratified by region, sex, age group and the country's level of development (i.e. high income vs. low and middle income countries). Two dietary patterns were created. The first one was based on the high consumption of 10 selected healthy items (such as fruit, vegetables, nuts and seeds, whole grains, fibre, beans and legumes, etc.). The second one reflected the low consumption of 7 selected unhealthy items (such as processed meats, saturated fat, unprocessed red meats, sugar-sweetened beverages, etc.). A score ranging from 0 to 100 was created for each of the patterns, with scores close to 100 reflecting healthier dietary patterns. The findings of the study revealed that over time, dietary scores based on healthy food items improved in middle-income countries. However, dietary scores based on unhealthy items worsened. Furthermore, middle-income countries experienced the biggest deterioration in comparison to other countries between 1990 and 2010. Younger adults and men displayed poorer dietary patterns in comparison to older adults and women. When looking more specifically at South Africa, a middle-income country, the consumption of unhealthy items such as fruit juices, sugar sweetened beverage, processed meat, saturated fat were above the recommendations whilst the consumption of fruit, vegetable, fibre, nuts and seeds were below the recommendations. The findings of this study show that the transition in South Africa is occurring in adults. Our study extends this by suggesting that diets are transitioning in adolescence.

The final dietary analyses conducted in this thesis used PCA to describe adolescents' dietary patterns (Chapter 6, Section 6.4). This analysis allowed a summary of the complex nature of the dietary information and identification of the different patterns of consumption within this cohort of adolescents. Furthermore, dietary patterns gave us an idea of how foods were combined and related to one another. This analysis complemented the individual nutrients and food items analysis. The body of evidence on dietary patterns obtained from factor or cluster analysis is large for high income countries. Most of the research conducted in HICs focusses on adults (Kant 2004; Kant et al. 2004; Newby et al. 2004) with fewer studies focusing on adolescents (Aranceta et al. 2003; Song et al. 2005; Ambrosini et al. 2009; Kourlaba et al. 2009; Wang et al. 2010). Similar studies conducted in Africa are lacking (Sodjinou et al. 2009; Becquey et al. 2010; Aounallah-Skhiri et al. 2011) which makes comparisons with our study difficult. To our knowledge, this study is the first to assess dietary patterns, using this method, in urban adolescents living in Sub-Saharan Africa.

Two main patterns of consumption are commonly described in the literature; the 'prudent' and the 'western' pattern. The 'western' pattern was defined by Slattery et al. (1998), as a diet characterised by high consumption of red meat, processed meat, fast food, refined grains and sugar, alongside a low consumption of vegetables and fruits. The 'prudent' pattern was defined as a diet characterised by a high consumption of fruit and vegetables, fish and poultry alongside a low consumption of red meat, processed meat and sugar (Slattery et al. 1998). Many studies conducted in HICs in adults identified these two types of patterns and labelled them according to the definitions given above (Hu et al. 1999; Crozier et al. 2006; Paradis et al. 2009).

The analysis in this thesis revealed four main dietary patterns: "high energy" (similar to the western pattern or to a pattern of modernity); "low-cost food"; "healthy" (similar to the prudent pattern); and a "snacks and sweets" patterns.

The first component, termed “high energy”, explained 13.8% of the variance and was characterised by a high consumption of dairy products, poultry, processed meat, red meat, chips, biscuits, and sauces. This component showed similar features to the “western” pattern. This “high energy” or “western” pattern was reported in other studies conducted in urban areas in Africa. Becquey et al. (2010) who assessed dietary patterns of adults living in Ouagadougou, Burkina Faso identified a pattern of “modernity”, characterised by a high consumption of scrambled eggs, chicken, tomato sauce, pastas, cheese, meat, sodas, soup, French dressing, hamburgers and low consumption of traditional dishes, sauces and local snacks. In a study conducted amongst adolescents aged 15-19 years old in an urban setting in Tunisia, the dietary patterns analysis revealed a “modern” pattern characterised by high consumption of white bread, dairy products, sugars, added fats, fresh fruits, canned fish, processed turkey and a low consumption of oils, cereals and grains, legumes and chicken (Aounallah-Skhiri et al. 2011).

The second component termed “low-cost food”, explained 6.3% of the variance and had high positive factor loadings on tea, nuts and seeds, margarine, whole grains, sugar and high negative factor loadings on beverages, high fat dairy products, pizzas and dessert. This pattern was specific to the cohort and was not found in other studies conducted in similar settings.

The third component termed “healthy” pattern, explained 4.8% of the variance and had high positive factor loadings on processed fruit, vegetables, legumes, fresh fish, processed fish, canned fish, savoury tarts and high negative factor loadings on soft drinks, refined grains, chips and sweets. This pattern seemed to reflect a balanced, diversified and relatively high-cost diet. Interestingly, in their systematic review conducted in children and adolescents in HICs, Ambrosini (2013) did not identify a “healthy” pattern.

The fourth component explained 4.0% of the variance and was characterised by a high consumption of coffee, low fat dairy products, chocolate, dessert, sugar, snacks and a low consumption of alcohol, offal, poultry and eggs. Becquey et al. (2010) also identified a “snacking” pattern (fried foods, vegetable-sourced fats, sugar sweetened products, cereal, sweetened drinks, milk/yoghurt, etc…) in their sample of adults living in Ouagadougou, Burkina Faso. Other studies conducted in HICs also identified this “snacking” pattern amongst children and adolescents (Ambrosini 2013).

Cutler et al. (2009) assessed the evolution of dietary intake patterns over time in adolescents in the USA. Middle school (younger cohort group, 12 years old) and high school (older cohort group, 16 years old) students were interviewed at the beginning of the study (time 1) and then again five years later (time 2). During this time, the younger cohort group progressed from early adolescence to middle adolescence and the older cohort from middle adolescence to late adolescence. At time 1, four dietary patterns were identified (using principle component analysis): vegetable, fruit, sweet/salty snack food and starchy food. At time 2, these four identified patterns remained present but a fast-food pattern had also emerged. The frequency of fast-food consumption increased significantly from early to middle adolescence among both males and females. However, from middle to late adolescence, a significant increase occurred only among males. The study above highlights the importance of studying dietary patterns longitudinally in childhood and adolescence, as it appears that nutrition behaviours develop and transition during this period. Moreover, evidence shows that there is a significant association between food intake in adolescence and food intake in adulthood (Lake et al. 2006). Thus, interventions aiming to improve nutrition behaviours in adolescence can also be effective for obtaining long-term health benefits via a mechanism in which healthy dietary patterns track through the lifecourse. In this context, it is essential to identify the factors that influence dietary intake.

- Anthropometric profile

The findings show that in adolescents, the patterns of nutrition transition differ between sexes. The 2012 South African NHANES (Shisana et al. 2014) showed that the prevalence of thinness in 15-17 year olds was 26.2% in males compared to 15.4% in females. Contrastingly, the prevalence of overweight was 8.8% in males and 27.3% in females. In the current study, similar results were found, with a twofold higher prevalence of thinness observed in males compared to females (22.2% vs. 10.6%). The proportion of overweight was approximately three times higher in females than in males (26.2% vs. 8.2%). 5.2% of males had a high percent fat compared to 24.0% of females. Similar proportions were observed when assessing body fatness with waist-to-height ratio (5.1% of males had a high waist-to-height ratio compared to 26.0% of females). These findings are in line with the results of a systematic review conducted by Muthuri et al. (2014) on the overweight/obesity transition among children and adolescents in Sub-Saharan Africa. Their study showed that the weighted average of overweight/obesity was higher amongst females compared to males. It also highlighted that under-nutrition remained a concern in Sub-Saharan Africa.

The overweight: thinness ratio was 0.37 in males and 2.47 in females. These figures represent a clear shift from thinness to overweight in females and also highlight the existence of a dual burden of malnutrition within the area of Johannesburg/Soweto, with high prevalence of thinness in males and high prevalence of overweight in females. This dual burden between the sexes in South Africa has been reported in other studies (Reddy et al. 2009; Reddy et al. 2012; Bibiloni et al. 2013; Ginsburg et al. 2013; Shisana O 2014).

The concurrence of under- and over-nutrition at the population/neighbourhood, household or individual level is called the “nutritional dual burden” or “double burden of malnutrition” (Varela-Silva et al. 2012). This burden of diseases is mainly observed in LMICs. Corsi et al. (2011) assessed the double burden of malnutrition in LMICs, in males and females separately, using a multilevel analysis of the correlation between the residuals for underweight and overweight at the national and neighbourhood levels. This study showed that South Africa meets the criteria for a dual burden of malnutrition at the national level with above average levels of both underweight and overweight. However, unlike in this study, the presence of the dual burden was not found at the neighbourhood level. However, as mentioned above, their analysis was looking within sexes, with no comment on differences between the sexes at each particular level. Thus if one was to only focus on the study by Corsi et al. (2011) an erroneous conclusion may be made that the dual burden is not an issue at the neighbourhood level in South Africa.

The overweight: thinness ratio that we have observed here is likely to be even greater among adult women. Mendez et al. (2005) reported that in 1998 the overweight: thinness ratio amongst women aged 20-49 years was 14.2 in urban areas of South Africa. Although the female overweight: thinness ratio is much lower in adolescents than in adults, this result suggests that the nutrition transition starts before adulthood in South African females. Earlier work with the cohort revealed little difference in mean BMIs between males and females at ages 9/10 years (Griffiths et al. 2008).

It has been consistently reported that in South Africa and other countries in sub-Saharan Africa, rates of obesity are greater in females than in males. Case and Menendez (2009) propose a possible mechanism by which this sex disparity may exist. The authors found that, despite similar levels of nutritional deprivation in childhood between the sexes, an increased level of childhood nutritional deprivation was positively associated with adult obesity rates in females only, implying a possible sex-specific sensitivity to childhood nutritional inadequacy.

9.1.2.3.2 Neighbourhood and household SES influences on diet and anthropometric status

- Neighbourhood and household SES influences on diet

The general pattern of association between SES (measured at both the neighbourhood and household levels) and dietary intake in the current study is complex, with different associations observed for males and females. Overall results highlighted more frequent associations with the neighbourhood SES factors than with the household SES factors, especially in females, however the associations were weak. In females, the neighbourhood SES environment was associated with energy intake, fat, carbohydrate and added sugar intakes whilst in males the neighbourhood SES environment was associated only with added sugar intake. In females, being in the first tertile of the neighbourhood problem index (high perception of problems) resulted in a higher consumption of energy in comparison to females in the third tertile of the index. Females in the 1st tertile of the neighbourhood social support index (i.e. less support/unfavourable social environment) also had a significantly higher fat intake than those in the 3rd tertile. These results suggest that living in a deprived neighbourhood was associated with poorer diets. The results with carbohydrate intake were inconclusive and are therefore not discussed here. In males, being in the second tertile of the neighbourhood social support index (i.e. medium support/neutral social environment) in comparison to the third tertile of the index (high social support) resulted in a higher consumption of added sugars. No associations were found between the household SES variables (caregiver education, household wealth index) and dietary intake in either females or males.

The findings of this study are difficult to relate to the existing literature on neighbourhood and household SES influences on dietary intake as not only have few studies been conducted in LMICs, but furthermore, the studies which have been conducted, have investigated different exposure and outcome variables, thus limiting comparisons even further. Extensive literature exists in HICs, especially in North America, looking at the relationship between food environment and dietary intake but once again, most exposures (e.g. food desert, distance to supermarket/fast food outlet/convenience store) and outcomes (e.g. fruit, vegetable and fast food consumption) differed to the current study and thus also limit the ability to compare findings.

- Neighbourhood and household SES influences on anthropometric status

The general pattern of association between SES (measured at both the neighbourhood and household levels) and anthropometric status in the current study is complex, with different associations observed for under- and over-nutrition. Overall results highlighted more frequent associations with household factors than with neighbourhood indices, especially for males, however the associations were weak. A positive association was found between household SES and overweight in males whilst in females no SES gradient was identified. These results are not in line with the results of reviews on overweight/obesity in LMICs which showed an overall positive SES gradient in obesity in youths (Dinsa et al. 2012; Muthuri et al. 2014). The neighbourhood SES environment, as measured in this study, showed very little effect on the anthropometric status of these adolescents and contrasts with evidence from high income countries. A review from developed countries specifically studied the association between neighbourhood SES such as the food environment, physical and built environments in relation to weight status in youth and adults (Black and Macinko 2008) and found that a deprived neighbourhood in terms of economic and social resources was associated with high obesity rates in 15 of the 16 studies. This was supported by other reviews in children and adolescents assessing the association between the built environment and overweight/obesity (Dunton et al. 2009; Galvez et al. 2010). Gordon-Larsen et al. (2006) also found an inverse relationship between the number of physical activity and recreational facilities and obesity rates in youths.

It is also important to mention that there were differences between findings using the conventional measure of BMI compared with body fatness (whether assessed using either percent fat or waist-to-height-ratio). BMI is widely used regardless of its limitations (Bogin and Varela Silva 2012). The importance of the neighbourhood social environment for female body fatness would not have been observed if this study had focused only on BMI as a proxy for body fatness. Furthermore, if using BMI only, we would have concluded that there was a positive relationship between household SES and thinness in females, whereas there was no such association with low percent fat. However, a positive association between household SES and low waist-to-height ratio (equivalent to thinness) in girls was also observed (i.e.

lower odds of low waist-to-height ratio for the first tertile (poor) vs. the third tertile (wealthy)). These findings underline that studies regarding SES influences on anthropometric outcomes in adolescents should not solely rely on the use of BMI, as the proxy of body fatness. As consistent associations were mostly observed with SES, when using either percent fat or waist-to-height ratio, either of these may be recommended in addition to BMI. However the expense and onerous nature of measuring percent fat may preclude the use of this tool in low and middle income countries, thus suggesting waist-to-height ratio may be the most appropriate indicator.

The pattern of association between SES and anthropometric status also showed clear differences between sexes. In males, a positive household SES gradient in overweight was observed. Those whose caregivers attained a secondary school level education vs. a higher education level had significantly lower odds for overweight. Poorer status on the household wealth index was associated with lower odds of being overweight and of having high percent fat and increased odds of being thin. These findings are in line with another study conducted in South African adults (Alaba and Chola 2014) and with other studies conducted in LMICs which revealed a positive gradient between wealth and BMI/overweight in males (Monteiro et al. 2004b; Subramanian et al. 2009). Wrotniak et al. (2012) observed a positive association between SES (type of school attended; assets ownership) and obesity in adolescents in Botswana. However, the males and females were pooled in the analysis. A study conducted by Bovet et al. (2010) in the Seychelles (part of the African region) also showed a positive relationship between SES and overweight in males. Similar findings were reported in a review assessing overweight and obesity in children and youth in Sub-Saharan Africa (Muthuri et al. 2014). In terms of fat mass, previous work with a sub-sample of the Bt20+ cohort showed that high SES children aged 9-10 years old had higher fat mass compared to low SES children (Griffiths et al. 2008). The results of our study demonstrate that, in South African male adolescents, the shift of overweight from high to low household SES groups has not begun. The high SES group presents a higher risk for overweight and obesity in adolescent males and thus policy regarding NCDs should focus on wealthy and well-educated households. At the neighbourhood level, the odds of being overweight were increased for those in the poorest tertile of the neighbourhood economic index. This result was inconsistent with the household level findings and thus warrants further investigation.

A different dynamic was observed in females. At the neighbourhood level, the odds of having a high percent fat were increased for those in the middle tertile of the neighbourhood social support index compared to those with a favourable social environment. The pattern of increased risk in lower SES groups, apparent in MICs, is evident here (Monteiro et al. 2004a; Monteiro et al. 2004b; Jones-Smith et al. 2011b; Jones-Smith et al. 2011a; Goryakin and Suhrcke 2014). The neighbourhood variables have been used previously in this cohort, relating SES to anthropometric measures at 16 years (Griffiths et al. 2013). This previous study found no neighbourhood SES effect on anthropometric outcomes (though underweight was not investigated). The results found in the present study in relation to the neighbourhood social support environment suggest that, as the cohort transitions to a higher prevalence of overweight and obesity, the neighbourhood environment could begin to have more influence on anthropometric outcomes. The household SES influences were minor for females. No SES gradient in overweight was observed at the household level, similar to the findings of Alaba and Chola (2014). These results contrast with reviews on overweight/obesity in youths in LMICs (Dinsa et al. 2012; Muthuri et al. 2014) and with a previous study on females aged 15-49 years in LMICs which showed that wealthy women had higher odds of being obese compared to their poor counterparts (Subramanian et al. 2011). These results suggest that policy regarding NCDs in Johannesburg and Soweto should target all female adolescents regardless of their household SES. The odds of being thin decreased for those in the poorest tertile of the household wealth index. This implies that thinness is less prevalent in the poorest households and that the stage of nutrition transition is more advanced in female adolescents. Other contributing influences to thinness in females could be cultural factors such as body image perception and peer influences, which may differ by SES (West 1997; Renna et al. 2008; Trogdon et al. 2008; Puoane et al. 2010; Voorend et al. 2013).

This study provides a greater understanding of the dietary patterns and relationships between two levels of SES in relation to dietary intake and anthropometric status in adolescents living in this urban transitioning society. The pattern of association between SES and diet differed to that between SES and anthropometry in both males and females. This study is unable to provide an explanation for this unexpected finding, however, availability of physical activity data (the other proximal determinant of anthropometric status) may have been able to shed some light on this.

The fact that there are different problems affecting males and females within the same area adds complexity to the designing and implementation of appropriate health policies and makes the planning of public health services difficult. Understanding the challenges for different sexes at different ages is vital in helping to plan public health services.

9.1.3 CRM for obesity prevention interventions

9.1.3.1 Research aim

The purpose of this research was to evaluate the potential for religious groups such as Churches to be used as community-based organisations for obesity intervention. This was done by assessing the readiness of leaders from such organisations to engage in such interventions (Chapter 8).

9.1.3.2 Summary of findings

The CRM survey provided information on the obesity readiness scores. The mean obesity readiness score was 2.67 which relates to the second out of nine stages of the community readiness. This stage is called the “denial/resistance stage”. This stage is reached when “at least some community members recognise that it is a concern, but there is little recognition that it might be occurring locally“. FGDs provided a wide range of information which allowed the in depth interpretation of the CRM scores.

9.1.3.3 Discussion of the key findings

No other studies in Sub-Saharan Africa have used the CRM to assess the stage of community readiness to address overweight/obesity in adolescents, making relevant comparisons difficult. However, studies utilising the CRM for obesity prevention intervention have been conducted in HICs (Findholt 2007; Sliwa et al. 2011; Kesten et al. 2013; Millar et al. 2013; Frerichs et al. 2015). As such, comparisons of our findings will be made against the literature available for HICs.

The mean obesity readiness score in our study was 2.67 (“denial/resistance stage”). The scores found in the current study are low compared to those observed in HICs. For example, a study conducted in the UK by Kesten et al. (2013) assessed the community readiness to prevent overweight/obesity in pre-adolescent girls. This study split the issue of overweight/obesity into its two determinants and assessed the community’s readiness for implementing both physical activity and dietary interventions. The authors reported a readiness score of 6.08 for the physical activity readiness which corresponds to the 'initiation stage' (as described by Plested et al. (2006) as when there is "enough information is available to justify efforts. Activities are underway"). For the dietary readiness, the authors report a score of 5.74, corresponding to the 'preparation stage', described as "Active leaders begin planning in earnest. Community offers modest supports of efforts" (Plested et al. 2006). However the obesity readiness score observed in a disadvantaged community of a HIC (Latino community in Nebraska) was 3 (Frerichs et al. 2015), corresponding to the "vague awareness stage" which is achieved when "most feel that there is a local concern, but there is no immediate motivation to do anything about it" (Plested et al. 2006). This is evidently a lot more similar to the stage of readiness observed in our study (2.67) and illustrates the fact that even in higher income countries, the presence of deprivation may delay the stage of readiness.

Our overall score suggests that this community of religious leaders is at an earlier stage of readiness and, according to Plested et al. (2006), interventions for this stage should focus around raising awareness that the problem of overweight/obesity exists in this community.

The scores for the six dimensions of the CRM will now be discussed to further understand the low overall score.

The readiness score for resources was the highest of all of the dimensions (3.75), followed by knowledge of the issue (3.18). In the HIC study by Kesten et al. (2013), the highest score was community efforts, followed by leadership, whereas in the deprived community in a HIC (Frerichs et al. 2015), the highest score was observed for community efforts, followed by resources (stage 3), which was the highest score in our study.

The lowest score in our study was seen for community knowledge of efforts (1.88), with the second lowest score being community climate (2.16). This is compared to Kesten et al. (2013), whose two lowest scores were knowledge of the issue and resources. Finally, the lowest scores in the Latino community in Nebraska were observed for knowledge of the issue and community climate. Our results suggest that religious leaders in some churches are relatively knowledgeable about the issue and that there might be potential for resources to be developed to support obesity prevention. The community knowledge of efforts and community climate being low imply that the awareness of the issue and the need to develop initiatives have to be increased.

Plested et al. (2006), in their Community Readiness Handbook, state that for an intervention to be effective, each dimension should be at an equal stage of readiness. Therefore, based on our results, an initial focus should be on increasing the community efforts, knowledge of efforts and the community climate.

This study provides an overall idea of the community readiness to prevent overweight/obesity in adolescents and the necessary actions and strategies required to improve the readiness for addressing this issue. The study has highlighted that the first starting point for an intervention in this setting will be to mobilise communities.

The FGDs which complemented the CRM survey, scoped out the potential for churches to be used as vehicles for obesity prevention intervention in adolescents. Increasingly, churches are recognised as being popular settings for implementing health promotion programmes (Ammerman et al. 2003; Corbie-Smith et al. 2003; Boltri et al. 2006; Campbell et al. 2007; Baruth et al. 2008). Several church-based obesity and chronic disease prevention interventions have been conducted in African Americans adults which have focused on: increasing healthy eating patterns only (*increasing fruit and veg:* (Campbell et al. 2000; Resnicow et al. 2000); *increasing fruit and veg whilst reducing fat intake:* (Baruth et al. 2011), increasing physical activity only (Young and Stewart 2006; Wilcox et al. 2007) or increasing both healthy eating patterns and physical activity (Fitzgibbon et al. 2005; Kim et al. 2006; Wasserman et al. 2010; Yeary et al. 2011) and have provided positive results. Importantly, all of these interventions emphasised the role that religion and faith can play in influencing behaviour change and improving health.

Conducting research through churches is a form of community-based participatory research (CBPR), in which researchers, religious leaders and congregants participate equally in the research process and towards improving participants' health, complementing each other by providing their own unique strengths (Minkler et al. 2003). Minkler et al. (2003) state that CBPR stimulates a sense of empowerment and community ownership of the health program, thus resulting in improved participation and long-term sustainability.

Fewer studies have investigated the role of churches in addressing childhood obesity prevention (Reifsnider et al. 2010; He et al. 2013). He et al. (2013), conducted interview discussions with Latino church leaders in Texas, US, in order to obtain their views on childhood obesity prevention and reported similar findings to the ones generated from our FGDs. Firstly, community leaders were enthusiastic and recognised that they were perceived as role models within the community and thus play an important role in improving children and adolescent's health. Furthermore, they also recognised that their role was not limited solely to spiritual guidance and mentoring, but also to physical well-being. They were also shown to be knowledgeable with regard to the causes and consequences of the obesity issue. Both groups also highlighted that they could develop the necessary resources (human or physical) to implement this kind of intervention.

Findings from our study and that of He et al. (2013) highlighted that if an intervention is to be implemented, it should not be labelled as an 'obesity intervention'. This is because leaders in both contexts felt that this label could stigmatise or embarrass overweight or obese members of the congregation. Rather, it is suggested that the intervention be labelled 'health or well-being intervention'.

9.2 Strengths and limitations of the study

In this section, strengths and limitations of each study conducted in this thesis will be discussed. The most unique aspect of this thesis is the availability, in a fairly poor urban community, of such a rich set of different SES indicators measured at both the household and neighbourhood level, as well as the wide-ranging outcome variables (diet, BMI, percent fat, WHTR). Furthermore, this thesis employed both quantitative and qualitative methods in an attempt to understand the determinants of unhealthy dietary patterns and overweight/obesity and also identified potential mechanisms through which potential obesity prevention interventions could operate in this transitioning environment.

This thesis overall has adopted a mixed methods approach, essential in the field of public health.

9.2.1 Neighbourhood deprivation

Many qualitative studies have focused on children and adolescents' perceptions of their environment (Kruger and Chawla 2002; Chawla and Driskell 2006; Adams and Savahl 2015), however the current study is the first to assess quantitatively the neighbourhood socio-economic and school environments in South Africa, using an innovative tool designed specifically for the urban South African context. Furthermore, this study provides a thorough analysis of both the economic and social environment across different population groups.

In this study, neighbourhood was defined for each individual as an area that is approximately 2 kilometres from the participant's house in every direction. This radius was chosen as it is the distance from the residence that can be walked in approximately 20 minutes (Sheppard et al. 2010). The definition of neighbourhood used in this study is similar to ones used in other studies, which also employed a criterion based on geographical boundaries (Jeffery et al. 2006) (Burgoine and Monsivais 2013). Importantly, however, this self-defined categorisation of neighbourhood was developed through formative research in the communities. It encapsulated both the geographical area and social aspects within that specific area. As such, although a geographical definition was employed, the study also aimed to assess perceptions of participants' place of residence as a community. A key strength is the inclusion, in the neighbourhood SES questionnaire, of questions assessing not only the economic indicators of the area, but also the social aspects (community spirit, social support, trust, happiness etc.). Despite being a key component of SES, in reality, research studies typically focus only on economic indicators, with little emphasis given to the social context. Furthermore, whilst census data and household surveys can provide a great diversity of indicators (and their serial collection means that trends can be identified), they too lack information on the social environment and physical characteristics of the neighbourhood.

An Index of Multiple Deprivation (IMD) based on the census data is available and used to compare communities in South Africa. This index is composed of smaller subscales assessing employment deprivation, income and material deprivation, education deprivation and living environment deprivation. However, this tool is available only at the provincial (Wright et al. 2009a) and municipality (Wright et al. 2009b) levels and is thus unable to provide assessments of deprivation to a level as small as that of the tool used in this study. However, our tool may not have captured the full range of SES environments within the Soweto-Johannesburg area, as informal settlements may not have been covered by the Bt20 study.

It is important to highlight that this study used subjective neighbourhood boundaries (self-defined by each individual) as opposed to pre-defined ones (using GIS coordinates or census data). Furthermore, perceptions were used to define adolescents' socio-economic and school neighbourhood environments and this subjective assessment presents various pros and cons.

For example, this method adopts more of a participatory and grass roots approach in which the community members themselves (in this case adolescents) had a voice in describing their living conditions. However, perceptions are likely to differ by gender, age etc. which may lead to differing opinions from people residing in the same neighbourhood. This may potentially increase variation within a neighbourhood, with a possible consequence of diluting differences between neighbourhoods. These perceptions were also used to create neighbourhood indices and classify these neighbourhoods as either low, medium or high SES. Therefore it is important to mention that if objective measures had been used to determine SES, a neighbourhood's SES classification may have differed but the neighbourhood would also have had different meaning.

In our sample, around 70% of the sample reported living in an average neighbourhood (72% for Black African, 65.0% for Mixed Ancestry, 79.3% for Indian/Asian and 49.2% for White). Two possible explanations for this finding are a) that rich people tend to rank themselves lower whilst poorer people tend to rank themselves higher and b) that this cohort is an established cohort (since 1990) and thus a selection effect may be occurring where lower income households from recent migrants are not included and higher income households have been shown to have greater attrition in Bt20 (Richter et al. 2007). The former point will likely result in an over-representation of people in the middle area of the distribution which may consequently make it difficult to assess associations with outcome (Howe et al. 2012). The latter point may contribute to this perception of average status because they have been established in the area for a long time and have thus developed stronger social networks, better links to the community, greater access to facilities etc. Whilst acknowledging that they are not high SES, they perceive their situation as more advantageous than, for example, migrant groups who have recently moved to the area.

Although this neighbourhood SES tool was developed to describe the environment in which the adolescents reside, it can also have value in decision making regarding the allocation of resources to specific areas of need and for the defining of appropriate policies (Sheppard et al. 2010).

This study has used six different indices to represent different dimensions of the neighbourhood socioeconomic environment. This was done because there were, in excess of 100 individual variables generated by the neighbourhood SES questionnaire. Therefore, PCA was used to summarise the information and make the models more parsimonious. We are conscious, however, that the creation of indices may have resulted in the loss of some potentially relevant variables (Sheppard et al. 2009), whose individual effect may have provided independent contributions. Nonetheless, with the available sample size and the number of variables already included in the models, the creation of indices was deemed to be the best approach in order to avoid potentially unstable/non-significant estimates, resulting from a lack of power. These indices were based on the paper by Griffiths et al. (2012) and although they have been used previously in several different analyses, it could have been possible to create a novel set of indices. For example the neighbourhood social support index could have been split into two separate indices, one representing trust within the neighbourhood and the other representing happiness.

One limitation of this study is the relatively low number of Indian adolescents, which precluded the inclusion of this group in the univariate and multivariate analyses. Further studies using oversampling techniques are urgently required to capture Indians' perceptions of their neighbourhood SES environment. Further work could also explore more in depth the association between gender roles and perceptions of the neighbourhood socio-economic environment.

Another potential limitation is the fact that this study did not adjust for household SES factors other than caregiver education as these were not available at the time of analysis, due to the fact that only half of the dataset had been cleaned. The fact that comprehensive household SES measures were not included might have changed results and interpretation of findings.

We need to be very careful how results from the school analysis are interpreted as only those in school were included. The adolescents not in school may be different to those in school. The not in school group will be a mixture of those in university and those who dropped out so we could potentially be missing the most advantaged and least advantaged group in drawing conclusions regarding the school SES environment.

9.2.2 Neighbourhood and household SES influences on dietary intake and anthropometric status

To the authors' knowledge, this study is the first to look at household and neighbourhood SES in relation to dietary intake and the dual burden of malnutrition in male and female adolescents. Previous research conducted in South African adolescents aged 16 years old

(Griffiths et al. 2013) focused on the relationship between household/neighbourhood SES and anthropometric outcomes such as (BMI), overweight/obesity, fat mass and lean mass. However, the prevalence of underweight was not investigated and thus the potential for an assessment of the dual burden of malnutrition was not possible.

This study is also novel in that it focuses on sex differences in the nutrition transition in urban South Africa. Furthermore, in this study both economic and social aspects of SES have been examined, encompassing a wide range of SES measures at the household and neighbourhood levels. This provides a more comprehensive assessment of SES than most previous studies on this topic, which have only focussed on household SES measures (Ziraba et al. 2009; Jones-Smith et al. 2011a; Jones-Smith et al. 2011b; Subramanian et al. 2011; Wrotniak et al. 2012; Goryakin and Suhrcke 2014; Alaba and Chola 2014). This cohort is the first to use a novel quantitative tool to measure self-perceived deprivation at the neighbourhood level amongst adolescents. This differs from previous studies which related child health outcomes to SES data obtained mainly from national censuses and DHS, including measures such as employment, education, income and urban vs. rural (van Vuuren et al. 2014). The use of convenient administrative boundaries to define neighbourhoods has been studied by Pickett and Pearl (2001) and Riva et al. (2007), with the former stating that boundaries "do not correspond to the actual geographical distribution of the causal factors linking social environment to health" (Pickett and Pearl 2001). Census data and household surveys do not take into account the social aspects of life and physical characteristics of the neighbourhood. Also, the resident's perspective is lacking (Weiss et al. 2007). The tool used in the present study was based on previous formative work with the cohort. In a recent review, van Vuuren et al. (2014) reported that, unlike this study, a majority of studies (13 out of 19) assessing neighbourhood SES and child health outcomes did not use theory-based neighbourhood constructs.

As the objective of this study was to look at the influence of SES at a single time point of adolescence (18 years), it is not possible to speculate as to potential underlying causal relationships. The lack of significance or consistent associations between neighbourhood SES, diet and the anthropometric outcomes could be explained by the neighbourhoods not varying enough to capture SES-related differences. However, it could also result from the tool used to measure neighbourhood SES deprivation. It is important to mention that the questionnaire developed was a general questionnaire designed to understand the nature of the SES environments in which adolescents were residing. Further research using a more specific tool (including more refined measures, such as food environment, built environment, and peer interactions (Lake and Townshend 2006; Carroll-Scott et al. 2013), to study diet and nutritional outcomes, and adapted to urban settings in LMICs may be required to clarify the associations between neighbourhood and health outcomes in adolescents.

Lifestyle factors (diet and physical activity) on the pathway between SES and anthropometric outcomes need to be further investigated to guide policy. Despite dietary data being available, only one third of the dataset could be used for analysis as limited resources allowed for only a subset of the data to be coded, entered and cleaned. This small sample (relative to those with anthropometric and SES data) of those with dietary data meant that a large proportion of the adolescents would have been excluded in the complete case analysis, thus affecting the reliability of the estimates. Therefore, it was decided that dietary adjustment could only be conducted once the full dietary dataset becomes available. In an attempt to adjust for the clustering of SES characteristics within an area, multilevel modelling is often employed. However, the definition of neighbourhood used in the cohort resulted in no two households having the exact same neighbourhood and therefore no household shared exactly the same cluster, making the use of a multilevel structure difficult.

The lack of significant or consistent associations between SES (household and neighbourhood) and dietary intake could also be explained by the tool used to measure dietary intake. It is widely acknowledged that the collection of quantitative dietary data at the population level is notoriously challenging even in high income countries where there is greater access to suitable materials, and human resources (aiding efficient collection, processing and analysis of data). Conducting this type of research in LMICs, with the associated reduced resources, represented an even greater challenge. Furthermore, assessing diet in a sample of adolescents living in a transitioning environment is associated with various difficulties. For example, the estimation of quantities and ingredients added, especially during the cooking process (e.g. added fats), can be difficult, especially individuals who are less involved/interested in the food preparation process. Staff members in charge of the dietary data collection reported that adolescents, especially males, did not engage with the FFQ enthusiastically due to the high participant burden (i.e. the multitude of questionnaires that adolescents are asked to fill in as part of the Bt20 study) and the length and detail of the FFQ.

Assessing diet using a quantitative FFQ is plagued with a range of biases, present throughout the entire process from collection to analysis (collection, coding, entering, cleaning, analysing). Common biases include (and have been discussed more comprehensively in the literature review section): non-response bias, respondent bias (systematic over- or under-reporting, social desirability and approval biases), interviewer bias, respondent memory lapses and coding errors. It is also important to mention that the tool has not been validated against superior methods (e.g. doubly labelled water) thus limiting any conclusions regarding the accuracy of the tool. Even with validation, prospective and retrospective methods of dietary assessment will always have an inherent error associated with them (Rutishauser 2005).

In summary, measurement errors in dietary measures can affect or mask relationships between dietary variables and health outcomes and represent an important challenge for the interpretation of results (Cade et al. 2002; Börnhorst et al. 2013). We therefore have to be cautious in the interpretation of the dietary results.

9.2.3 CRM for obesity prevention interventions

This study is novel in that it is the first to use the CRM to assess the readiness of religious leaders to engage in obesity prevention interventions in adolescents living in Africa. With the emergence of the nutrition transition in South Africa, there is an urgent need for interventions to be implemented. Before implementing an intervention, we first need to ascertain the stage of readiness of the community in which the intervention will be implemented. This study sheds light on this and suggests that the community under study was not yet ready for an intervention to be implemented.

A further strength of this study is the use of FGDs in partnership with the CRM tool. This allowed for an in-depth investigation of the scores and why such scores were achieved. The FGDs provide a real understanding of the situation within the community and highlight vital information which may aid the design and implementation of interventions. The strengths of focus groups are numerous. One of the strengths is that it is not a discriminating technique as it allows, for example, illiterate people to contribute to the debate. It also improves the participation of people who would not normally talk if interviewed individually (Kitzinger

1995). A focus group gives the opportunity to examine people's thoughts but also brings information on the causes of complex behaviours and motivations (Morgan and Krueger 1993). However, the real strength of this technique resides in the group interaction (respondents have to explain themselves to each other and question each other) which offers rich information on the level of consensus and disagreement among participants' opinions and experiences (Morgan and Krueger 1993). The participants play an immense role in the data collection process. Indeed, they work by the side of the researcher when there is a positive group interaction and they can raise new issues and take the research in unanticipated directions (Kitzinger 1995). One of the weaknesses of FGDs is that there is no confidentiality of the research session (Kitzinger 1995), because participant's opinions and experiences are shared between the group of participants and not only with the researcher. The group composition, if not well thought out, can hinder the group interaction. Indeed, some influential participants in the group may prevent other participants from expressing divergent opinions (Kitzinger 1995). A high level of disagreement in the group can also be deleterious as it may cause conflict. The level of the moderator involvement can also disrupt the group dynamic (Agar and MacDonald 1995) and therefore impact the data.

Prior to its formal use with the religious leaders, the CRM survey was pilot tested with both Bt20 staff and a sample of religious leaders (n=13) from Soweto. Based on the findings of these pilot tests, the tool was amended and adapted to the urban South African context (re-phrasing of sentences, altering terminology and modifying the tool's Likert scale by including smiley faces to aid comprehension). It is important to mention that participants with a lower level of education found the CRM survey challenging to complete.

Scoring the transcripts using pre-defined anchored rating statements has been criticised (Beebe et al. 2001; Mayer 2008) for permitting too much researcher subjectivity into the process. In order to reduce this potential bias, the CRM surveys were scored independently by two reviewers and then combined. If discrepancies arose between reviewers, these were discussed until consensus was reached.

The final strength is that the CRM enables community members, in this instance religious leaders, to be the actors in the process of ameliorating the well-being of fellow members, in this instance adolescents. However, this study could have been improved had the adolescent's views on the use of churches as vehicles for obesity interventions, been included. This was not possible due to very limited time and resources during fieldwork.

Furthermore, the absence of information about peer influences on diet, physical activity and anthropometric status in the FGDs is also likely borne out of the fact that adolescents were not interviewed. This information is essential when designing interventions in adolescents.

Another limitation is that the CRM scores may not be representative of the Johannesburg/Soweto area as a whole. Indeed, choosing different churches and religious leaders may have led to different results. However, sampling until theoretical saturation was achieved, goes some way to reducing this possibility.

Additionally, the CRM tool captures an image of the readiness of the community only during the interview period and is not representative of communities which are continuously changing or evolving (Sliwa et al. 2011). Furthermore, the model places complete responsibility for health issues on the shoulders of communities. A further limitation is linked to the assumption that communities will fit into one of the nine stages of readiness defined (Mayer 2008), whereas in reality, they may be operating at an intermediary stage.

Some biases may have been introduced by the (White European) researcher when conducting the study. For example, some participants may have omitted certain pieces of information which may not have occurred with a local interviewer. It may also have been the case that participants overestimated their willingness to engage in obesity prevention intervention (social desirability bias). However, in order to reduce this bias, a local field worker was employed in order to legitimise the researcher's presence and facilitate discussion. Also the researcher's pre-defined opinions may have altered the interpretation of the findings, thus biasing results. For a further critique of the CRM and for methods to reduce bias when using the tool, see the paper by Kesten et al. (2015).

Although churches have been recognised as potential levers for obesity prevention intervention, it is important to acknowledge that interventions operating through churches would miss all adolescents without religious affiliation or those belonging to other religious groups. As such, though the majority of adolescents would be targeted, other means need to be employed in order to reach those missed.

9.3 Future research

Further research questions have been raised during the period of this PhD and it is hoped that the following projects could be undertaken to develop this field of research:

- Improve understanding and characterisation of the food environment and its relationship with dietary intake and anthropometric status in urban adolescents living in South Africa;
- Understand neighbourhood and household SES influences on physical activity patterns in urban adolescents living in South Africa;
- Understand the roles dietary intake and physical activity play in mediating the relationship between SES and nutritional outcomes;
- Investigate the relationship between dietary patterns obtained from PCA and socio-demographic and anthropometric characteristics;
- Investigate the relationship between SES (neighbourhood and household), lifestyle factors, anthropometric factors and diet-related NCDs;
- Raising the awareness of the obesity issue amongst religious leaders and re-evaluate the CRM stage after such an intervention;
- Develop innovative Community Based Participatory Research to capture adolescents who cannot be targeted via the church.

9.4 Recommendations and conclusion

The quantitative and qualitative findings of this study have identified key points that can be used to guide policies with regards to urban South African adolescents' health (i.e. well-being, dietary patterns, and anthropometric status). Based on our findings, gender specific and locally relevant recommendations will be made to suggest ways of improving adolescents' well-being and nutritional status in this transitioning context. Overall the qualitative and quantitative findings of the study highlighted that this sample of adolescents is facing a complex range of social and health related issues.

The first study on neighbourhood deprivation allowed for a further understanding of the socio-economic and school neighbourhood environments in which adolescents reside. Understanding the socio-economic context is essential to understand health trajectories. This study highlighted that improvements in the school environment could be used as a leverage point to reduce socio-economic inequalities between the different population groups. Improvements in the school environment might lead to better education, employment and equal opportunities which might in turn have a positive impact on health and lifestyle choices. The neighbourhood deprivation study also showed that adolescents in this sample experienced issues of violence and crime. In light of these findings, we recommend community-based participatory research in which adolescents and key informants in the community (community leaders, parents, government officials) would be responsible for promoting collective action to solve neighbourhood problems and thus creating positive and safe environments.

The second study assessing neighbourhood and household SES influences on anthropometric status revealed that, in the area of Johannesburg-Soweto, the nutrition transition manifests itself differently in males and females and across SES indicators. As such, females had a significantly higher combined prevalence of overweight/obesity than males whereas males had a significantly higher prevalence of thinness. Furthermore, poor household SES was associated with lower odds of overweight in males but no associations were observed among females implying that the prevalence of overweight in females was high across SES groups. The fact that different problems affect males and females within the same area adds complexity to the designing and implementation of appropriate health policies and makes the planning of public health services difficult. We recommend that policies should target all females regardless of their SES and that policies should address the double burden of malnutrition faced between sexes at the neighbourhood level.

The third study assessing the stage of readiness of religious leaders to engage in obesity interventions in adolescents showed that the community readiness scores were low. The first actions should aim to increase the awareness of the obesity issue amongst religious leaders. This study also scoped out the potential for churches to be used as a leverage point in addressing overweight and obesity in adolescents. Overall, these findings highlighted that the community is ready to move forward the obesity prevention agenda in adolescents.

Based on the findings of the second and third study, it is recommended that community-based participatory programmes could be implemented through Churches to improve adolescents' health and nutritional status. Interventions should be targeted at both male and female adolescents in the Church to prevent overweight and obesity in adulthood. Furthermore, interventions should focus on promoting healthy dietary and physical activity patterns to improve general well-being and happiness rather than focussing on weight-loss. Interventions could be adapted from programmes already in place within the churches such as cultural dance and football matches.

It is important to mention that interventions through churches might miss the ones not affiliated with any religious institutions whilst interventions through schools might miss the most vulnerable and disadvantaged part of the population. Targeting more than one community might provide opportunities for wider access. This requires the development of innovative community based participatory research using grass-roots as opposed to top-down approaches.

Our study also showed that adolescents consume processed foods and high fat, high sugar products. A possible mechanism attempting to reduce this consumption could be the introduction of legislative measures (e.g. reduction in fat, sugar and salt content of processed foods, practising responsible marketing/advertising).

The adolescent period represents a window of opportunity for obesity prevention intervention at a time when individualised behaviours develop. Thus the adoption of healthy lifestyles during this period may have the potential to track throughout adulthood. Finally, prevention is essential but there is also a need to strengthen the current health care system (e.g. training of health workers) to deal with people already experiencing overweight or obesity and risk factors for NCDs.

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Appendices

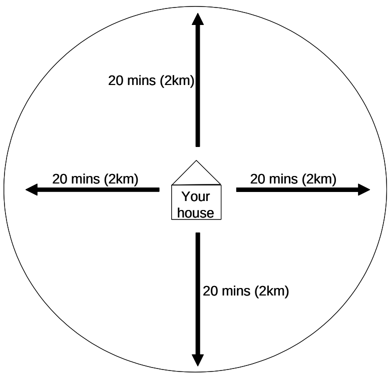
University of the Witwatersrand

Department of Paediatrics and Child Health

Introduction

We learnt some interesting things from the families visiting the Medical School Site recently about the places where they lived. We asked about the places where they lived because we thought it was important for understanding health and well-being. We would now like to find out more about the places where you live as you become young adults. It is hoped the study will help the government to design environmental, social, and health policies that reduce the risk of poor health and improve the wellbeing of those living in cities, adding to Birth to Twenty's vision to produce research that makes a difference.

The following questions refer to the **neighbourhood** where you live which we consider to be the **area where you could potentially walk to in about 20 minutes from your house, that is, approximately 2km in any direction from your house.**



If you live in more than one house because for example you stay with your mother/father/partner, as they do not live in the same house, please answer the questions based on the neighbourhood where you spend **most** of your time. There are no right or wrong answers to the questions we are asking you as we are only interested in your **perceptions** of the neighbourhood where you live. The questions are split into four main sections: section A addresses economic aspects of your neighbourhood, section B deals with social aspects of your neighbourhood, section C asks about your school/college/university if you are still studying, and finally section D asks about your employment status and place of work if you are employed.

Section A: Economic aspects of your neighbourhood

The first few questions ask about the level of wealth in your neighbourhood. Remember we are interested in the area where you could potentially walk to in about 20 minutes from your house, that is, approximately 2km from your house.

1. How do you describe your neighbourhood in terms of wealth?

Response	**Code**	**Please tick one box only**
Very poor	1	
Poor	2	
Average	3	
Wealthy	4	
Very wealthy	5	

2. Do you think people living **outside** of your neighbourhood see **your** neighbourhood as being:

Response	**Code**	**Please tick one box only**
Very poor	1	
Poor	2	
Average	3	
Wealthy	4	
Very wealthy	5	

3. Which of the following statements do you think is **true** about your neighbourhood?

Response	**Code**	**Please tick one box only**
There is a **big** mix of living standards	1	
There is **some** mix of living standards	2	
Most households have the same living standards	3	
All households have the same living standards	4	

The next few questions are about the main type of housing in your neighbourhood. Remember we do not want to know about **your** house but the houses that are **most common** in your **neighbourhood**.

4. What type of housing is **most** common in your neighbourhood?
(please show flashcards of types of housing and tick corresponding box)

Response	Code	Please tick one box only
Shacks	1	
Government housing/flats e.g. Municipal/RDP housing	2	
Improved government housing/flats e.g. extended Municipal/RDP housing	3	
Bond housing/flats/townhouses (need a bank loan to buy)	4	
Other (please **specify** in detail – housing type and ownership) ______________________	5	

5. How would you describe the general condition of **most** houses in your neighbourhood?

Response	Code	Please tick one box only
Very bad condition	1	
Bad condition	2	
Average condition	3	
Good condition	4	
Very good condition	5	

6. Do **most** of the houses in your neighbourhood have yards?

Response	Code	Please tick one box only
No	0	
Yes	1	

7. Do **most** of the people in your neighbourhood have a place to park a car near to their house, either in their yard or on the street?

Response	Code	Please tick one box only
No	0	
Yes	1	

8. Do **most** houses in your neighbourhood have fences or walls around their property?

Response	Code	Please tick one box only
No	0	
Yes	1	

(If answered 'no' to Q8, do not ask Q9 but tick N/A, and move to Q10)

9. **IF MOST HOUSES HAVE FENCES/WALLS,** which of the following are the fences/walls **mainly** used for in your neighbourhood?

Response	**Code**	**Please tick one box only**
Status	1	
Noise prevention	2	
Security	3	
Privacy	4	
Boundary	5	
Other (please **specify**) ______________________________	6	
Don't know	7	
N/A (most do not have fences/walls)	**98**	

The next few questions ask about the facilities in your neighbourhood.

10. I am going to read out a list of facilities and please let me know which ones there are in your neighbourhood? That is, which of these facilities are within about 2km from your house that you could walk to within about 20 minutes? ***(please tick one box for each facility)***

Facility	**No [0]**	**Yes [1]**	**Don't know [2]**
a) Primary school			
b) Secondary school			
c) College			
d) University			
e) Registered day care/crèche			
f) Hospital			
g) Primary health clinic			
h) Pharmacy/chemist			
i) Police station			
j) Shopping mall e.g. Eastgate, Southgate, Westgate, Jabulani, Maponya etc			
k) Fast food outlet/takeaway e.g. Nando's, KFC, Carioca			
l) Other restaurant			
m) Place to buy food e.g. shop/spaza			
n) Internet café			
o) Tavern or licensed bar			
p) Nightclub			
q) Cinema			
r) Community/recreational centre			
s) Church			
t) Library			

Facility	No [0]	Yes [1]	Don't know [2]
u) Sports field, pool or tennis courts			
v) Gym			
w) Park (open grassed area)			
x) Petrol station			
y) Car dealership (car sales)			
z) Bus stop			
aa) Train station			
bb) Taxi rank			
cc) Postal service			
dd) Street lighting in working condition			
ee) Piped water supply			

11. I am now going to read a list of some of the facilities again and please tell me if you think your neighbourhood needs **more** of any of the following:
(please tick one box for each facility)

Facility	No [1]	Yes [0]
a) Primary school		
b) Secondary school		
c) Hospital		
d) Primary health clinic		
e) Community/recreational centre		
f) Sports field, pool or tennis courts		
g) Park (open grassed area)		
h) Street lighting in working condition		
i) Piped water supply		
j) Police officers patrolling your neighbourhood		

12. When you are unwell, which suburb(s)/area(s) do you **usually** go to for health care?____

13. When you go shopping at a mall, which suburb(s)/area(s) do you **usually** go to?____

14. When you go food shopping, which suburb(s)/area(s) do you **usually** go to?____
15. Do you eat out?

Response	Code	Please tick one box only
No	0	
Yes (please **specify** the suburb(s)/area(s) of the restaurants	1	

you **usually** go to) ___________________________________		

16. Do you go to taverns or bars?

Response	Code	Please tick one box only
No	0	
Yes (please **specify** the suburb(s)/area(s) of the taverns/bars you **usually** go to) ____	1	

17. Do you go to nightclubs?

Response	Code	Please tick one box only
No	0	
Yes (please **specify** the suburb(s)/area(s) of the nightclubs you **usually** go to) __________________________________	1	

The next couple of questions are about the road networks in your neighbourhood. We are interested in the type of roads that are **most common** in your neighbourhood**.**

18. What is the **main** type of road in your neighbourhood?

Response	Code	Please tick one box only
No roads	0	
Gravel/dirt roads	1	
Tarred roads	2	

(If answered 'no' to Q18, do not ask Q19 but tick N/A, and move to Q20)

19. **IF THERE ARE ROADS,** in general what kind of condition are most of the roads in your neighbourhood e.g. potholes etc

Response	Code	Please tick one box only
Very bad condition	1	
Bad condition	2	
Average condition	3	
Good condition	4	
Very good condition	5	
N/A (answered 'no roads' to previous question)	**98**	

20. Do you have a driving licence?

Response	Code	Please tick one box only
No	0	
Yes – learner licence	1	
Yes – official licence	2	

(If answered that did not have official licence to Q20, do not ask Q21 but tick N/A, and move to Q22)

21. **IF YOU HAVE AN OFFICIAL LICENCE,** do you have access to use a car?

Response	Code	Please tick one box only
No	0	
Yes – at least once a week	1	
Yes – have own car	2	
N/A (do not have official licence)	**98**	

The next few questions ask about important issues in your neighbourhood, that is, the area 20 minutes walk/2km from your house.

22. Are there a large number of teenage pregnancies in your neighbourhood?

Response	Code	Please tick one box only
Yes	0	
No	1	

23. I am going to read a list of potential neighbourhood problems. In general, do you think your neighbourhood has a problem with any of the following? ***(please tick one box for each problem)***

Problem	Yes [0]	No [1]
a) Traffic congestion		

b) Road safety		
c) Road rage		
d) Sewerage		
e) Illegal dumping		
f) Pollution		
g) Overcrowding		
h) People born outside South Africa		
i) Minority attacks e.g. sexual orientation, ethnicity		
j) Delinquency e.g. people hanging around causing trouble		
k) Homelessness		
l) Repossession (houses being taken away)		
m) Unemployment/retrenchment		
n) Prostitution		
o) Alcohol abuse		
p) Drugs		
q) Gangsters		
r) Shebeens		

Section B: Social aspects of your neighbourhood

The first few questions in this section refer to safety and crime in your neighbourhood. Remember we are interested in the area 20 minutes/2km from your house.

24. How safe do you feel in your neighbourhood?

Response	Code	Please tick one box only
Very unsafe	1	
Unsafe	2	
Average	3	
Safe	4	
Very safe	5	

25. In your opinion, how much crime is there in your neighbourhood?

Response	Code	Please tick one box only
A lot	1	
Some	2	
Average	3	
Not much	4	
None	5	

26. In your opinion, what is the **most** common type of crime in your neighbourhood?

Response	Code	Please tick one box only
Murder	1	
Rape	2	
Physical abuse/beating	3	
Hijacking/car theft	4	
Break-in (car and house)	5	
Mugging	6	
Vandalism	7	
Other (please **specify**) ______________________________	8	

27. I am going to read out a list of potential crime prevention and security measures. Do **most** households in your neighbourhood have the following **to prevent crime/ensure safety**?
(please tick one box for each item)

Item	No [0]	Yes [1]	Don't know [2]
a) Dogs			
b) Weapons			
c) Security guards/policing forums			
d) High walls/fences/gates			
e) Electric fences			
f) Alarms/panic buttons			
g) Security doors			
h) Barred windows			
i) Security lights			

The next few questions ask about social networks and community spirit.

28. Are there any activities for young adults like yourself run in your **neighbourhood** e.g. sports clubs etc?

Response	Code	Please tick one box only
No	0	
Yes (please **specify** all known activities) _______________ ____ ____	1	

29. How often do you spend time with friends **living in your neighbourhood excluding time spent at school/college/university/work?**

Response	Code	Please tick one box only
Never	0	
Less than once a week	1	
Once a week	2	
2-6 times a week	3	
Daily	4	

30. How much **peer pressure** is there for you to keep up with your neighbours and friends in your neighbourhood in terms of what you wear, your cell phone, your ipod/MP3 player, drugs etc?

Response	Code	Please tick one box only
A lot	1	
Some	2	
Average	3	
Not much	4	
None	5	

31. Would you say **most** people living in your neighbourhood are:

Response	Code	Please tick one box only
Black	1	
Coloured	2	
Indian	3	
White	4	
Mix of people	5	

32. How quiet is your neighbourhood in terms of **general** noise e.g. traffic, dogs, music etc?

Response	Code	Please tick one box only
Very noisy	1	
Noisy	2	
Average	3	
Quiet	4	
Very quiet	5	

33. How lively is your neighbourhood?

Response	**Code**	**Please tick one box only**
Not at all lively	1	
Not very lively	2	
Average	3	
Lively	4	
Very lively	5	

34. How strong is the community spirit in your neighbourhood?

Response	**Code**	**Please tick one box only**
Very weak	1	
Weak	2	
Average	3	
Strong	4	
Very strong	5	

35. Other than your family, who do you trust in your neighbourhood?

Response	**Code**	**Please tick one box only**
Nobody	1	
Few people	2	
Some people	3	
Most people	4	
Everybody	5	

36. During a crisis e.g. close family member dies or is unwell, could you or your caregiver depend on other people in your neighbourhood?

Response	**Code**	**Please tick one box only**
No	0	
Yes	1	

37. Could you or your caregiver borrow a cup of sugar from one of your neighbours?

Response	**Code**	**Please tick one box only**
No	0	
Yes	1	

38. If you were away from home overnight, could you or your caregiver ask one of your neighbours to look after your house?

Response	Code	Please tick one box only
No	0	
Yes	1	

39. How happy are you living in your neighbourhood?

Response	Code	Please tick one box only
Very unhappy	1	
Unhappy	2	
Don't mind	3	
Happy	4	
Very happy	5	

40. How do you feel about your neighbourhood?

Response	Code	Please tick one box only
Ashamed	1	
Embarrassed	2	
Not bothered	3	
Proud	4	
Very proud	5	

The next couple of questions ask you to rank the good things and bad things about your neighbourhood. These issues were mentioned as being important during some group discussions we conducted with some families who visit the Medical School Site. However, we would now like to find out what **you** see as being most and least important in **your** neighbourhood.

41. Please put the following good things about your neighbourhood in order of importance with 1 being the least important and 4 being the most important to you:
(please ask the young adult to sort the ranking flashcards into order of importance and note the order below, and then confirm that you have understood the ordering)

Good things about your neighbourhood	RANKING (1 = LEAST IMPORTANT 4 = MOST IMPORTANT)
a) Security	
b) Community spirit and support	
c) Transport and communication networks	
d) Services and facilities e.g. health care and shopping malls	

42. Please put the following bad things about your neighbourhood in order of importance with 1 being the least important and 6 being the most important to you:
(please ask the young adult to sort the ranking flashcards into order of importance and note the

order below, and then confirm that you have understood the ordering)

Bad things about your neighbourhood	**RANKING (1 = LEAST IMPORTANT 6 = MOST IMPORTANT)**
a) Crime	
b) Drugs	
c) Unemployment	
d) Teen pregnancy	
e) Lack of transport and communication networks	
f) Lack of services and facilities e.g. health care and shopping malls	

43. Are you a member of any religious group?

Response	**Code**	**Please tick one box only**
No	0	
Yes	1	

(If answered 'no' to Q43, do not ask Q44-46 but tick N/A, and move to Q47)

44. **IF YOU BELONG TO A RELIGIOUS GROUP**, do you go to church?

Response	**Code**	**Please tick one box only**
No	0	
Yes (please **specify** the suburb(s)/area(s) of the church you **usually** go to) ____	1	
N/A (do not belong to a religious group)	**98**	

45. **IF YOU BELONG TO A RELIGIOUS GROUP,** how often do you spend time with members of your religious group **outside** of religious service?

Response	**Code**	**Please tick one box only**
Never	0	
Less than once a week	1	
Once a week	2	
2-6 times a week	3	
Daily	4	
N/A (do not belong to a religious group)	**98**	

46. **IF YOU BELONG TO A RELIGIOUS GROUP,** could you or your caregiver depend on these people during a crisis e.g. close family member dies or is unwell?

Response	**Code**	**Please tick one box only**
No	0	

Yes	1	
N/A (do not belong to a religious group)	**98**	

47. Where do you spend most of your time outside of education/working hours?

Response	**Code**	**Please tick one box only**
Home neighbourhood (within 20 minutes' walk from your house)	1	
School/college/university neighbourhood (within 20 minutes' walk from your school/college/university)	2	
Work neighbourhood (within 20 minutes' walk from your place of work)	3	
Other (please **specify** province and suburb/area where spend most time) Province: ____ Suburb/area: _____________________________________	4	

Section C: About your educational institution

This section asks a number of questions about the education institution that you attend, if indeed you are still studying, even if it is on a part-time basis.

48. Are you still studying?

Response	**Code**	**Please tick one box only**
No	0	
Yes – part-time	1	
Yes – full-time	2	

(If answered 'no' to Q48, do not ask remaining questions in section C but tick N/A, and move to section D)

49. **IF YOU ARE STILL STUDYING,** are you at school, college or university and what is its name, province and suburb/area? If you are at **school,** what Grade are you in? If you are at **college/university**, what course(s) are you registered for, what is its duration in months, and what year of study are you currently in?

Response	Code	Please tick one box only	Please specify the following information for the appropriate category only
School	1		School name: ____________________ School province: ____________________ School suburb/area: ____________________ Present Grade: ____________________
College	2		College name: ____________________ College province: ____________________ College suburb/area: ____________________ Course(s) registered for: ____________________ Duration in months: ____________________ Year of study: ____________________
University	3		University name: ____________________ University province: ____________________ University suburb/area: ____________________ Course(s) registered for: ____________________ Duration in months: ____________________ Year of study: ____________________
N/A (not studying)	98		

(Please ask subsequent questions corresponding to the answer they gave to Q49, that is, whether they attend school/college/university as appropriate)

50. **IF YOU ARE STILL STUDYING,** do you attend school/college/university **within** the neighbourhood where you live, within 20 minutes' walk from your house?

Response	Code	Please tick one box only
No	0	
Yes	1	
N/A (not studying)	**98**	

51. **IF YOU ARE STILL STUDYING,** do you attend a government or a private school/college/university?

Response	Code	Please tick one box only
Government	0	
Private	1	
N/A (not studying)	**98**	

52. **IF YOU ARE STILL STUDYING,** is your school/college/university boys only, girls only or mixed?

Response	Code	Please tick one box only
Boys only	1	

Girls only	2	
Mixed	3	
N/A (not studying)	**98**	

53. **IF YOU ARE STILL STUDYING,** are **most** learners at your school/college/university:

Response	**Code**	**Please tick one box only**
Black	1	
Coloured	2	
Indian	3	
White	4	
Mix of people	5	
N/A (not studying)	**98**	

54. **IF YOU ARE STILL STUDYING,** how many learners are **usually** in your class? Approximately__________ learners ***(write 'N/A' if not studying)***

55. I am going to read out a list of facilities at schools/colleges/universities. **IF YOU ARE STILL STUDYING,** does your school/college/university have the following facilities? ***(please tick one box for each facility)***

Facility	**No [0]**	**Yes [1]**	**Don't know [2]**	**N/A [98] (not studying)**
a) Library				
b) Computer room				
c) Science lab				
d) Sports field				
e) Swimming pool				

56. **IF YOU ARE STILL STUDYING,** does your **school/college/university run** after-hours activities e.g. sports, music or drama clubs?

Response	**Code**	**Please tick one box only**
No	0	
Yes	1	
N/A (not studying)	**98**	

57. **IF YOU ARE STILL STUDYING,** is your school/college/university used for other purposes within the neighbourhood where it is located e.g. neighbourhood meetings, church, weddings, community garden etc?

Response	**Code**	**Please tick one box only**
No	0	
Yes (please **specify** what) ______________________________	1	
Don't know	2	
N/A (not studying)	**98**	

58. **IF YOU ARE STILL STUDYING,** how safe do you feel **inside** your school/college/university?

Response	**Code**	**Please tick one box only**
Very unsafe	1	
Unsafe	2	
Average	3	
Safe	4	
Very safe	5	
N/A (not studying)	**98**	

59. I am going to read out a list of potential problems in schools/colleges/universities. **IF YOU ARE STILL STUDYING,** in your opinion, does your school/college/university have problems with any of the following? ***(please tick one box for each problem)***

Problem	**Yes [0]**	**No [1]**	**N/A [98] (not studying)**
a) Poor academic standards			

b) Lack of resources			
c) Lack of discipline			
d) Overcrowding			
e) Lack of dedicated teachers			
f) Teachers who cannot teach well			
g) Bullying/teasing			
h) Bunking off			
i) Smoking			
j) Learners under the influence of alcohol during teaching hours			
k) Teachers under the influence of alcohol during teaching hours			
l) Drugs			
m) Weapons			
n) Violence			
o) Teenage pregnancy			
p) Rape			
q) Sexual relationships between learners and teachers			

The next couple of questions ask you to rank the good things and bad things about your school/college/university. These issues were mentioned as being important in schools during some group discussions we conducted with families who visit the Medical School Site. However, we would now like to find out what **you** see as being most and least important in **your** school/college/university.

60. Please put the following good things about your school/college/university in order of importance with 1 being the least important and 4 being the most important to you:
(please ask the young adult to sort the ranking flashcards into order of importance and note the order below, and then confirm that you have understood the ordering)

Good things about your school/college/university	**RANKING (1 = LEAST IMPORTANT 4 = MOST IMPORTANT)**	**N/A [98] (not studying)**
a) Disciplined learners		
b) Facilities		
c) Neighbourhood friendly e.g. hold neighbourhood meetings		
d) Good teachers and management		

61. Please put the following bad things about your school/college/university in order of importance with 1 being the least important and 7 being the most important to you:
(please ask the young adult to sort the ranking flashcards into order of importance and note the order below, and then confirm that you have understood the ordering)

Bad things about your school/college/university	RANKING (1 = LEAST IMPORTANT 7 = MOST IMPORTANT)	N/A [98] (not studying)
a) Drugs		
b) Bunking off		
c) Poor teaching		
d) Crime and safety		
e) Teen pregnancy		
f) Alcohol consumption		
g) Not enough schools/colleges/universities and resources		

Section D: About your place of work

This final section asks briefly about your employment status and place of work, if you are working, even if on a part-time basis.

62. Please state which of the following best describes your employment status:

Response	**Code**	**Please tick one box only**
Unemployed not looking for work	1	
Unemployed actively looking for work	2	
Housewife by choice	3	
Student	4	
Employed in informal/casual work **(please specify occupation, hours worked per week, province and suburb/area where work)** Occupation: ________________ Hours worked per week: ________________ Province: ________________ Suburb/area: ________________	5	
Employed in formal work **(please specify occupation, hours worked per week, province and suburb/area where work)** Occupation: ________________ Hours worked per week: ________________ Province: ________________ Suburb/area: ________________	6	
Other (please **specify**) ________________	7	

(If stated that not employed in Q62 (unemployed/housewife/student), do not ask Q63 but tick N/A, and please thank the participant for their time)

63. **IF YOU ARE EMPLOYED,** is your place of work:

Response	Code	Please tick one box only
Within your neighbourhood, that is, within 2km/20 minutes' walk from your house	1	
Outside your neighbourhood, that is, more than 2km/20 minutes' walk from your house	0	
N/A (not employed)	**98**	

The NEXT section we are going to talk about your household and access to facilities

Do you have no access, shared access or sole use of the following facilities: (please tick one box for each **facility**)

Facility	**No access [0]**	**Shared access [1]**	**Sole use [2]**
a) Indoor running hot and cold water			
b) Indoor running cold water only			
c) Outside tap only on property			
d) Water from other sources (please **specify**) ____________________			
e) Flush toilet inside the home			
f) Flush toilet outside the home			
g) Pit latrine			
h) Bucket system			
i) Other type of toilet (please **specify**) __________________			

64. Which of the following do you have in your household at the **present** time? (please tick one box for each **item**)

Item	**No [0]**	**Yes [1]**
a) Electricity		
b) Motor vehicle		
c) Fridge		
d) Microwave		
e) Washing machine		
f) Landline telephone		
g) Cell phone		
h) Television		
i) Radio		
j) Video machine/DVD		
k) MNet		
l) DSTV/Satellite		
m) Computer		
n) Internet access		

Do you have medical aid?

YES	**NO**

Is the Bt20 adolescent covered by this medical aid?

YES	**NO**

Food items	Description of food item	Tick for yes	Item code	Amount usually eaten (g)	Eaten every day	Eaten every week
					Times/day	Times/week
Tea	Ordinary					
	Herbal					
	Rooibos					
Sugar in tea						
Milk in tea	Full cream					
	Low fat 2%					
	Skim fat free					
	Other					
Coffee						
Milk in coffee	Full cream					
	Low fat 2%					
	Skim fat free					
	Other					
Sugar in coffee						
Milk as a drink	Full cream					
	Low fat 2%					
	Skim fat free					
Buttemilk/Maas	Buttermilk					
	Maas					
Milk drinks, flavoured						
Yoghurt	Flavoured					
	Plain					
Sugar						
Breakfast cereals						
Milk added to cereal						
Sugar added to cereal						
Ice cream	Full cream					
	Low sugar					
Ice lollies						
Bread/rolls	White					

Food items	**Description of food item**	**Tick for yes**	**Item code**	**Amount usually eaten (g)**	**Eaten every day**	**Eaten every week**
	Brown					
	Whole wheat					
	Traditional					
	Roti					
Spread? Y/N	Brand name					
Brick margarine						
Tub margarine						
Butter						
Cheese spread						
Fish paste						
Honey/syrup						
Jam						
Marmite/bovril						
Sandwich spread						
Peanut butter						
Chocolate spread						
Cold meats	Ham					
	Polony					
	Salami					
Cottage cheese	Low fat					
	Full fat					
Cheddar						
Gouda						
Other cheese						
Cheese wedges						
Fat cakes						
Quarter						
Maize porridge stiff						
Maize porridge soft						
Milk on soft porridge						
Sugar on soft porridge						

Food items	Description of food item	Tick for yes	Item code	Amount usually eaten (g)	Eaten every day	Eaten every week
Fat on soft porridge						
Mabele/maltabella stiff						
Mabele soft						
Milk on Mabele						
Sugar on Mabele						
Fat on Mabele						
Oats						
Milk on oats						
Sugar on oats						
Maize and pumpkin porridge						
Pasta/pasta dishes						
Spaghetti Bolognaise						
Macaroni and cheese						
Lasagne						
Rice	White					
	Brown					
	With fat?					
Samp/mealie rice	With fat?					
Wheat rice	With fat?					
Pizza	Vegetable topping					
	Meat topping					
	Meat and vegetables					
Savoury tart						
Eggs						
Boiled						
Fried						
Omelette						
Scrambled						
Fruits-orange						
Apples						
Bananas	Fresh					

Food items	Description of food item	Tick for yes	Item code	Amount usually eaten (g)	Eaten every day	Eaten every week
	Fried					
Berries	Fresh					
	Canned					
	Candied					
Figs/prickly pears and coconuts, dates	Fresh					
	Candied					
Fruit salad	Fresh					
	Canned juice					
	Canned syrup					
Grapes						
Guavas	Fresh					
	Canned juice					
	Canned syrup					
Mango	Fresh					
	Canned juice					
	Canned syrup					
Pawpaw	Fresh					
	Canned juice					
	Canned syrup					
Kiwi fruit						
Leechies						
Watermelons						
Sweet melon						
Naartjies	Mineola fresh					
	Naartjie fresh					
	Naartjie canned in syrup					
Oranges	Fresh					
Grapefruit	Fresh					
Peaches	Fresh					
	Canned juice					

Food items	Description of food item	Tick for yes	Item code	Amount usually eaten (g)	Eaten every day	Eaten every week
	Canned syrup					
Nectarines	Fresh					
Pears	Fresh					
	Canned juice					
	Canned syrup					
Pineapple	Fresh					
	Canned juice					
	Canned syrup					
Plums	Fresh					
Apricots						
Dried fruit						
Dry stewed fruit						
Raisins						
Fruit juice	Fresh					
	Sweetened					
	Unsweetened					
Canned fruits						
Soup, legumes, nuts						
Soups	Homemade					
	Commercial					
	Vegetable					
	Meat					
	Meat and vegetable					
	With bones					
Beans and lentils	Anything added					
Nuts						
Peanuts						
Fish and seafood						
Fried fish						
Fish cakes						
Fish fingers						

Food items	**Description of food item**	**Tick for yes**	**Item code**	**Amount usually eaten (g)**	**Eaten every day**	**Eaten every week**
Calamari						
Grilled/smoked/dried fish						
Haddock						
Pilchards and sardines	Canned water					
	Canned tomato sauce					
	Mayonnaise					
Tuna	In brine water					
	In oil					
	Mayonnaise					
Pickled fish						
Meat						
Roast beef						
Beef chops						
Beef steak (bone)						
Beef steak (no bone)						
Beef stir-fry						
Beef stew/carrots						
Beef stew/cabbage						
Beef patties						
Mince	Regular					
	Lean					
	With fat					
	With vegetables					
Meatballs						
Cottage pie						
Burgers	Homemade					
	Fried					
	Takeaway					
	Crumbed					
Hot dog						
Pita with…						

Food items	Description of food item	Tick for yes	Item code	Amount usually eaten (g)	Eaten every day	Eaten every week
Chicken burger	Crumbed					
	Not crumbed					
	Takeaway					
	Home made					
	Shop bought					
Chicken nuggets						
Chicken stew						
Fried chicken pieces	With skin					
	Without skin					
Roast chicken	With skin					
	Without skin					
Chicken stir-fry						
Chicken schnitzel						
Fat cake and mince						
Meat pies	Homemade					
	Commercial					
Samoosas	Meat					
	Vegetable					
Sausage rolls						
Spring rolls						
Mutton stew no veg						
Mutton stew with veg						
Mutton leg chop						
Mutton loin chop						
Roast mutton						
Spare ribs						
Pork chops						
Bacon						
Roast pork						
Pork sausages						
Viennas						

Food items	Description of food item	Tick for yes	Item code	Amount usually eaten (g)	Eaten every day	Eaten every week
Frankfurters						
Boerewors						
Traditional/organ meats						
Chicken livers						
Chicken organ meats						
Chicken head and feet						
Liver and fat						
Sheep interstine/lungs						
Pork shank						
Mopani worms						
Vegetarian products						
Dry sausages						
Biltong						
Vegetables						
Asparagus	Fresh					
	Canned					
	Fat added					
	Sugar added					
Avocado	Fresh					
Baby marrows	Fat added					
	Sugar added					
	Sauce					
Beetroot	Boiled					
Butternut/pumpkin	Fat added					
	Sugar added					
Broccoli	Fat added					
Cauliflower	Fat added					
Cabbage	Boiled					
	Fried					
Carrots	Boiled					
	Fat added					

Food items	**Description of food item**	**Tick for yes**	**Item code**	**Amount usually eaten (g)**	**Eaten every day**	**Eaten every week**
	Sugar added					
Gem squash	Boiled					
	Sugar added					
	Sauce					
Green beans	Fat added					
	Sugar added					
	With onions					
	With potato					
	Sauce					
Mealies	Fat added					
	Creamed					
Mixed vegetables	Frozen					
	Fat added					
	Sugar added					
	Sauce					
Mushrooms	Fat added					
	Sauce					
Peas	Fat added					
	Sauce					
Potatoes	Boiled					
	Roasted					
	Baked					
	Mash with fat					
Potato salad						
Potato chips	Homemade					
	Fried oil					
	Oven baked					
	Takeaway					
	Mayonnaise					
	Tomato sauce					
Salad vegetables	Mayonnaise					

Food items	**Description of food item**	**Tick for yes**	**Item code**	**Amount usually eaten (g)**	**Eaten every day**	**Eaten every week**
	Dressing					
Cucumber						
Peppers						
Spinach/Morogo	Fat added					
	Sauce added					
	With onions					
	With potatoes					
Sweet potatoes	Fat added					
	Sugar added					
Tomatoes	Raw					
	Cooked					
	With onion					
	Fat added					
Fats						
Tub margarine	Where used					
	number of spoons					
	Number in family					
Butter						
Brick margarine						
White margarine						
Cream and substitutes						
Oils	Where used					
	Number of spoons					
	Number in family					
Salad dressings	Homemade					
	Shop bought					
Mayonnaise	Where used					
	Number of spoons					
	Number in family					
Biscuits, cake and pudding						
Biscuits/cookies	Homemade					

Food items	Description of food item	Tick for yes	Item code	Amount usually eaten (g)	Eaten every day	Eaten every week
	Shop bought					
Biscuits/savoury						
Special buns						
Muffins						
Scones						
Tart						
Cake	Iced/cream					
	Plain					
Doughnuts	Plain					
	Filled					
Eclairs						
Koeksisters						
Pancakes/crumpets	Spread					
	Syrup					
	Ice-cream					
Waffles	Spread					
	Syrup					
	Ice-cream					
Trifle						
Baked pudding						
Instand pudding						
Custard						
Rusks						
Special breads						
Snacks, sweets and cold drinks						
Carbonated cold drinks						
Diet cold drinks						
Mageu						
Cold drinks						
Energy drinks						
Squashes						

Food items	**Description of food item**	**Tick for yes**	**Item code**	**Amount usually eaten (g)**	**Eaten every day**	**Eaten every week**
Crisps						
Popcorn						
Sweets						
Lollipops						
Chocolates						
Sauces and condiments						
Cheese sauce	Full cream milk					
	Butter					
	Margarine					
White sauce	Full cream milk					
	Butter					
	Margarine					
Chakalaka						
Atjar						
Tomato sauce and other						
Chutney						
Alcoholic drinks						
Beer						
Cider						
Wine						
Champagne						
Spirits						
Liqueurs and fortified wine						

Assumptions

Meat and meat products:

Chicken:

Chicken in batter e.g. KFC (3018)

Wing, thigh, drumstick, neck = coded as dark meat (3025 - moist, 3027 – dry/roast)

Breast = coded as white meat

Code 10% of weight of chicken piece as skin (4201 – moist, 4300 – dry/roast)

e.g. chicken drumstick with skin = 40 g

code 4 g as chicken, skin and 36 g as chicken, dark meat

The codes for chicken, meat and skin (2926, 2925) and chicken, meat only (2963, 2950) are mostly used in stews etc. as these codes are a combination of dark and white meat.

Fried, roasted, grilled = cooked – dry

Boiled = cooked – moist

Chicken fried in oil = add about 5 g sunflower oil (3507) depending on the size of the chicken portion (wing ± 2 g oil and breast ± 5 g oil)

If also rolled in flour, code 3 g – 5 g cake flour (3273)

Chicken ribs 40 g: 50% 3018 and 50% 2997 (usually KFC)

4375 Chicken (with skin) curry

Chicken meat skin, curry sauce incl oil, potato

4380 Chicken (without skin) curry

3014 Chicken giblets, curried

2926 Chicken, meat and skin, frozen, boiled [used in stew/pies both dark, white and skin)

4292 Chicken, meat and skin, frozen, raw [used in stew/pies both dark, white and skin)

2925 Chicken, meat and skin, frozen, roasted [used in stew/pies both dark, white and skin)

2963 Chicken, meat only, frozen boiled [white and dark meat, no skin]

2950 Chicken, meat only, frozen roasted [white and dark meat, no skin]

2985 Chicken (with skin), stew, tomato and onion

4379 Chicken (without skin), stew, tomato and onion

3005 Chicken (with skin), stew, with vegetables

4378 Chicken (without skin), stew, with vegetables

2954 Chicken pie (commercial)

2970 Chicken livers (55%) + 3925 tomato and onion stew (45%)

Beef:

Use the code for beef, chuck (2945) in stews etc.

Beef chop use code for beef, loin (2946)

Steak can be 2946 or rump (2943) – dry cooked / also for sliced roast beef

Regular beef mince = beef, brisket (4363)

Lean beef mince = beef, topside (2921)

Bully beef = corned beef, canned (2940)

For beef steak: I would suggest beef, loin, cooked - dry (2946) or beef, rump, cooked - dry (2943). They both have a higher fat content than beef fillet.

2987 Beef, mince (lean), savoury (tomato, onion)

75 g 2921 Beef, topside/lean mince, cooked, moist

25 g 3910 tomato and onion, stewed (with sugar)

3006 Beef, stew with cabbage

3120 Beef, stew with vegetables

3009 Cottage pie

2953 Cornish pie (commercial)

2957 Steak and kidney pie, commercial

2939 Sausage roll (beef)

2979 Steak and kidney stew

Biltong assume 50 g if no amount recorded

Mutton:

Use the code for mutton, shoulder (2974) in stews etc.

Mutton chops = mutton, loin, grilled, chop (2927)

3039 Mutton curry (shoulder, sauce, potatoes)

3040 Mutton stew with green beans

2916 Mutton stew with vegetables

Pies:

Sometimes people report having had a **steak pie**. We only have a code for steak and kidney pie. The code for steak and kidney pie cannot be used for a steak pie.

Steak pie was coded as follows:

Assume steak pie = ±150 g:

Steak (2943) = 35 g (23%)

Gravy (3119) = 23 g (15%)

Flaky pastry (3306) = 33 g (22%) (top of pie)

Short pastry (4413) = 60 g (40%) (bottom of pie)

2953 Cornish pie/pasty

Other meat:

Chicken Vienna is coded as Vienna (2936)

3003 Offal, cooked (tripe, brawn, brain, tongue)

4377 Offal, curried

Polony = 5 g (assume all portions are 5 g)

4345 white liver (on fat cakes) / pork liver

Fish:

Tuna (70%)

Mayonnaise (20%)

Onion (10%)

Cereals:

The following assumptions were made for **maize meal porridge:**

Crumbly maize porridge

Small bowl = 200 ml = 112 g (if maas was added = ± 150 ml)

Medium bowl = 250 ml = 140 g (if maas was added = ± 200 ml)

Large bowl = 350 ml = 196 g (if maas was added = ± 250 ml)

If porridge was reported in ladles: 1 h LS = 75 g

Soft maize porridge

Small bowl = 200 g

Medium bowl = 250 g

Large bowl = 350 g

If porridge was reported in ladles: 1 h LS = 120 g

Stiff maize porridge

Small bowl = 200 g

Medium bowl = 250 g

Large bowl = 350 g

If porridge was reported in ladles: 1 h LS = 120 g

Maize meal **instant** porridge was coded as maize meal, soft porridge

3402 Samp and Beans (has its own code)

Oat so Easy:

Code ± 125 g oats, cooked (3239) + 10 g sugar (3989) + 10 g creamer, non-dairy (2751)

Cornflakes in small bowl = 30 g flakes (2 h LS) + ± 180 g milk

Cornflakes in large bowl = 45 g flakes (3 h LS) + ± 220 g milk

2 minute noodles:

Code ± 198 g pasta, cooked (3262) + 6 g soup, powder average (3158)

Chocolate muffin – use code for chocolate cake (3289)

Carrot muffin – use code for carrot cake (3392)

Banana muffin – use code for banana loaf (3333)

Cupcake – use code for cake butter, plain (WM, HM) (3288). There is a weight for a cup cake (20 g)

Bread:

Albany bread slice = 40 g (white and brown)

Sasko and Blue Ribbon = 150 g (3 – 4 slices)

One loaf of bread is usually 700 g.

Bread home-made/Potbread = coded as white bread. One slice is usually 52 g.

Pretzels are coded as cream crackers.

If doughnuts or "koeksisters" were sprinkled with coconut, code 2 g coconut (3462).

Pizza (note FCT has only a cheese and tomato pizza code) so add 10 g of meat or vegetable as appropriate

<u>Milk and Milk Products:</u>

Cheese slices are coded as processed cheese (2728)

1 packet = 200 g and contains 12 slices, so 1 slice = 17 g

Fiesta, Cabana, Tropika – coded as dairy – fruit juice mix (2791)

SteriStumpie (350 ml) can be coded as 2% milk (2772) + 2 h tsp Nesquick (2830).

Custard (2724) 125 ml portion

Trifle: 2716 custard (25%)
3481 cream (25%)
4006 jelly and fruit (50%)

<u>Eggs:</u>

We only have codes for scrambled eggs with milk. Sometimes people scramble egg only in sunflower, they do not add milk.

Then code egg, boiled, poached (2867) and code 2 g sunflower oil per one large egg.

<u>Fats and Oils:</u>

Sunflower oil (3507)

<u>Vegetables:</u>

One medium potato cooked = 70 g.

1 h LS potato cooked = 105 g.

Tomato and onion, stewed (with sugar) (3910) mostly used. Remember to code sunflower oil as onion will be fried.

Tomato, onion and green pepper (3865) → Tsp = 35 g Ssp = 75 g

Use weight of spinach, boiled (3761 or 3913) for weights of indigenous leaves.

3776 Average, carotene-rich vegetables boiled (pumpkin, squash, spinach, squash, carrot)

3781 Average, other vegetables, boiled (peas, beetroot, onion, green beans, brinjal, parsnip, turnip, taro, marrow, waterblommetjies)

3803 Brinjal, dipped in egg, fried in sun oil

3800 Brinjal, fried in HM

3802 Brinjal, fried in sun oil

3796 Brinjal, green pepper, tomato, onion, cooked HM

3798 Brinjal, green pepper, tomato, onion, cooked sun oil

3805 Broccoli, boiled with HM

3808 Brussels sprouts, boiled with HM

3813 Cabbage, cooked with potato HM

3815 Cabbage, cooked with potato sun oil

3810 Cabbage, sauteed HM

3812 Cabbage, sautéed sun oil

3816 Carrot, boiled with HM

3817 Carrot, boiled sun oil

3818 Carrot, boiled sugar

3819 Carrot candied with HM

3820 Carrot candied with PUM

3822 Carrot cooked with potato, onion HM

3824 Carrot cooked with potato, onion sun oil

3934 Carrot cooked with potato, onion no shortening

3825 Cauliflower, boiled HM

3826 Cauliflower, boiled PUM

3788 Green beans boiled HM

3789 Green beans boiled PUM

3792 Green beans cooked with potato, onion and HM

3794 Green beans cooked with potato, onion and sun oil

3933 Green beans cooked with potato, onion no shortening

3835 Mixed vegetables (carrot, corn, peas, beans etc) with HM

3836 Mixed vegetables (carrot, corn, peas, beans etc) with PUM

4264 Mixed vegetables, canned (carrot, potato, peas, beans)

3727 Mixed vegetables, frozen, boiled (carrots peas, mealie, green beans)

4265 Mixed vegetables, frozen, boiled (cauliflower, carrots green beans, broccoli)

4269 Mixed vegetables, stir-fry, frozen in sun oil (baby marrow, carrot etc)

3839 Mushrooms, sautéed HM

3841 Mushrooms, sautéed sun oil

3940 Okra sun oil (bhindi curry → okra, onion, tom, yoghurt, garlic)

3844 Onion, sautéed HM

3730 Onion, sautéed sun oil

3849 Parsnip boiled HM

3851 Parsnip boiled sun oil

3856 Peas, frozen, boiled, HM

3720 Peas, frozen boiled, sugar

3859 Peas, frozen, boiled, sugar HM

3865 Pepper, sweet, green, cooked, tomato onion sun oil

3867 Potato (without skin), boiled HM

3868 Potato (without skin), boiled PUM

3875 Potato, mashed (SM, PUM)

3876 Potato, mashed (WM, HM)

3878 Potato roasted in beef fat

3923 Potato roasted in chicken fat

3735 Potato roasted in lamb fat

3956 Potato roasted in pork fat

3979 Potato roasted in sun oil

3871 Potato sautéed in HM

3873 Potato sautéed in sun oil

3699 Salad: Beetroot salad (sugar, vinegar)

Beetroot salad (mayonnaise, onion)

3705 Salad: Coleslaw

3921 Salad: French (lettuce, tomato, cucumber, onion, no dressing)

4271 Salad: Greek (lettuce, tomato, cucumber, olive, feta, no dressing)

3926 Salad: Mixed fresh vegetables (carrot, tomato, lettuce, apple, onion, no dressing)

3927 Salad: Green (lettuce, cabbage, cucumber, apple, celery, pepper, onion, no dressing)

3928 Salad: Potato (mayonnaise, egg)

4272 Salad: Sambal (tomato, onion)

3898 Spinach (Swiss Chard), boiled HM

3899 Spinach (Swiss Chard), boiled PUM

3901 Spinach (Swiss Chard) cooked with potato, onion HM

3786 Spinach (Swiss Chard) cooked with potato, onion sun oil

3728 Squash, butternut boiled with sugar

4273 Squash, butternut boiled with sugar and HM

3754 Squash, gem, boiled, with sugar

4274 Squash hubbard, candied with HM

3885 Squash, marrow, candied with HM

3749 Sweet potato (white fleshed), candied HM

3925 Tomato and onion stewed (no sugar, no fat)

3910 Tomato and onion stew (sugar, no fat)

3908 Tomato fried HM

3767 Tomato fried sun oil

3791 Vegetable curry (mixed veg, tom, onion, sun oil)

Creamed vegetables → 70% vegetable

30% white/cheese sauce

Salad with salad dressing → e.g. potato salad, coleslaw etc

75% vegetable

25% salad dressing/fruit

Salad, serving spoon (mixed leaves/vegetables) average = 43 g

Commercial fries:

Steers:

Small = 158 g

Medium = 209 g

Large = 465 g

KFC:

Regular = 130 g

Large = 154 g

Tomato sauce sachet = 8 g

<u>Fruit:</u>

Nectarine (4228) no weights in Quantities Manual – use weight of peaches.

Prune (4230) no weights in Quantities Manual – coded 50 g for a medium prune. Compare measurements of plum (3570).

Sugars, sweets etc.

Bashew, Double O, Jive = coded as cold drink carbonated (3981)

Lucozade contains more kJ and CHO than Energade/Game/Powerade. We have a code for Lucozade (4007). When coding Energade/Game/Powerade, use the code for Lucozade, but code about half the amount. E.g. instead of 500 ml, code 250 ml.

Drink O' Pop/Eleven-in-One coded as cold drink, squash, diluted (3982)

Tang coded as cold drink, Clifton (4027)

Halls Vitamin C sweet coded as Super C (4022)

Smoothies = 5 g each (3986)

Fast food:

QUARTER/Kota		
White bread	3210	¼ loaf = 225 g
Fried Chips	3740	1 portion = 90 g
Cheese	2722	___ slices x 20 g =
Polony / French	2919	___ slices x 15 g =
Vienna (Russian)	2936	___ unit x 40 g =
Fried egg	2869	___ medium x 45 g =
Atchar	3117	___ Tsp x 40 g =
Tomato sauce	3139	___Tsp x 25 g =

Recipes to create once we have foodfinder3 working:

Chakalaka

Lunch bar medium (standard) 46 g or man size (large) 52 g

Peanuts: handful small = 15 g

Medium = 30 g

Large = 45g

LFM	low fat milk
WM	Whole milk **(full cream milk)**
SM	Skimmed milk
HM	Hard margarine (brick)
PUM	Poly unsaturated margarine (tub)
Sun oil	Sunflower oil **(fish oil)**
tsp	Teaspoon
Tsp	Tablespoon
Spn	Serving spoon
l	Level
H	Heaped

Exploration of the potential to develop obesity prevention interventions for adolescents through religious institutions

1. Sex

1. ☐ Male
2. ☐ Female

2. Age

1. ☐ Under 20 years old
2. ☐ 20-29 years old
3. ☐ 30-39 years old
4. ☐ 40-49 years old
5. ☐ 50-59 years old
6. ☐ Above 60 years old

3. What is your level of education?

1. ☐ Never went to school
2. ☐ Some Primary school
3. ☐ Primary school completed
4. ☐ Some secondary school
5. ☐ Secondary school completed
6. ☐ Some High school
7. ☐ High school completed
8. ☐ More than high school

4. What is your marital status?

1. ☐ Single
2. ☐ Married
3. ☐ Widow
4. ☐ Divorced
5. ☐ Cohabiting

5. What is your role in this Church?

1. ☐ Pastor
2. ☐ Teacher
3. ☐ Elder
4. ☐ Health professional
5. ☐ Youth worker
6. ☐ Other

If other, specify________________________

6. How long have you been associated with this Church?

1. ☐ Less than 1 year
2. ☐ 1-5 years
3. ☐ 5-10 years
4. ☐ More than 10 years

In many questions in this survey I am going to ask you to respond to questions in relation to a scale. The scale will be from one to ten and you will need to respond according to how much you agree with that particular question.

<u>For example</u>, a question might ask: How much do you like Bunny Chow? You will need to respond on the scale from one to ten. If you very much like Bunny Chow, then you would respond "10". But if you don't like Bunny Chow at all you would respond with a "1". If you like it a little bit then you would respond with a "3" or if you somewhat like it then you would respond with "5" or "6" and if you like it you would respond "7" or "8".

1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐

Not at all — Somewhat — Very much

7. How much of a concern is overweight or obesity in adolescents in your congregation? (with 1 being "not at all" and 10 being "a very great concern")?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Not at all — Somewhat of a concern — A very great concern

8a. Please list the programmes that are available in your congregation to address overweight or obesity?

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________

/!\ If no programmes are available, move to question 16 /!

8b. Are any of the programmes you listed in question 8a for adolescents?

1. ☐ Yes
2. ☐ No

9. Do these programmes you listed in question 8a serve people outside the congregation?

1. ☐ Yes
2. ☐ No

10. For how many years has your congregation provided overweight or obesity prevention programmes for adolescents?

1. ☐ Less than one year
2. ☐ 1-3 years
3. ☐ 4-10 years
4. ☐ More than 10 years

11a. How many adolescents from your congregation participate in these programmes that focus on overweight or obesity?

1. ☐ Less than 10
2. ☐ 10-20
3. ☐ 20-30
4. ☐ More than 30

11b. How many adolescents from outside your congregation participate in these programmes that focus on overweight or obesity?

1. ☐ Less than 10
2. ☐ 10-20
3. ☐ 20-30
4. ☐ More than 30

12. List 3 good points of these programmes that focus on preventing overweight or obesity among adolescents:

1. ____________________
2. ____________________
3. ____________________

13. List 3 weak points of these programmes that focus on preventing overweight or obesity among adolescents:

1. ____________________
2. ____________________

3. ____

14. Do you think these programmes that teach about overweight or obesity have influenced adolescent behaviours?

1. ☐ Yes 2. ☐ No 3. ☐ Don't know

15. Do adolescents in your congregation know about these programmes that teach about overweight or obesity? (tick one box below)

1. ☐ No adolescents know about them
2. ☐ Not very many adolescents know about them
3. ☐ Some adolescents know about them
4. ☐ Most adolescents know about them
5. ☐ All adolescents know about them
6. ☐ Don't know

16. How much of a concern is <u>adults'</u> overweight or obesity to the leadership in your congregation (tick one box, with 1 being "not at all" and 10 being "of a great concern")?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Not at all Somewhat of a concern A very great concern

17. How much of a concern is <u>adolescents'</u> overweight or obesity to the leadership in your congregation (tick one box, with 1 being "not at all" and 10 being "of a great concern")?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Not at all Somewhat of a concern A very great concern

18. Are leaders involved in programmes regarding adolescents' overweight or obesity?

1. ☐ Yes 2. ☐ No

If yes, please explain____

19. Would the leadership support additional programmes in adolescent health?

1. ☐ Yes 2. ☐ No

If yes, please explain____

<u>/!\ If your congregation has any programmes that address overweight or obesity please refer to question 20 and 21, if not, then go to question 22 /!\</u>

20. List 1 to 3 ways that the congregation supports the programmes to address overweight or obesity among adolescents (we only want to know about existing programmes)

1. ____
2. ____
3. ____

21. List some of the barriers to programmes addressing adolescent overweight or obesity in your congregation:

1. ____
2. ____
3. ____

22. Do you think overweight or obesity is a problem for adolescents?

1. ☐ Not at all 2. ☐ Somewhat 3. ☐ Very much

23. Do other people in your congregation think overweight or obesity is a problem for adolescents

1. ☐ Not at all 2. ☐ Somewhat 3. ☐ Very much 4. ☐ Don't know

24. Do religious leaders know a lot about overweight or obesity?

1. ☐ Not at all 2. ☐ Somewhat 3. ☐ Very much

25. List 1 to 3 types of information that are available in your congregation regarding overweight or obesity:

1. ______________________________
2. ______________________________
3. ______________________________

26. Is any of this information for adolescents?

1. ☐ Yes 2. ☐ No

27. List 1 to 3 types of local sources of information on overweight or obesity in your congregation?

1. ______________________________
2. ______________________________
3. ______________________________

28. Is any of this information for adolescents?

1. ☐ Yes 2. ☐ No

29. List 1 to 3 ways people obtain information about overweight or obesity problems in your congregation

1. ______________________________
2. ______________________________
3. ______________________________

30. Is any of this information for adolescents?

1. ☐ Yes 2. ☐ No

31. List 1 to 3 people to whom in your Church an overweight or obese adolescent would turn to first for help?

1. ______________________________
2. ______________________________
3. ______________________________

32. Why do you think they would turn to these people?

1. ______________________________
2. ______________________________
3. ______________________________

33a.What is the congregation's attitude about people volunteering time to address obesity

1. ☐ Supportive
2. ☐ Somewhat supportive
3. ☐ Not supportive
4. ☐ Don't know

33b. What is the congregation's attitude about people making financial donations

1. ☐ Supportive
2. ☐ Somewhat supportive
3. ☐ Not supportive
4. ☐ Don't know

33c. What is the congregation's attitude about people providing space

1. ☐ Supportive
2. ☐ Somewhat supportive
3. ☐ Not supportive
4. ☐ Don't know

34. List up to 3 proposed programmes/action plans that have been submitted for funding that address overweight or obesity in your Church?

1. ____
2. ____
3. ____

35. Do you know if there is any evaluation of programmes that are in place to address overweight or obesity?

1. ☐ Yes
2. ☐ No
3. ☐ Don't know

<u>/!\ If no or don't know, then the survey is finished /!\</u>

36. If yes, how effective is the evaluation of these programmes (with 1 being "not at all" and 10 being "very good?")

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Not at all ☹ Average 😐 Very good ☺

37. Are the evaluation results being used to make changes in programmes, activities, or policies or to start new ones?

1. ☐ Yes
2. ☐ No

If yes, please explain____

Thank you very much for completing this survey

Rating	Dimension A- Existing community efforts	Dimension B- Community knowledge of the efforts	Dimension C- Community Leadership	Dimension D- Community Climate	Dimension E- Community knowledge about the issue	Dimension F- Community resources
1. No awareness	No awareness of the need for efforts to address the issue	Community has no knowledge of the need for efforts addressing the issue	Leadership has no recognition of the issue	The prevailing attitude is that it's not considered, unnoticed or overlooked within the community "It's just not our concern"	Not viewed as an issue	There is no awareness of the need for resources to deal with this issue
2. Denial	No efforts addressing the issue	Community has no knowledge about efforts addressing the issue	Leadership believes that this is not an issue in their community	The prevailing attitude is "There's nothing we can do", or "Only those people do that", or "We don't think it should change"	No knowledge about the issue	There are no resources available for dealing with the issue
3. Vague awareness	A few individuals recognize the need to initiate some type of effort, but there is no immediate motivaton to do anything	A few members of the community have heard about efforts, but the extent of their knowledge is limited	Leader (s) recognize (s) the need to do something regarding the issue	Community climate is neutral, disinterested, or believes that the issue does not affect the community as a whole	A few in the community have some knowledge about the issue	The community is not sure what it would take, (or where the resources would come from) to initiate efforts
4. Preplanning	Some community members have met and have begun a discussion of developing community efforts	Some members of the community know about local efforts	Leader (s) is/are trying to get something started	The attitude in the community is now beginning to reflect interest in the issue. "We have to do something, but we don't know what to do"	Some community members recognize the signs and symptoms of this issue, but information is lacking	The community has individuals, organizations, and/or space available that could be used as resources.
5. Buy-in Direct Impact Planning	Efforts (programs/activities) are being planned	Members of the community have basic knowledge about local efforts (e.g. purpose)	Leaders are part of a committee or group that addresses this issue	The attitude in the community is "we are concerned about this", and community members are beginning to reflect modest support of efforts	Community members know that the signs and symptoms of this issue occur locally, and general information is available	Some members of the community are looking into the available resources

Rating	Dimension A-Existing community efforts	Dimension B-Community knowledge of the efforts	Dimension C-Community Leadership	Dimension D-Community Climate	Dimension E-Community knowledge about the issue	Dimension F-Community resources
6. Initiation of work	Efforts (programs/ activities) are being implemented	An increasing number of community members have knowledge of local efforts and are trying to increase the knowledge of the general community about these efforts	Leaders are active and supportive of the implementation of efforts	The attitude in the community is "This is our responsibility" and is now beginning to reflect modest involvement in efforts.	A majority of community members know the signs and symptoms of the issue and that it occurs locally, and local data are available	Resources have been obtained and/or allocated for this issue
7. Stabilization Positive outcomes	Efforts (programs/ activities) have been running for several years	There is evidence that the community has specific knowledge of local efforts including contact persons, training of staff, clients involved etc.	Leaders are supportive of continuing basic efforts and are considering resources available for self-sufficiency	The majority of the community generally supports programs, activities, or policies. "We have taken responsibilities"	Community members have knowledge of, and access to, detailed information about local prevalence	A considerable part of support of on-going efforts are from local sources that are expected to provide continuous support. Community members and leaders are beginning to look at continuing efforts by accessing additional resources
8. Confirmation And expansion	Several different programs, activities and policies are in place, covering different age groups and reaching a wide range of people. New efforts are being developed based on evaluation data.	There is considerable community knowledge about different community efforts, as well as the level of program effectiveness	Leaders are supportive of expanding/improving efforts through active participation in the expansion/improvement	Some community members of groups may challenge specific programs, but the community in general is strongly supportive of the need for efforts. Participation level is high. "We need to keep up on this issue and make sure what we are doing is effective".	Community members have knowledge about prevalence, causes, risk factors, and consequences	Diversified resources and funds are secured and efforts are expected to be ongoing. There is additional support for further efforts.

Rating	Dimension A- Existing community efforts	Dimension B- Community knowledge of the efforts	Dimension C- Community Leadership	Dimension D- Community Climate	Dimension E- Community knowledge about the issue	Dimension F- Community resources
9. Professionalization	Evaluation plans are routinely used to test effectiveness of many different efforts, and the results are being used to make changes and improvements.	Community has knowledge of program evaluation data on how well the different local efforts are working and their benefits and limitations	Leaders are continually reviewing evaluation results of the efforts and are modifying support accordingly	All major segments of the community are highly supportive, and community members are actively involved in evaluating and improving efforts and demand accountability	Community members have detailed information about the issue as well as information about the effectiveness of local programs	There is continuous and secure support for programs and activities, evaluation is routinely expected and completed, and there are substantial resources for trying new efforts.

	Boys (17-17.99 years)		Girls (17.17.99 years)	
	mean/median	**SD/IQR**	**mean/median**	**SD/IQR**
	n=339		**n=431**	
Weight (kg)	57.40	53-62.9	56.8	50-64.8
Height (cm)	170.81	6.39	159.78	6.2
BMI (kg/m²)	19.55	18.33-21.14	22.11	19.85-25.26
	n=337		**n=423**	
Waist circumference (cm)	70.50	67.5-74.3	73.00	67.5-80.2
Waist-to-height ratio	0.41	0.40-0.43	0.46	0.42-0.50
	n=299		**n=390**	
Percent fat (%)	12.35	10.1-15.4	33.12	28.6-38.8
	Boys (18-18.99 years)		**Girls (18-18.99 years)**	
	mean/median	**SD/IQR**	**mean/median**	**SD/IQR**
	n=542		**n=527**	
Weight (kg)	58.40	53.8-65.6	55.80	50.2-63.8
Height (cm)	171.62	6.93	159.72	6.46
BMI (kg/m²)	19.94	18.50-21.75	21.87	19.76-24.91
	n=506		**n=505**	
Waist circumference (cm)	72.00	68.80-76.20	73.5	68.3-80.5
Waist-to-height ratio	0.42	0.40-0.44	0.46	0.43-0.50
	n=466		**n=433**	
Percent fat (%)	11.60	9.76-15.21	32.42	27.33-37.80
	Boys (19-19.99 years)		**Girls (19-19.99 years)**	
	mean/median	**SD/IQR**	**mean/median**	**SD/IQR**
	n=93		**n=87**	
Weight (kg)	62.8	55.4-72.0	58.2	53.2-67.8
Height (cm)	172.96	8.53	161.18	7.05
BMI (kg/m²)	20.91	19.43-23.56	22.41	20.37-26.03
	n=90		**n=84**	
Waist circumference (cm)	72.4	68.6-78.4	70.5	64.8-78.5
Waist-to-height ratio	0.42	0.39-0.45	0.44	0.40-0.49
	n=74		**n=66**	
Percent fat (%)	12.59	10.70-16.25	32.6	27.88-37.28

Table 1: Odds ratios and 95% CI for overweight from the adjusted logistic regression analysis in 18 year old females

	n	Step 0 Adjusted odds ratios (SE) [a]	Step 1 Adjusted odds ratios (SE) [a]
Intrinsic factors			
Age of entry into menarche (Ref [b] 9-13)	123		
13-17	148	0.56 (0.15)*	0.56 (0.15)*
Diet			
z-score of energy intake	271		0.68 (0.11)*

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

Table 2: Overweight logistic regression model parameters in females

Parameter	Model 1	Model 2
Deviance	335.24	329.59
Model significance (p value)	0.026	0.005
Cox and Snell R square	0.018	0.038
Nagelkerke R square	0.025	0.054
Correctly classified cases	67.9%	67.5%
Hosmer and Lemeshow p-value	_	0.40

Table 3: Odds ratios and 95% CI for thinness from the adjusted logistic regression analysis in 18 year old females

	n	Step 0 Adjusted odds ratios (SE) [a]	Step 1 Adjusted odds ratios (SE) [a]	Step 2 Adjusted odds ratios (SE) [a]	Step 3 Adjusted odds ratios (SE) [a]
			Intrinsic factors		
Ethnicity (Ref [b] blacks)	135				
White	_	_	_	_	_
Mixed Ancestry	36	2.39 (1.03)*	2.66 (1.24)*	2.29 (1.10)†	1.76 (0.87)
			Neighbourhood socio-economic factors		
Place of residence (Ref [b] Soweto)	145				
Johannesburg	26		0.69 (0.41)	0.62 (0.37)	0.61 (0.36)
			Household socio-economic factors		
Household SES index (Ref [b] 3rd tertile (wealthy))	54				
1st tertile	63			0.65 (0.34)	0.77 (0.42)
2nd tertile	54			1.20 (0.57)	1.36 (0.66)
			Diet		
zscore of energy intake	171				0.55 (0.15)*

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

Table 4: Thinness logistic regression model parameters in females

Parameter	Model 1	Model 2	Model 3	Model 4
Deviance	161.02	160.60	159.15	153.69
Model significance (p value)	0.05	0.12	0.22	0.048
Cox and Snell R square	0.022	0.025	0.033	0.063
Nagelkerke R square	0.036	0.040	0.053	0.102
Correctly classified cases	81.3%	81.3%	81.3%	80.7%
Hosmer and Lemeshow p-value	_	0.64	0.26	0.32

Table 5: Odds ratios and 95% CI for high percent fat from the adjusted logistic regression analysis in 18 year old females

	n	Step 0 adjusted odds ratios (SE) [a]	Step 1 adjusted odds ratios (SE) [a]	Step 2 adjusted odds ratios (SE) [a]
Individual factors				
Height	235	0.94 (0.02)**	0.94 (0.02)**	0.94 (0.02)*
Age of entry into menarchy (Ref [b] 9-13)	101			
13-17	134	0.66 (0.20)	0.63 (0.19)	0.60 (0.19)
Neighbourhood socio-economic factors				
Neighbourhood social support index (Ref b 3rd tertile (favourable))	82			
1st tertile	83		0.94 (0.35)	0.98 (0.37)
2nd tertile	70		2.03 (0.74)†	2.20 (0.82)*
Diet				
zscore of energy intake	235			0.61 (0.12)*

*p<0.05; **p<0.01; ***p<0.001, † p<0.1

Table 6: High percent fat logistic regression model parameters in females

Parameter	Model 1	Model 2	Model 3
Deviance	274.08	268.69	261.96
Model significance (p value)	0.005	0.003	<0.001
Cox and Snell R square	0.043	0.065	0.092
Nagelkerke R square	0.062	0.093	0.13
Correctly classified cases	71.5%	71.9%	71.0%
Hosmer and Lemeshow p-value	0.18	0.26	0.40