THE INFLUENCE OF TYPE OF RESIDENCE AND HABITUAL ACTIVITY ON LUNG FUNCTION AND BODY COMPOSITION IN CHILDREN

by

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A Thesis

Submitted for the Degree of Master of Science

to the

Department of Human Sciences

Loughborough University of Technology

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ACKNOWLEDGMENTS

I am indebted to the Directors of Education and Headmasters who permitted the use of school facilities and promoted child participation in this study.

The value of the sabbatical term granted by the City of Coventry Education Department was fully appreciated.

I gratefully acknowledge the advice and assistance generously given by my supervisor Dr P. R. M. Jones, which gave additional incentive to the investigation. I also extend my gratitude to Mr Ian Galer for his help in the analyses of questionnaires.

I would like to thank my many colleagues for their interest and encouragement and finally my husband for his continued forbearance.

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INTRODUCTION

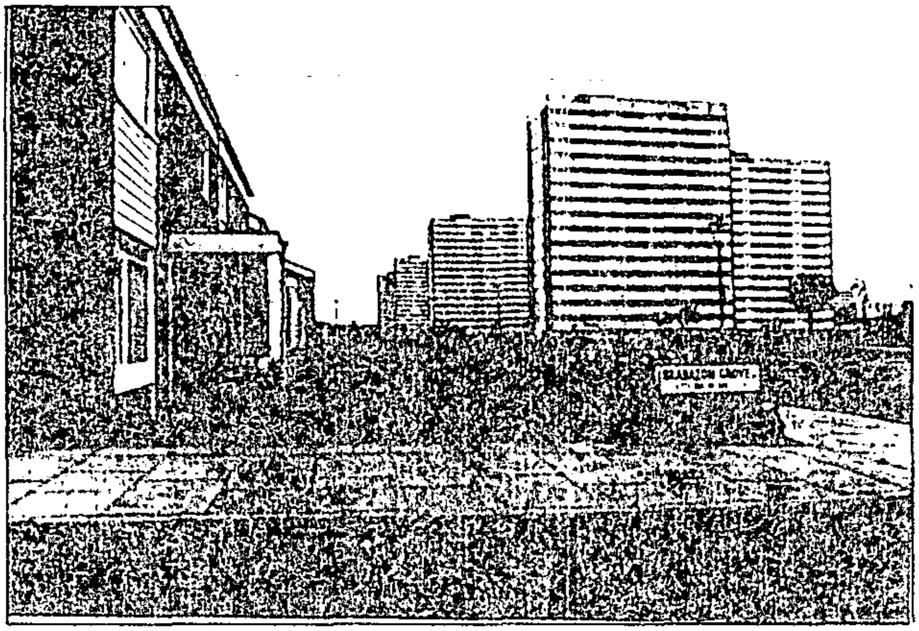
INTRODUCTION

This study set out to investigate the possible effects that prolonged high rise living could have upon some aspects in the anatomical development of children. Their measurements of lung function, body composition and an estimation of their level of habitual activity, were all compared with children living in conventional two storeyed houses. Assessments were also made of the subjects' level of health and their response to a physical fitness running test. Despite the diverse nature of literature published on high rise living, no one has specifically directed their attention to this topic.

The surge of high rise building began in 1950 as the Government's answer to the acute housing shortage. Much of this post-war building consisted of the redevelopment of restricted sites within built-up areas. This together with the high cost of both building and land led to high density estates which included flats, many of them high rise.

The four estates selected for this study had all been fully operative for twelve years or more. Mixed dwellings of three-storeyed maisonettes, two-storeyed houses and high rise flats up to 18 floors were to be found. Although the layout of each estate differed, they all possessed some outdoor play facilities for the children.

The actual indoor living space in both abodes appeared to offer to children comparable opportunity for movements and active play. Except that a flight of stairs in a house often acts as an attraction for energetic



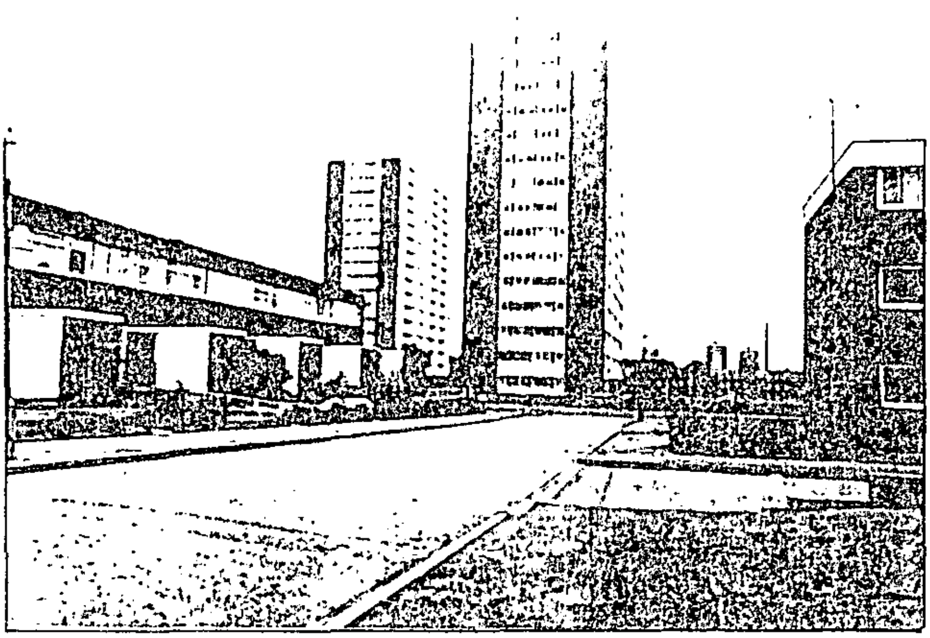


PLATE 1 : Illustrating mixed dwellings in a high density urban estate

play whereas the communal stairways in blocks of flats are unattractive play spaces for the young occupants. Many multistorey flats do possess balconies thereby giving extra floor space. However, these could be a positive safety hazard for a young unattended offspring.

Children who live in high rise flats have greater barriers between them and the outdoor environment which offers space and stimuli for mild and vigorous activity. From a house, it is possible for a child to go out into the garden to try out his new ball by opening and closing the back door - less than ten seconds. For the child on the eleventh storey (and upwards) in the high rise block, the transaction could take more than a minute. Also this excursion would have to be planned, at the least to inform Mother, to prepare for the weather and check suitable footwear. Finally, having arrived outside the main entrance to the flats, ball playing in that area might not be permitted! So,for the impulsive child,unless play is immediate, it becomes less attractive and so an indoor alternative is sought. Hence, a different pattern of living could develop for the high rise child which would be likely to affect the habitual level of physical activity.

In order to estimate the extent of each child's day to day activity, two questionnaires were prepared. The first was answered by parent and child combined and the second was completed by the child's class teacher. Information from both papers contributed to placing each child in a final habitual activity category.

Darke and Darke (1970) in their paper 'Health and Environment in High Flats' state, "The empirical evidence is very sparse. Most of the comment is pure speculation and there is an urgent need for careful research into the effects of high buildings". A few studies however have turned their attention to the incidence of physical ill health amongst the occupants of high rise dwellers (Skone, 1962; Hird, 1966 and 1967; Fanning, 1967; Gilloran, 1968; Stewart, 1970; Rickman, 1974). Hird and Fanning, both general practitioners, found significantly more cases of upper respiratory illness occurring amongst their patients who lived in high rise accommodation. Hence the questionnaires in this study also sought information on the child's incidence of upper respiratory illness and the state of their general health. This information led to them being placed in a final health category.

However, none of the aforementioned investigators had focused their attention on actual lung function of the high rise child. If it is so, that their level of habitual activity is restricted, then this could be apparent in the actual lung development. The work of Jones, Baber, Heywood and Cotes (1977) found, "independent support for the hypothesis that the level of habitual activity during childhood contributes to the ventilatory capacity". Their study took place in Kowloon and involved Chinese children where the high level of habitual activity group had lived all their lives up on the hillside in squatter huts. So for them a physically active life was mandatory. There have been other recent studies in different countries concerning lung function and children (Uchidda, Sasagawa, Ooshinia et al, 1971; Miller, Saunders, Gilson and Ashcroft, 1977; and Anderson, Anderson, King and Cotes, 1978). This present study therefore gave an opportunity to include the lung function of children living in England, to the existing list of values (see Table 18).

If high rise living does bring about a different pattern of day-to-day living, then body composition in the form of total % fat and amount of fat free mass could be affected. Hence fourteen physical anthropometrical measurements were made on each subject in this study. A field test of physical fitness was administered to all subjects in the form of a timed six minute run (Cooper, 1968; Jackson and Coleman, 1976). This test was selected as being within the capabilities of this age group (Cooper*, 1975) and it was expected to reveal an objective measure of the individual's physical working capacity.

It was felt relevant and interesting to review the literature published on the development of high rise living. For throughout, investigators express concern that families with young children should have easy access to the outdoor and therefore be housed near to the ground floor. Even now housing authorities appear unable to implement this (Jephcott, 1975; Birmingham Housing Department*, 1980).

Reports have constantly urged that outdoor play facilities should be both provided and well planned in order to attract children to use and enjoy them. Although the majority of official bodies recognise the importance of play and physical activity for the young child, they still have in many cases been unsuccessful in establishing adequate facilities.

House and high rise flat children spend their school day time together and they could share the same or similar play spaces in their

* personal communication

out of school time; but does their type of living accommodation encourage them to be equally habitually active? If so, it would follow that there would be no apparent differences in anatomical development between the ages of 7 and 11 years.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

PLAY FOR CHILDREN

The statement that most consistently reoccurs throughout high rise literature is that mothers are constantly anxious about the limitations placed on the play activities of their children. So before looking into the many aspects of high rise living, it is necessary to understand why for every child play is so important.

Children must play! In all its many aspects, play is essential for the full physical, emotional and intellectual development of the child. It was a century and a half ago that Froebel expounded that 'play is the highest stage of child development' (Murray,1914). To pioneer such theories was revolutionary, as then play was considered meaningless, unproductive and frivolous. But Froebel, determined in his beliefs, devised a system of education which was based upon using play as an educational tool, whereby learning was through experience and from the environment. There followed a slow, but certain, acceptance of the importance of play, but perhaps the greatest contribution to the understanding of the role of play in childhood came from Piaget (1951). He also saw play as part of the child's response to his environment and emphasised that this was a key process in achieving conceptual proficiency and intellectual progress. He stressed that the child's full potential would only be fully realised if the right sort of situation and environment was presented at each stage in the child's development. Today many well documented theories of play are to be found (Giddens,1964; Miller,1968; McLellan,1970; Holme and Massie,1970) but the view that all appear to hold in common, is that childhood experience in the form of play is a major component in the development of the adult personality. So the child's opportunity for play may decide to a great extent the sort of adult that he is to become. The importance of play is now undisputed. The Department of the Environment (1973) sums up the justification of play by stating, "It is now widely accepted that children have a deep and urgent need for play", but Bengtsson (1974) would add indeed, "and the right to play".

Having put forward the importance of general play for children, it is the physically active aspect of play that particularly concerns this study.

Holme and Massie (1970) in their report sponsored by the Council for Children's Welfare, stress the importance of activity for children in the form of physical exercise, exploration of the environment and imaginative games. Dattner (1969) had previously acknowledged activity importance when interpreting a sense of play as being, "exercise and action for amusement; freedom, room, or scope for motion or action". All these words imply the need for physical vigour that involves gross motor movement in space. To run, jump, climb, swing, roll, throw and kick are all important actions contributing to the physical development of the child. Falls, Wallis and Logan (1970) confirm this by stating that "Vigorous physical activity is essential in order that the child's physical potential may be realised".

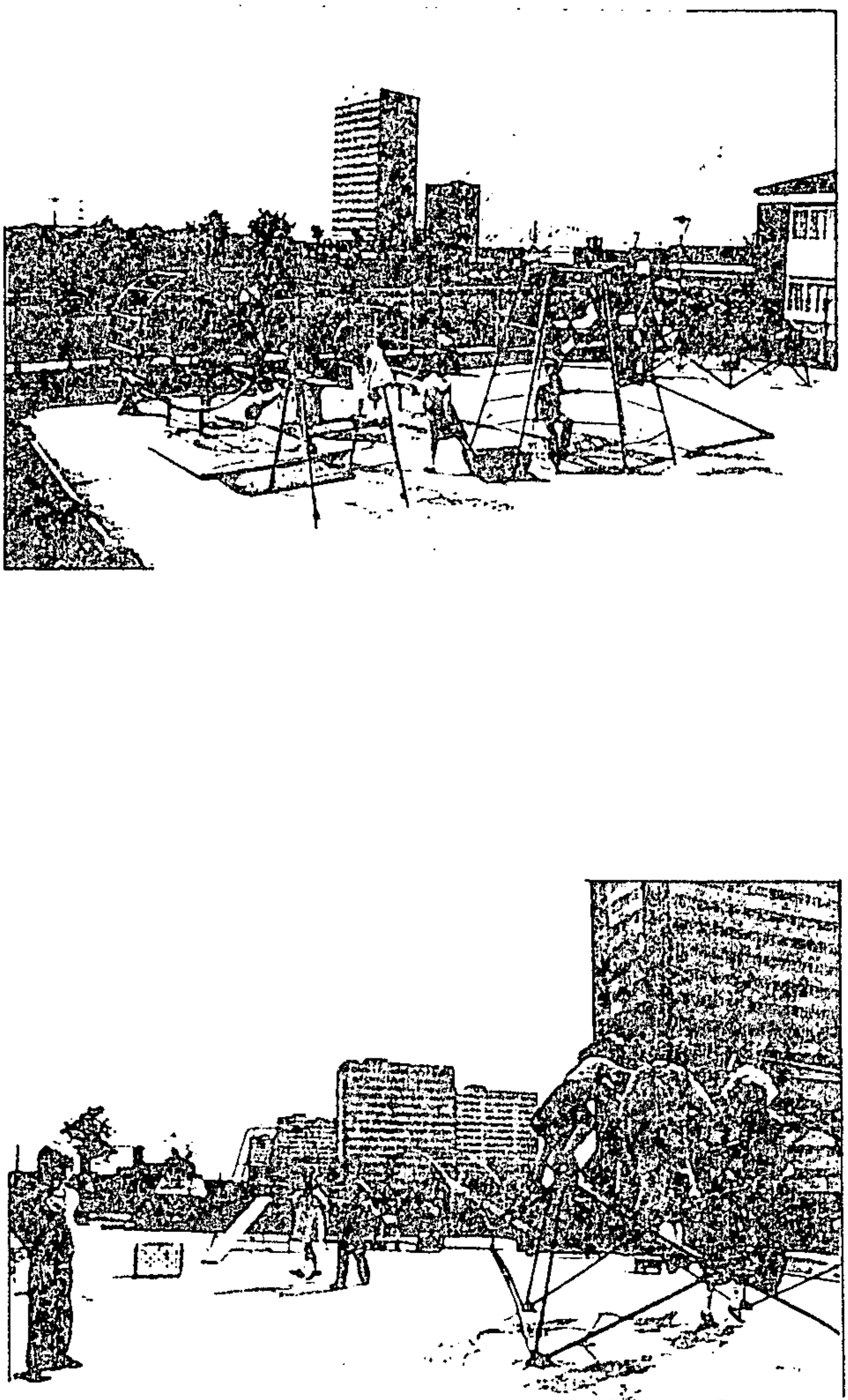


PLATE 2: Children using a well supervised nursery school play area

The Provision of Planned Play Facilities

Is the present day society catering for the play needs of children who live in the high density urban areas? H.R.H. The Duke of Edinburgh K.G., K.T., in his foreword to "Children at Play", (Bengtsson 1974) caused people to examine their thinking when he wrote, "It is possible for adults to force the industrial system to provide for their immediate needs, but what may be tolerable for adults may be less than adequate for children".

Following the 1939-45 war years there was an urgent need to build houses quickly. Many existing restricted sites were redeveloped which favoured building up as an economical and speedier method of alleviating the housing shortage. Thus blocks of flats emerged, many of which grew to more than ten storeys and some topped thirty storeys. Thus, the urban high density estates came into being.

The spaces offered for children's play were areas that happened to be left vacant after building was completed. Hence they were inadequate and in some cases non-existent. So within this system planners were not catering for the play needs of children. Where communal play areas do exist, it is difficult to place them conveniently for all the flat dwelling families. A parent will want to accompany and supervise particularly the younger child's journey and activities. Hence this limits the time that can be afforded for their outdoor play.

Areas that are handy are often adjacent to the flats. In time these become prohibited places due to the noise arising from vigorous children's play, which annoys and disturbs the ground floor residents. Play areas may seem to be conveniently near to the high rise buildings, but the journey down from the upper floor adds distance and extra effort to the excursion.

HIGH RISE LIVING

Diverse investigation

A vast amount of literature has accrued on different aspects of high density living. Particularly the theme of family life in high rise flats has attracted authors from a wide range of disciplines and social groups; they include architects, educationalists, voluntary welfare organisations, housing managers and local government workers, national government department members, social science researchers and medical doctors. Also many different patterns of research have been adopted, so there is some difficulty in comparing the available literature. Hence attention will be drawn only to studies that set out to investigate children in high flats and their opportunities or lack of opportunities for play space. As will be evident, this situation is closely related to a variety of other problems.

Children in high rise flats

In 1952 "Living in Flats" (The Brooke Report) appeared after a sub-committee was appointed by the Central Housing Advisory Committee to examine the social needs and problems of families living in large blocks of flats. This report urged the need for further research into playground planning, noise in flats and the disposal of refuse. It is noteworthy that children's play was one of the very first problems to emerge. Willis (1955) reported at the Royal Institute of British Architects

Symposium that safety and convenience for young children were the main reasons why families on upper floors of high rise flats wanted to move down. A child up to seven years of age on an upper floor had to play indoors unless he is taken out by his mother - even so playgrounds are often inadequate and not within sight of the mother in the flat. Strong advice followed not to house families with young children above the third or fourth floor. But advantages of living high were also expressed in terms of "better air and healthier atmosphere", plus greater quiet and privacy, a better view and light and a feeling of openness. However two thirds of these people said that "ideally they would like a little house and garden".

The proportion of high flats being built was steadily increasing and by 1960, forty per cent of all dwellings put out to contract by the London County Council were blocks of flats of ten storeys or more. This trend was also becoming apparent in the provincial cities such as Birmingham, Manchester, Liverpool and Sheffield. Thus a study was undertaken by Maizels (1961) to enquire into play provision for children aged two to five years living in high flats. Of the 206 mothers and 7 fathers interviewed, all had at least one child between two and five years. The sample came from all floors, for although there was a policy to accommodate young children close to the ground, evidence showed that it was not in operation. Seventy per cent of all flat dwellers experienced difficulty with regard to the play of their young children. For those living above the fifth floor, the difficulties were more acute. Using the flat as the main play area meant noise disturbance to neighbours and young children could not play away from the flat on their own. The recommendations made to the Ministry of Housing and Local Government were that planning for high rise flats should include, standards of play space and equipment specifically designed for the under-fives.That it was imperative to provide some supervision if children under five were to have adequate exercise and outdoor play. Also further attention should be paid to the design of balconies so that children could use them safely.

Many of the above findings were endorsed by Townsend (1961) who conducted a study with the aid of students from the London School of Economics. They were disturbed by the fact that most of the children tended to be out of the flat for only two hours or less in the day and eleven out of eighty three children did not leave the flat at all on the day prior to the questionnaire (only four of them were unwell).

Gradually as literature built up a public awareness developed and in many areas of Britain the desirability of high rise flats for young families became challenged. This was instrumental in bringing about a change in the Government's planning policy in 1967 (Circular 36/7), which effectively reduced the rate of building high rise accommodation.

High Rise Living Abroad

About this time, literature was filtering into this country from Stockholm, Melbourne and New York, stating their problems and views of high rise living. Stevenson, Martin and O'Neill (1967) were particularly concerned with the parents loss of contact and controlling influence over the children once they disappeared out to play. Parents had no influence over behavioural standards or the kind of contacts that were made. They stressed their lack of a backyard or garden. Extreme reactions were also reported whereby parents attempted to keep the children in the flats nearly all the time. Ensuing frustration of children and anxiety of parent was often illustrated. However, forty per cent of the parents from the Melbourne study stated that their children had benefitted from living in high rise flats for they seemed to have developed independence, self-reliance and tolerance.

Dattner (1969), an architect in New York City, showed great insight into possible designs for play areas which were rich in experience and offered choice of exercise for the child. With other designers he planned play spaces on roof-tops, on wide pavement stretches and on little used areas of the waterfront. Light and inexpensive prefabricated equipment was designed for paths and recreation spaces. Shopping areas provided trained supervisors to run "Check a Child" playgrounds where each child received a numbered tag, and the parents a numbered check with which to reclaim the child. This scheme was financed by the retail stores. Each summer, the Police Athletic League operated play programmes in many streets which were closed off for play at stated times. The street furniture (lamp posts and hydrants) was adapted and these play streets were highly successful for they were efficiently and enthusiastically supervised.

Children's play needs

In this country Hole (1966) had looked beyond the dwellings to the urban environment and the space allocation within high density development. Through this study involving children at play, clear information was provided to guide planners on children's needs for play space and facilities. Abernethy (1968) furthered facility suggestions and stressed the need for local authorities and planning departments to become enlightened and to implement recreational facilities for all ages.

On behalf of the NSPCC, Stewart (1970) concluded that the housing in flats of families with young children was restrictive, undesirable and could lead in some instances to human discomfort and suffering. There were also indications of resultant behavioural difficulties. He however stated that the tenants dissatisfaction came about throught the inept management on the part of the housing authority. A plea was put forward for Housing Officers to improve, indeed humanise, their services.

Department of the Environment Guidance

The Department of the Environment over the years 1970 - 1972 issued three Design Bulletins (Numbers 20, 21, 22) all of which investigated the general problems of families living on high density estates. These Bulletins were followed in 1972 by the Government's introduction of new recommended standards of play space for all densities of living (Circular 79/72). General guidance was given to local authorities and the actual size of play space was set down according to the number of child bed spaces. This was at least one play area of thirty square metres per ten - nineteen child bed spaces. Minimum play equipment was also stipulated. Further help for local authorities was then published in the form of 'Children at Play' (D of E, 1973). Here it was reiterated that "Wherever possible families with young children should be allocated houses. If density or other design factors make this impossible, only the dwellings on the ground or first floor of a multistorey building should be considered."

Edinburgh Study 1974 - children's activity diaries

Byrom (J. 1974) voiced deep concern for the lack of adequate play provision in Edinburgh. He suggested the possibility that if children were denied the scope for learning through play, because their housing estates "were compounds of restriction and constraint", it would not be unexpected to find their energies being expressed in an anti-social way. He suggested to the Edinburgh Society that half the amount of money spent at present on making good the damage of vandalism could be wisely spent on improving play opportunities on new estates. Byrom (C. also 1974) looked further into the Edinburgh children's use of the environment by conducting a small but valuable survey on the pattern of activities of children once they were out of school. To know how these children actually spent their hours is interesting and important. Eighty-six children aged 10 - 12 years kept a diary for one week and reported their day-to-day activities. Although it was June, the children mostly spent more time indoors than outdoors.

Girls tended to stay indoors for slightly longer than boys, but went outside more often for shorter periods. The main indoor activity was television viewing and on average each child spent 20 hours watching during this particular week. More time was devoted to television viewing than to any other leisure activity. The second most mentioned indoor activity was 'helping around the house' and play became the third most frequently mentioned activity.

A wide range of activities occupied these children when they were outdoors, but over half the time was spent in some form of play. Football in different forms was outstandingly the most popular activity for boys and the teams often consisted of a wide age range. The girls tended to play on the hard surface areas and ball games were most popular and skipping came second. Then followed a wide variety of impromptu and general games which were sometimes quite traditional. Thirty per cent of the children did say that at some time during the week that when outside they were bored, with nowhere to play and nothing to do and so they retreated indoors to watch television. On this particular estate it was impossible to play anywhere else but close to dwellings. So it was not surprising that over a third of the children referred to intervention and curtailment by adults and older children of their outdoor activities. It appeared that football caused particular friction.

The diaries revealed that although television took up much of the children's time particularly around tea time and before bed time, it did not provide a serious challenge to their outdoor pursuits. However, Byron's study, though giving specific and important evidence on children's play patterns, was conducted on one estate only.

Children's response to the environment

It is Holme and Massie (1970) who after conducting extensive research throughout twenty-nine boroughs in England and Wales, remind us that children in their play activities do respond to their environment. On one new medium density housing estate the play tended to be individual, passive and home oriented. Whereas children living in an old and unplanned area with overcrowded housing and congested streets tended to play in groups away from home; they were more active and their games were of a more traditional character. These children had a strong influence over each other, whereas the former children were likely to be more parent influenced.

Children may be classed as outdoor or indoor types. Newson (1976) found that the child who resisted outdoor play did so for temperamental reasons and he or she chose to remain indoors. They were likely to be described as shy and inclined to be worriers. They could however sit still indoors and they had good reading capabilities. But overall, Newson found that parents generally assumed that to be outdoors was in itself good for the child. Parents therefore urged their child outside to "get some air in his lungs" or "so as not to waste the sunshine".

Jephcott Study (1975)

A unique study carried out by Jephcott (1975) should be mentioned in that she actually lived in high rise accommodation in order to gain sustained contact with these families. This she did over a period of eighteen months and was able to assess the suitability of flat life for families with children. Although, mainly a sociological study, Jephcott acknowledged that families with primary school aged children did experience endless problems about their play.

Play limitations

Linking evidence from many studies it appears that difficulties increase with height of living and consequently children from the upper floors do play outside less. Their indoor play must be safe and the noise should not disturb neighbours living above, below, to right or left, or across the hall. However, being separated by a single wall seldom acoustically reinforced, is likely to cause one out of five neighbours to object. Accessibility to outdoor play is troublesome and either takes the child out of touch from mother, or demands that mother should be in accompaniment.

Opportunities for play matter very much indeed. The child's future character and outlook on life are greatly influenced by his play experience in these formative years. Through a child's basic need to be active, he explores, experiments and so acquires skill in the use of his body and in manipulating objects (Gabriel, J., 1970). In a study undertaken by Wardle (1976), it was found that pre-school children who lived in high rise flats had less motor skill ability than their counterparts from houses. It is possible that these children could suffer a permanent physical skill deficiency or they could possibly undergo a catch up process. However, this is probably yet another outcome of the play limitations placed upon the child who lives in high rise accommodation.

HEALTH AND VERTICAL LIVING

A small amount of literature exists directly related to high rise living and positive health. Dr Beatson Hird (1966) in general practice for 12 years on a new housing estate published his concern for the health of his flat dwelling patients. From his records it emerged that, "In flat dwellers there were twice as many upper respiratory infections in children below the age of 10 years as there were in house dwellers, and twice as many consultations in which symptoms of emotional disturbance predominated". The suicide rate on his estate was nine times above the national annual rate. In the past ten years there were twelve suicides and all but one were women. He suggested that the weaker inhabitants of the community felt isolated and disillusioned and their lives developed a pattern of indifference and they became sick. In a second article Hird (1967) suggested that practising medicine was not so much a natural, but social science, where one of its main functions was to enable man to adjust to his environment. He pointed out that it was the general practitioner who was best placed to study and evaluate the effect of living conditions on health. Although he mostly concerned himself with emotional health he stressed that physical fitness was a major support towards achieving a balanced emotional health.

The same year Fanning (1967) published a detailed report after comparing one group of 398 families living in 4 storeyed flats with 160 families living in 2 storeyed houses. These were British Service families stationed in Germany. The difference in the rate of first attendance to the general practitioner showed an increase of morbidity of 57% in those families who lived in flats, compared with house dwellers. However admission to hospital was the same for both groups, possibly indicating that flat dwellers were ill more often but the degree of serious illness was similar.

There was a marked difference in the incidence of respiratory disorders in children under the age of ten years, which confirmed Hird's (1966) findings. First consultation for disorders of the respiratory tract amounted to 60% in flat children compared with 30% in house children. The incidence of respiratory infection increased slightly as the height of the flat increased. In the instance of disorders of the bones and organs of movement however, the house dwellers incidence was more than twice as frequent. This is noteworthy as it suggests a greater degree of activity amongst people living in houses.

Fanning's explanation for the difference in respiratory infection was similar to Hird's (1966) in that flats were relatively smaller in space than houses and the families were often confined within the flat. This confinement and resulting social isolation were the possible reasons for the increase found in psychoneuroses in flat women.

The following year Fanning (1968) advised the Town and Country Planners on the need for increased indoor space for flat dwellers, so that social contacts could be more easily made and children had room to play indoors. There was also a plea for space outside for children to meet and to play safely.

Power (1968) studying Service families in Hong Kong which is noted for its high rise density, found respiratory diseases most prevalent in flat families with young wives and children under four years. He suggested that the quality of maternal care might be inferior in young mothers in flats. Dalton (1966) has shown that minor coughs and colds in children are disproportionately common during the four days before and the first four days of the mother's menstruation. In Fanning's investigation, menstrual irregularity was more frequent in flats than in houses and this was connected with the increased neurosis-rate. The M.O.H. for Edinburgh (Gilloran, 1968) issued a report on chiefly social problems which he suggested could escalate into health problems within families in tall flats. Stewart (1970) in his report on behalf of the NSPCC, briefly suggested that bronchial and nervous health may be detrimentally affected by flat living. Richman (1974) stressed the isolation problem of flat mothers with pre-school children. These mothers complained of depression and loneliness and expressed greater dissatisfaction with their housing, particularly lack of play space. Other publications concerned with the health of high rise children were found in the British Medical Journal and The Lancet, but they were confined to reviews and comments on existing literature.

LUNG CAPACITY AND DETERMINANTS OF VARIATION

Lung Development

The bronchial system is entire at birth, whereas the alveolar system is complete at "about the eighth year", as stated by Cotes (1975). Further development of the lung takes place by the enlargement of existing alveoli (Sinclair, 1973). Mansell, Bryan and Levison (1977) point out that the development of the respiratory system in children could be disproportionate in several features and the disproportions are more likely to occur during infancy and early childhood. In an extensive study with Japanese children, Tatai(1955) found that the rate of development in vital capacity was similar in both sexes from 8 to 10 years of age. Girls continued this marked increase in development up to the age of 11 years, whereafter there followed a decrease in development. Boys between 11 and 13 years appear to slow down in vital capacity development, but then show a marked increase up to the age of 16 years. Cotes (1975) adds to this work when he expresses that the growth of the lung is synonymous with the growth of the whole body including the growth spurt period in early adolescence. The adult size of the lung is usually achieved by girls at about 17 years of age and by boys approximately 2 years later.

Lung size and Vital Capacity correlation with stature

It is now widely acknowledged that lung size and ventilatory capacity both correlate with stature. This is due to the early work of Hutchinson (1846) who first claimed that vital capacity increased with standing height. This work was developed by Dreyer (1919) who established definite relationships between vital capacity, body surface, body weight, stem length and chest circumference. In addition he was the first to report that active and physically fit people appeared to have larger vital capacities. Valuable contributions confirming lung volume and height relationships followed from Edwards and Wilson (1922), Kelly (1933), Engstrom, Karlberg and Kraepelien (1956), Helliesen, Cook, Friedlander and Agathon (1958), Hepper, Fowler and Helmholz (1960) and Lyons and Tanner (1962). Cook and Hamann (1961) obtained such excellent correlation to both sexes throughout a wide range of heights that they claimed height to be a reliable basis for the prediction of lung volume. Petersen, Lapp and Amandus (1975) in their work with adults (666 American, non-smoking coal miners), found that the best predictors for $FEV_{1.0}$ and FVC were height and age and that the addition of weight accounted for little improvement in this relationship. A study of healthy boys and girls, 6 - 15 years of age by von der Hardt and Nowak-Beneke (1976) reaffirm that standing height is the best independent variable for predicting lung volume. These authors also found, as have other investigators (Emerson and Green 1921; Shephard, Lavallee, Lariviere et al, 1975; Miller et al, 1977 etc.), that lung volumes were significantly larger in boys than in girls. Cotes, Dabbs, Hall, Axford and Laurence (1973), found that the difference becomes apparent from the age of 8 years. In their particular study the boys appeared to be more active than the girls; also the boys cardiac frequency was significantly lower during exercise at an oxygen uptake of 0.5 l. min^{-1}, after standardizing for body muscle. As this sex difference is most marked in vital capacity values, it would suggest that the extent of physical activity pursued by the subject contributed to this difference (Andrew, Becklake, Guleria and Bates, 1972; Cotes, Adam, Anderson, Kay, Patrick and Saunders, 1972).

Determinants of lung volume

Vital capacity is dependent not only on lung size, but on such additional factors as lung elasticity, chest compliance and muscle tone and strength (Cook, Helliesen and Agathon, 1958). It is well known that repeated heavy exercise results in hypertrophy of muscle. In a study entitled, "Impact of age, diet, and exercise on Man's body composition", Parizkova (1963) used subjects ranging from 11 to 57 years. Each age grouping consisted of trained athletes and non athletes. A high body density, meaning a larger proportion of lean body mass, was always to be found in the trained group of athletes. This result was consistent throughout the age ranges with the most marked development of lean body mass showing in the 23 year-old age group of athletes. Parizkova explained that it was this intensity of physical activity that brought about this increase in muscular development.

Respiratory muscles in constant use could also respond equally well, enabling them to contract with a greater force, resulting in higher values in lung capacities. A relationship was demonstrated by Raper, Thompson, Shapiro and Patterson (1966), between scalene force, intrathoracic pressure and lung volume; they maintained that hypertrophy of respiratory muscles could make a positive contribution to increased oxygen requirement. It was suggested by Tatai (1955) that back muscle may also contribute to vital capacity. Shoulder girdle muscle development found in weight-lifters, oarsmen and archers has also led to an increase in vital capacity due to the increased strength of the accessory muscles of inspiration (Cotes, 1975). Andrew, and his co workers, (1972), also recognised that shoulder girdle muscle development partly explained the increased vital capacities found in boy and girl swimmers engaged in year round training. However, Faulkner's (1968) view is that the respiratory muscles of trained swimmers are likely to develop greater power. This is due to the extra work required of them throughout the respiratory cycle, in order to overcome the hydrostatic pressure set up by immersion.

Vital Capacity and physical training

Several authors have been able to illustrate an increase in VC due to various forms of physical training. Breath holding has been seen to bring about an increase in total lung capacity, vital capacity, inspiratory reserve and tidal volume. This information was revealed by Carey, Schaefer and Alvis (1956) following their work with skin diving instructors who, without the use of any special equipment, made a daily underwater descent to 100 feet and then returned to the surface. Their vital capacities were 14.6% higher than predicted values. Newman, Smalley and Thompson (1961) and Andrew and his co workers (1972), agreed that both boy and girl swimmers were taller at a given age and also produced higher values for VC and $FEV_{1.0}$ than a control group of non athletes. Endowment may have contributed to the superior measurements found in the swimmers, but the data does suggest that training between the years of 8 and 18 does affect the physical growth rate, and the heart and lung function. Also working with boys from 11 years old over a pèriod of 32 months, Ekblom (1969) found that the trained athletic group increased their VC by 54% compared with 31% improvement in the non athletic group. He too expresses difficulty in evaluating the contribution of physical training as distinct from the age dependent physical and physiological growths. Puberty is a time when the body appears to be particularly sensitive to the high concentration of growth hormone in the blood and increased amounts of physical activity during this period could possibly enhance the growth rate (Beznak, 1960).

However, reports on the effects of training are conflicting. There are authors who found no significant difference in the total lung capacity and its subdivisions, between distance runners and non athletes (Newman et al., 1961), or in runners before and after training (Adams, 1968). The functional capacity of the lungs based on laboratory testing of maximal oxygen consumption, showed no significant increase in a sporting group of boys tested over 3 years, when compared with the non sporting group, (Sprynarova, 1966). These results agree with the work of Stewart and Gutin (1976), who involved a similar age group of boys in a shorter 8 week programme of interval training. One explanation could be that most work tasks proceed at submaximal levels; therefore submaximal testing could be more important than maximal measures in the assessment of cardio respiratory fitness.

The above information indicates that rigorous swimming training has a more marked effect on lung volumes than other forms of athletic training. Bachman and Horvath (1968) found significant changes in pulmonary function of trained swimmers, but not in trained wrestlers. The swimmer's vital capacity increased due mainly to a larger inspiratory capacity; not unexpectedly, the swimmer's respiratory rate decreased with training.

Diffusing capacity

Reports on the effects of training on diffusing capacity of the lung also vary. Some workers have reported high values in trained athletes (Bannister, Cotes, Jones and Meade, 1960 and Newman et al., 1961) and in Olympic swimmers (Mostyn, Helle, Gee, Bentivoglio and Bates, 1963). Others have failed to observe any difference in the same individual studied before and after training (Cotes and Meade, 1959; Reuschlein, Reddan, Burpee, Gee and Rankin, 1968). Due to morphometric analysis on Japanese Waltzing Mice (J.W.M.) Geelhaar and Weibel (1971) have been able to contribute valuable information on the pulmonary diffusing capacity in these highly active animals. It was observed that the oxygen consumption of J.W.M. exceeded that of normal white mice (N.M.) by 80%.

Morphometric analysis revealed that the alveolar and capillary surface area and the capillary volume were also some 60% larger than N.M. The air blood barrier in J.W.M. was thinner; the alveolar surface showed a higher increase than the lung volume suggesting that these highly active mice develop a larger number of small alveoli. The diffusing capacity found in J.W.M. increased in approximate proportion to the observed level of oxygen consumption. Andrew and his colleagues (1972) suggest that similar changes in capillarity could explain the increase in diffusing capacity found in trained boy and girl swimmers.

Ethnic lung function

Many studies have taken place in different parts of the world to investigate the lung function of a variety of ethnic groups living in contrasting environments. It has been found that people of European descent have approximately 13% (Cotes, 1975) higher values in vital capacity and forced expired volume, than other ethnic groups. Negroid and Mongoloid stock record intermediate volumes whereas Indian and Polynesian people appear to have the smallest values. Genetic factors associated with ethnic groups, though having an important effect on lung size, show in several studies that considerable variations are being described within an ethnic group (Jones et al, 1977; Anderson, Anderson, King and Cotes, 1978). This could mean that a genetic selection has occurred over the years in that certain groups of people have elected to pursue a more rugged life at higher altitudes (Cotes, Dabbs, Malhotra and Saunders, 1973). Previously, in more primitive times, people with a superior respiratory system would have stood better chances of survival. However, weighting evidence away from the influence of genetic factors, Anderson and colleagues (1978) in a secondary study found that differences in children's lung volumes occurred according to their present living environment, rather than in accordance with their parentage.

Environmental and habitual activity influences on lung function

Studies of lung function that have involved groups of highland dwellers as opposed to those living at sea level have shown consistently higher lung values for the former group (Cotes, Adam, Anderson, Kay, Patrick and Saunders, 1972; Jones et al, 1977; Anderson et al, 1978). Apart from the genetic influences previously mentioned Cotes, Dabbs, Hall, Lakhera, Saunders and Malhotra, (1975), put forward several reasons why people living at higher altitudes should possess superior lung function. Firstly lungs may modify when constantly exposed to an energetic life based on a hillside amidst rough terrain. Secondly, altitude causes a lower blood oxygen tension increasing the ventilation level and this could encourage hypertrophy of the lung. However contrary information from studies in the United States and South Africa, found that living at 1800 m had no effect on lung volumes. In addition, lung values of Himalayans living at 1800 m were not found to be inferior to those living at much higher altitudes. Thirdly if highland children do experience a higher level of physical activity, this in turn could stimulate the growth hormone which appears to also influence the size and function of the lung (Andrew et al, 1972).

There is much indirect evidence that highland people are habitually more active than lowland people (Cotes et al., 1972; Cotes et al., 1975b; Jones et al., 1977; Anderson et al., 1978). This information is substantiated by the fact that altitude dwellers have a low level of cardiac frequency which suggests a high level of physical fitness (Cotes, Anderson and Patrick, 1974; Cotes, 1976; Miller, Saunders, Gilson and Ashcroft, 1977). The latter group of workers firmly stated that the most likely factor to influence the increased lung capacity shown in the rural children living in hill farming communities was the contribution of their habitually vigorous activity. Although this was not directly measured, the observers were fully convinced that the daily activities of these children were physically more demanding than those of urban children living on the coastal plains. Differences occurring in lung capacities between highland and lowland children were found by different authors to be: an 8% difference in ventilatory capacity (Jones et al., 1977); a 3% and 7% difference in vital capacity (2 studies, Miller et al., 1977) and at a higher altitude of 1500 - 2000 m., a 27% difference in forced vital capacity (Anderson et al., 1978). There is a further environmental factor that would influence the level of habitual activity. It is that these studies all took place in a tropical climate. The combination of a high ambient temperature with high humidity found in the coastal regions, would be a positive discouragement to physical activity. As high altitude is associated with steep terrain it becomes difficult to disentangle the contribution to lung function between altitude and habitual activity. However, Anderson et al. (1978) favour the altitude theory, whereas Jones et al. (1977), Miller et al. (1977), favour the childhood habitual activity theory.

Levels of habitual activity need to be very positive if they are to exert an effect on lung function, for evidence demonstrates unequivocally that this is largely genetically determined (Cotes, Heywood and Laurence, 1977). The findings of studies involving identical and non-identical twins have not consistently shown less within pair variability for the identical twin group (Cotes, 1979). So the degree of genetic influence is difficult to isolate from the many variables. However Klissouras (1977) claims that the total variance of functional capacity attributed to heredity, can be lowered to about 50 % when subjects are exposed to extreme environmental conditions. He concludes, "Habitual exercise can profoundly affect the expression of the genetic potential, but this can occur only within the fixed limits of heredity". This is a very important and sound statement which needs to be recorded.

BODY COMPOSITION AND ACTIVITY

Body Fat

Specific forms of training are capable of affecting body composition. Body fat content may be modified as a result of increased levels of physical activity (Wilmore, Girandola, and Moody, 1970). During work, obese people do not appear to exhibit any measurable pulmonary dysfunction (Wolfe, Hodgson, Bartlett, Nicholas and Buskirk, 1976). However they must be handicapped during activity in that they carry extra weight with them. This load does not produce extra stress on the cardiovascular respiratory system during exhausting work, but it makes accomplishment of a specific task more difficult. The excess fat does increase the oxygen cost and therefore the cardiovascular load in submaximal work (Buskirk and Taylor, 1957). Katch, Pechar, McArdle and Weltman (1973), found that the results of a 10 minute cumulative performance were inversely correlated with both body weight and % body fat.

Habitual Activity

In studying the effect of habitual activity on either body composition or other physiological parameters, any relationships found could be indirect, or even the physiological parameters themselves could have a direct influence on the level of habitual activity. For instance, it has been shown that obese individuals are less active than normal controls

(Bullen, Reed and Mayer, 1964), but it was not established that the inactivity was the cause of obesity. Watson and O'Donovan (1977), found no relationship between % body fat and level of habitual activity; in fact % body fat did not relate to any other variable. They suggested however that strength and motor ability could exert an influence on the level of habitual activity.

Compositional and activity influences on physical working capacity

Physical working capacity has been shown to be highly dependent on parameters of body size (Davies, Barnes and Godfrey, 1972; Cureton, Boileau and Lohman, 1975) and appears to be influenced by shape (Cotes, Davies, Edholm, Healy and Tanner, 1969; Watson and O'Donovan, 1977). Following cycle ergometer tests for maximum oxygen uptake, Cotes et al. (1969) and Mayhew and Gifford, (1975), would add that results depend upon the amount of muscle mass that can be brought into use. Smaller amounts of lean body mass found in girls in part explains their lower oxygen uptake (Davies et al., 1972). It is the additive endowment of body muscle plus the extent to which one is either habitually very active, or habitually inactive that determines cardiac frequency. Habitually active people have a lower cardiac frequency suggesting a higher stroke output (Cotes, Berry, Burkinshaw, Davies, Hall, Jones and Knibbs, 1973). In addition there is some evidence that exercise ventilation is less in subjects with a low exercise cardiac frequency (Cotes, 1976). Thus it would appear that intense habitual activity influences both body composition and the circulorespiratory potential. Jointly this contribution results in a high oxygen uptake which is a measure extensively used to evaluate physical fitness.

TIMED DISTANCE RUN TESTS

Cooper 12 minute run test (1968)

Distance run tests are now widely used as components of physical fitness tests. Cooper (1968) developed a modification of the original Balke Test using a 12 minute running performance. In studying 115 male Air Force Officers, he obtained a correlation coefficient of r = 0.897 between the distance covered in 12 minutes and $\dot{V}O_2$ max. He claimed this test to be an objective measure of physical fitness reflecting the cardiovascular status of the individual.

Correlation of $\dot{V}O_2$ max with various run distances

Since 1968 the validity of using timed distance runs as predictors of $\dot{V}O_2$ max in teenagers and adults has been evaluated with varying results. Comparing the distance run in 12 minutes to $\dot{V}O_2$ max, the reported coefficients vary from 0.65 for young males (Maksud and Coutts, 1971) to 0.90 for 12 to 14 year old boys (Doolittle and Bigbee; 1968). Correlation coefficients for $\dot{V}O_2$ max and the 600 yard run are found to be lower and range from -0.27 for 14 and 15 year olds to -0.66 for 11 and 12 year olds (Mertz and Alexander, 1970). Data were produced by Jackson and Coleman (1976) supporting the use of the 9 minute test for elementary school boys and girls. They stated that the extra 3 minutes of running time did not improve the correlation coefficient of 0.82 for boys and 0.71 for girls. Working with 8 year old children, Krahenbuhl, Pangrazi, Burkett, Schneider and Petersen (1977) found that the 600 yard, $\frac{3}{4}$ mile and 1 mile (i.e. 549, 1207 and 1609 metres) runs were significantly related to $\dot{V}O_2$ max, but the combination of the 1 mile run time with $\dot{V}O_2$ max resulted in the highest coefficient.

Adoption of 6 minute run test by California State (1970)

The Californian Physical Performance Test administered throughout all state schools, was revised in 1970 to adopt the 6 minute jog-walk as the endurance component. This test was selected over the 600 yard run-walk because of the low to moderate correlation with $\dot{V}O_2$ max found by some investigators. The 12 minute jog-walk though having both high and low correlations with $\dot{V}O_2$ max, did create administrative problems of availability of adequate space and sufficient time for testing. In using both the 6 minute jog-walk and the 600 yard run-walk to estimate the endurance capacity in 9 - 12 year old boys, Vodak and Wilmore (1975) found that while the reliability of the 2 tests were high ($r = 0.88$ and $r = 0.89$ respectively) they were both poor predictors of $\dot{V}O_2$ max ($r = 0.50$ and $r = -0.50$ respectively). The authors explained as did Kemper and Verschuur (1975) working with a similar age group. that the running results were noticeably influenced by motivational factors. Cureton, Boileau, Lohman and Misner (1977) concluded that the determinants of the 600 yard and 1 mile run in elementary school children are complex and that results of these tests reflect a number of individual attributes in addition to cardiovasular-respiratory capacity.

PROCEDURE

PROCEDURE

THE SUBJECTS

In order to acquire 202 subjects between the ages of seven to eleven years, ten junior schools were used, each sited on one of four post 1955, urban fringe housing estates in the West Midlands. The first forty-five boys and fifty-six girls were selected because they had lived all their lives in high rise flats above the second storey. There was the occasional case where high rise living was interrupted for a matter of months. To form the second half of the subjects, a match child of the same sex was chosen, provided that they had lived all their lives in a two-storeyed house. The match pair were as close in age as the limits of the particular school class would allow. Both children lived on the same mixed dwelling estate.

The study only included children of European descent as their lung capacities appear to be larger than those of other ethnic groups, despite living in a similar environment (Cotes, 1975). Children with known recurrent upper respiratory illness were also not included.

In each case permission from the Director of Education was obtained and the introduction to the schools was fostered by the Area Physical Education Adviser. The local Education Health Officer was informed and her advice was sought. Following headmaster approval, a letter of information about the study was sent to all parents. This was accompanied by a personal letter from the headmaster generally encouraging participation. Parents gave consent for their child to be measured and tested by signing and returning the form (see Appendix 1).

From the total returns of 230 consent forms only 2 sets of parents were unwilling to let their child participate in this study.

EQUIPMENT AND METHOD

To ensure consistent measurements, all equipment was transported from school to school and only used by the single observer. Each school was able to allot a small room to the project so that measurements could be carried out reasonably privately. The subjects were called in single sex groups of six and where possible from the same class.

An example of the profile used to record individual subject data, can be found in Appendix 2. Subject profile forms were coded blue for boys and pink for girls. All received a subject number:

Flat Boys	from	101
Flat Girls	from	201
House Boys	from	301
House Girls	from	401

For easy identification the matched pairs received the same last two figures. Thus if one was absent from a testing session, the partner could easily be withdrawn.

The date of birth was taken from the school records and coded into decimal years.

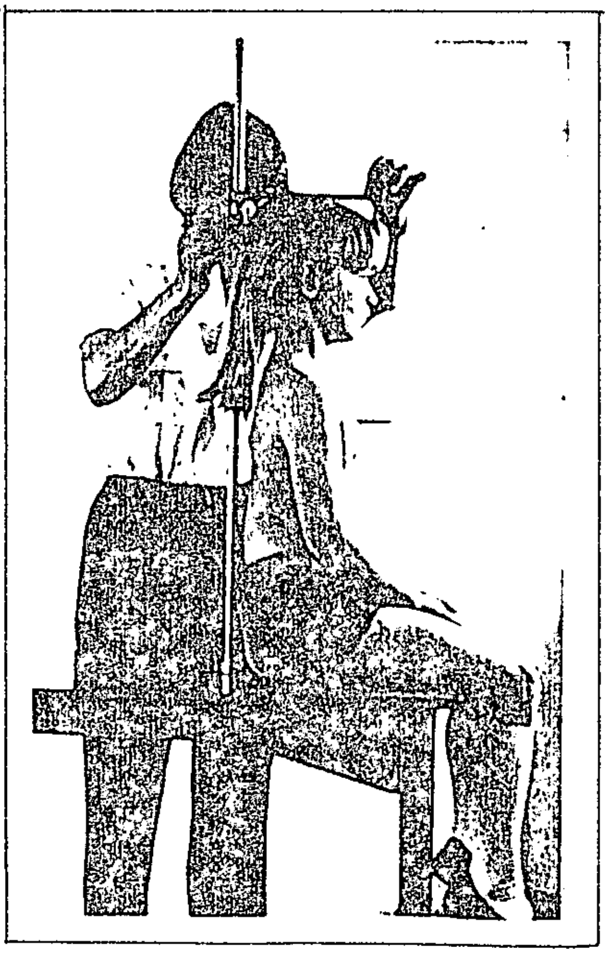
Anthropometric Measurements

Stature was measured to the nearest 0.001 m. using the same portable stadiometer throughout. The subject's heels were checked to

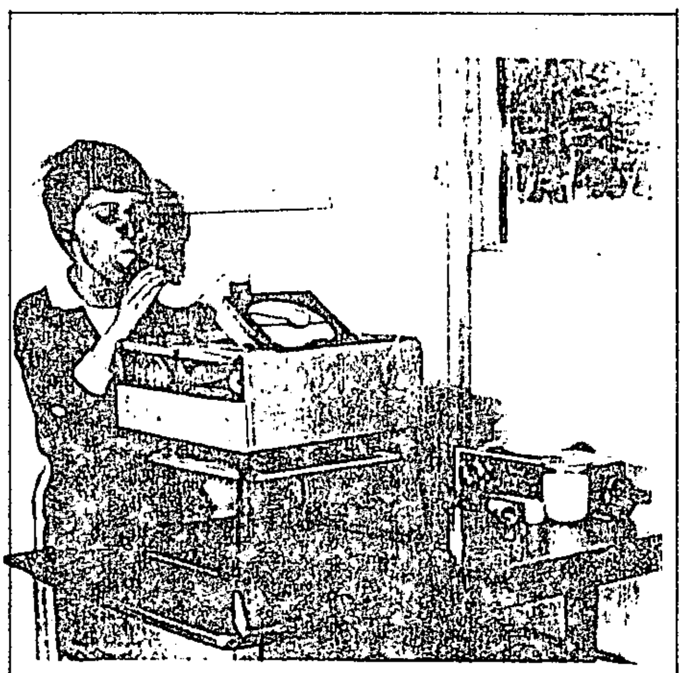
Plate 3 ILLUSTRATING EQUIPMENT AND METHOD

Stature

Suprailiac Skinfold



Sitting Height



Forced vital capacity

remain in contact with the floor. The head was held in the Frankfort plane and gentle traction was applied to minimise diurnal variation (Whitehouse, Tanner and Healy, 1974). This could have been considerable as measurements were taken throughout the school day.

The children were weighed in their underpants, using a Salter personal weigher Model 209, designed to ensure consistent weighing irrespective of changes in ambient temperature. The capacity and graduation were 125 kg x 500 g. This machine was conveniently portable, robust and contained shock protected mechanisms.

Sitting height was measured to the nearest 0.001 m. with an *Aba anthropometer. Subjects sat on a table top with the backs of the knees directly above the edge of the table and feet were hanging unsupported. The back was stretched up straight; gentle traction was applied under the chin and the head was held in the Frankfort plane. The anthropometer was held vertically and in contact with the sacral and interscapular areas.

All circumference and skinfold measurements were taken on the left side of the body. Circumferences were measured using a flexible steel tape which was lightly in continuous contact with the skin. Chest circumference was taken at the union of the 3rd and 4th sternebrae and at right angles to the axis of the body. One recording was made following expiration and a second recording was made following maximal inspiration. Thigh circumference was taken at a marked one third

* obtainable from Abawerk Gmbh, Aschaffenburg, West Germany

sub-ischial height measured up from the lateral tibio-femoral joint space.

Measurement of skinfold thicknesses were taken at five sites using the Holtain/Tanner-Whitehouse (1955) skinfold calipers. according to the International Biological Programme recommendations (Weiner and Lourie, 1969). The sites used were over quadriceps femoris (at $\frac{1}{3}$ subischial level), over biceps and triceps muscles and in the subscapular and suprailiac regions. Care was taken to relax the subject to ensure that muscle tissue was not included in the measurement (Burkinshaw, Jones and Krupowicz, 1973). From these measurements, thigh muscle width (TMW) was estimated (see calculation Appendix 4). Also the percentage of body mass which is fat (% fat), and the fat free mass (FFM) were estimated indirectly using measurements of body density as in the method of Durnin and Rahaman (1967) (see Appendix 3).

<u>Ventilatory capacity of the lungs</u>

This was measured in the form of forced vital capacity (FVC) and forced expired volume in one second ($FEV_{1.0}$). The FVC is the normal volume of gas which can be expelled from the lung during a forced expiration following a full inspiration. The $FEV_{1.0}$ is the volume of gas expired in one minute during a forced expiration. Forced expiratory volume ratio (FEV %) which is the $FEV_{1.0}$ expressed as a percentage of the FVC, was calculated.

Gas volumes were measured using a portable McDermott timed bellows spirometer (McDermott, McDermott and Collins, 1968). This was calibrated daily before use by inserting the standard nylon orifice and fixing the supplied 500 g weight to the base of the bellows.

Each child wore a noseclip that effectively closed both nostrils. They were directed to stand with feet firmly apart, opposite the spirometer and to hold the breathing tube to check that the apparatus was adjusted to the correct height. Using a detached mouthpiece, a demonstration of FVC was given by the observer. The subject was then instructed to take in as full a breath as possible; to insert the mouthpiece; to close the lips firmly around it and to blow out hard until no more air could be forced out. After an initial practice attempt, any faults were corrected and in most cases a second practice was sufficient to obtain a correct performance. Three technically satisfactory readings were recorded, the mean of which was corrected to body temperature and pressure saturated with water vapour (BTPS). The lung capacities were standardised to a mean height of 133.6 cm for boys and 134.7 cm for girls. The formula used for standardisation plus a worked example appear in Appendix 5. The data were converted to natural logarithms before using simple linear and multiple regression analysis. This has the effect of changing the curvilinear relationship between ventilatory capacity and height in children, to a linear relationship (Cotes, 1979).

Six Minute Run

In the school playground four skittles were placed to mark a rectangle 29.5 m x 19.5 m (see Figure 1). The children were instructed

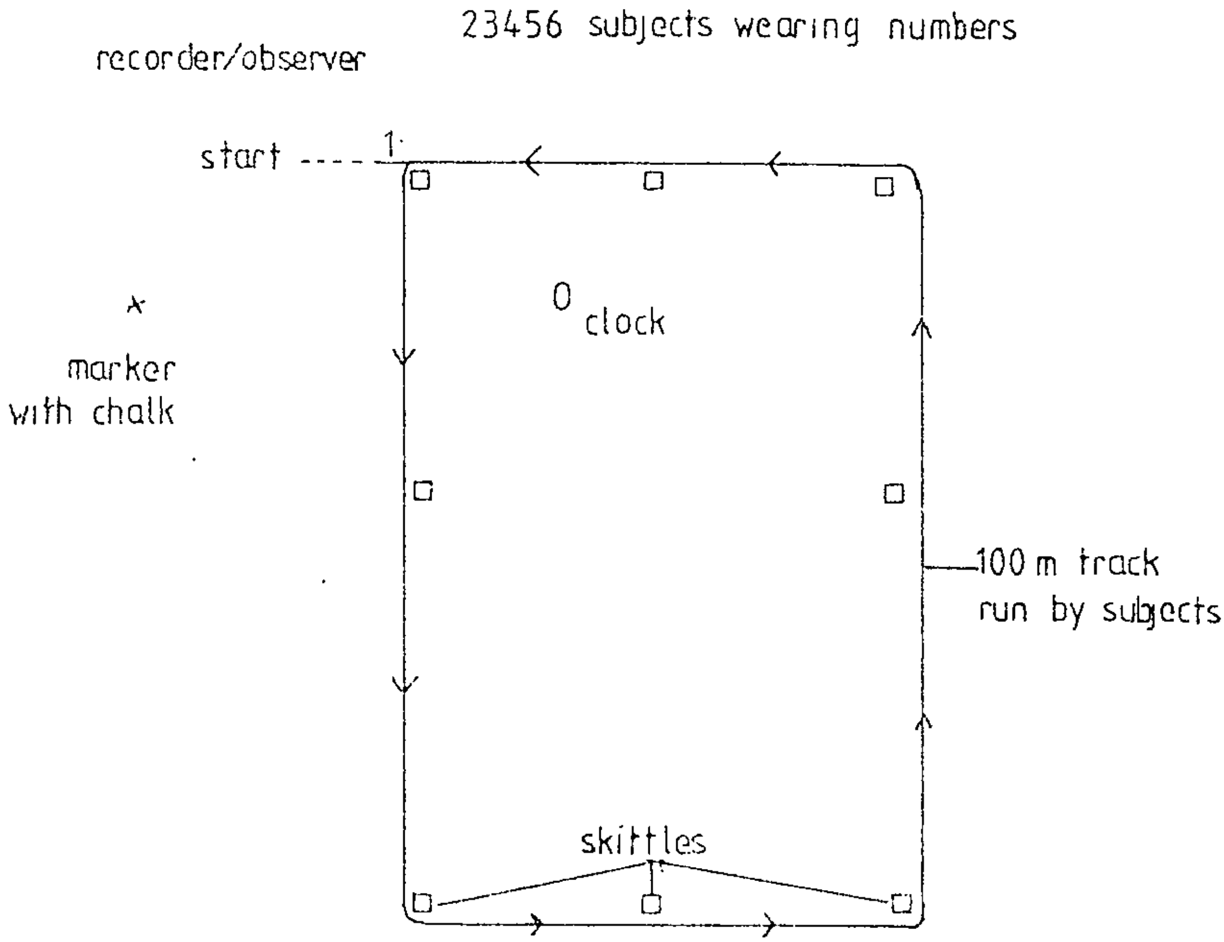


FIG. 1 ILLUSTRATION OF THE TEST RUN CIRCUIT AND ORGANISATION OF THE SIX MINUTE RUN

to run close to, but outside these markers so that in running one complete circuit, they covered 100 metres. Four other skittles were placed in the middle of the straights to guide the runners to keep to the 100 metre track. Subjects were tested in groups of six. Each were dressed in their PE kit wearing coloured bibs which displayed a number from one to six. Prior to the test the children spent a few minutes generally limbering and warming up and together they had a practice jog round the circuit. Then in numerical order they lined up, well back from the start, except for number one who stood at the start line. A clock with a sixty second sweep hand was positioned in view of all subjects. The children were told that the object of the test was to see how far they could run in six minutes. They were advised to run slowly for the first few laps and they could walk if they felt very tired. (In all, only ten found it necessary to slow down to a walk). At the end of the test it was suggested that they continued moving by walking away from the track for at least one further minute, in order to limber down.

The children set off at minute intervals. Each lap that was completed was recorded by the observer on a score sheet. This was double-checked by the child loudly shouting his own number as he passed over the starting line. Each child was informed when they had one minute left to run and this was followed by the final countdown of five seconds. No other verbal motivation was given. A helper ran and chalked the finishing spot at the end of the sixth minute. After the completion of all six runs, the distance from the starting line to the finishing spot was measured and added to the corresponding child's number of laps on the recording sheet. This gave a total distance in metres covered in six minutes for each subject. The results were read out to the children.

Questionnaires

Parent questionnaire(see Appendix 6)

After measuring children's lung capacity and recording anthropometric data, a questionnaire was given to each child. They were instructed to take this home and to help their parents answer the questions. When the form was completed it was to be returned to their class teacher. In all, 180 forms were completed and returned. The 24 children who failed to return their forms were interviewed; they discussed and verbally answered the questionnaire. The form was filled in by the observer.

Teacher questionnaire (see Appendix 7)

Class teachers were also given a questionnaire. This required them to enter two assessments; one of the child's habitual level of activity, and one of the child's general state of health. Also declared were the number of absences from school over the past year due to the child's genuine illness.

Information from both questionnaires was transferred to punch cards. Computer programmes were written to obtain data on all activity and health variables. Selected information was used to arrive at an Activity Grade and a Health Grade for each subject.

Activity Grade

Information from both questionnaires was used to place each child on an habitual level of activity scale, which ranged from 1 - 9. The variables selected from the parent questionnaire to assess habitual activity, were as listed below. Points for activity were awarded as shown.

Table 1: Selected questionnaire variables that contributed towards the subject's final Activity Grade

Question No	(as found in parent questionnaire Appendix 6)	Score
1	If the child walked or cycled more than 500 yds to school	2
2c, 3c	The number of hours spent being very active after school and during 1 weekend day, were added together.	
	If above 5 hours	2
	If between 3 and 4.9 hours	1
3h	If the estimated number of steps climbed per day were more than 60	2
	If between 20 and 59	1
6b	If the child used an outdoor playing area often	2
8	If the parent placed their child in a 'very active group'	2
	or 'of average activity group'	1
	MAXIMUM TOTAL	10

The score was then looked at in relation to the teacher's assessment of the child's activity level. If necessary the score was adjusted by a maximum of two classes to bring the final category closer to the teacher's assessment.

The Activity Scale ranging from 1 - 9 was then reduced to a final Activity Grade 1 - 3. It was observed that the activity grading of the children (1 - 9) produced a negatively skewed distribution, for it was likely that most children would score some points for activity. In order to obtain Very Active and Inactive groups fairly balanced in numbers, together with the observation that the 3 lowest categories of 2 of the conditions (i.e. House boys and House girls) contained no subjects; this resulted in grades being reduced as follows.

Table 2: Classification of Activity Grade

Description	Activity Scale (1 - 9)	Activity Grades (1 - 3)	N
Inactive	1 - 4 inclusive	1	33
Actively Average	5 - 7 inclusive	2	116
Very Active	8 - 9 inclusive	3	55

Later in this study just the 2 groups of Inactive and Very Active children were selected for further data analysis.

Activity preferences

The parent/child questionnaire asked for the child's most vigorous activity to be declared. These activities were then classified on a scale from 1 - 8; those deemed to be amongst the most energetic activities were placed in Class 1 and the less vigorous activities moved progressively down the scale. The classification was devised with reference to the energy requirements of various activities (Passmore and Durnin, 1955; Banister and Brown, 1968).

Class 1 Vigorous individual activity

e.g. swimming, gymnastics, dancing, wrestling, cycling

Class 2 Vigorous team activity

e.g. football, netball, badminton

Class 3 Intermittent vigorous activity

e.g. sports, miscellaneous running type activities, skipping, punchball

Class 4 Less vigorous activities

e.g. chasing games, horseriding

Class 5 Running and standing games

e.g. cricket, rounders, soldiers

Class 6 Slow moving activity

e.g. moving games, walking, cleaning

Class 7 Mild activity

e.g. visiting, Brownies, fishing

Class 8 Sedentary activity

e.g. talking, reading, drawing

Although it was indicated how long the child was generally involved in this activity the extent of their energetic participation was not assessed.

Health Grade

The questionnaires asked for three values on the present state of health of the child. Two were given by the teacher and one the parent.

The two assessments by the teacher were:

Item 1 - the estimated number of absences from school during the past year due to ill health

Item 2 - the placement of the child in one of three categories which were above, below, or of average health.

The one assessment by the parent was:

Item 3 - the estimated number of days ill over the past year due to upper respiratory illness.

Subjects scored when the tendency was towards the less healthy than average group. For Item 1 and Item 3, days were put into class intervals. Each subject scored one point for each class interval above the group average. For Item 2, children scored two points for being placed in the less healthy than average category, no points for being in the average health class and minus two points when placed in the more healthy than average class. A total score for all three items was accredited to each child. If this was five or above, then the child was deemed to be in the less healthy than average category.

Children placed in the healthier than average category were those with less than seven half days school absences (due to illness), plus the parents' indication that the child was ill for less than one week in the year.

In order that the final Health Grade should be consistent with the final Activity Grade, the numbers of 1, 2 and 3 were used for each as shown below.

Table 3: Final gradings of Activity and Health

Description	Activity Grade	Description	Health Grade
Inactive	1	Less healthy than average	1
Actively Average	2	Of average health	2
Very active	3	Healthier than average	3

SUBJECT GROUPINGS AND HYPOTHESES

The data were looked at first of all in boy groups and girl groups. The subjects were then divided into their four home dwelling groups of flat boys, house boys, flat girls and house girls; here comparisons were made between flat and house groups, but within the same sex. The Hø (null hypothesis) stated that there would be no differences between high rise flat children (living above the 2nd floor) and house children (living in a conventional 2 storeyed house) in the following variables:

1. Anthropometric characteristics (measured according to IBP Handbook No 9)
2. Ventilatory capacity (using a McDermott spirometer)
3. Six Minute Run Test (adapted from Cooper ,1968 and Jackson and Coleman, 1976)
4. Habitual Activity Grades (assessed from parent and teacher questionnaire)
5. Health Grades (free from upper respiratory illness over 1 year).

Different groups were then formed according to each subject's habitual Activity Grade. Children of Average Activity were withdrawn from the group leaving data from the Very Active group of 55 children to be compared with that of the Inactive group of 33 children. In this case, the Ho stated that there would be no differences between Very Active and Inactive children (as assessed from parent and teacher questionnaires) in

1. Anthropometric characteristics

2. Ventilatory Capacities

3. Six Minute Run Test

4. Health Grades (all as previously defined).

DATA ANALYSIS

The Statistical Package for Social Sciences computer programme was used to analyse the activity and health data from the parent/child and teacher questionnaires. Four subfiles were set up consisting of flat boys, house boys, flat girls and house girls. Certain variables were then selected in order to estimate a final Activity Grade and a final Health Grade for each subject. The procedure used in finding these grades is explained on page 51 and page 53 respectively. Grades were then entered onto the subject profile form (see Appendix 2).

All anthropometric and lung function measurements plus running distances were entered directly onto the profile form. Other entries required calculating first; the procedure involved for TMW is shown in Appendix 3 and the calculations for % body fat and FFM appear in Appendix 4. Added information required for computer analysis included $\log_e$ stature (cm) with $\log_e$ standardised $FEV_{1.0}$ (l) and FVC (l), and also $\log_e$ stature (m) with $\log_e$ standardised $FEV_{1.0}$(l) and FVC (l). All figures were then transferred to two punch cards per subject.

Three separate programmes were used to compute simple linear and multiple regression analysis, along with the calculations of other statistical parameters from the data such as means, standard deviations, ranges, coefficient of variation and standard errors.

Tests of relationship were calculated using the Pearson Product Moment Correlation Coefficient. Tests of significance of differences in the form of student 't', χ^2 and F tests were used where applicable in order to make comparisons between Dwelling groupings and Activity groups.

RESULTS

RESULTS

The results appear under three main headings according to the grouping of the subjects. The first section includes all 204 subjects where information is sometimes presented in separate boy and girl groups. The second section divides the total group into home dwelling groups and according to sex. The third section involves 88 children who belong either to an habitually Very Active group or an Inactive group.

TWO GROUPS : BOYS AND GIRLS

Anthropometric characteristics and lung capacity data

Measurements were taken on a total of 204 subjects, 92 of which were boys and 112 were girls. They all were within the age range of over 7 years but under 12 years old.

Table 4: Details of the total group of subjects (mean values and ranges)

		Boys	Girls
Number		92	112
Age	(a)	9.27 (7.2 - 11.5)	9.67 (7.3 - 11.6)
Stature	(m)	1.34 (1.1 - 1.5)	1.35 (1.12 - 1.55)
Sitting height	(m)	0.72 (0.6 - 0.8)	0.72 (0.57 - 0.84)
Body mass	(kg)	28.97 (17.6 - 50)	30.65 (18 - 54.5)
Thigh muscle width	(cm)	8.95 (7.4 - 10.6)	9.25 (8 - 10.9)
Expired chest circumference	(cm)	61.98 (54 - 83)	61.56 (53 - 80)
Inspired chest circumference	(cm)	67.74 (57.5 - 86)	67.34 (58 - 86.2)
Chest expansion	(cm)	5.74 (2.5 - 9)	5.77 (2.2 - 9)
Triceps skinfold	(mm)	7.36 (2.8 - 20)	8.99 (4.4 - 22)
Subscapular skinfold	(mm)	4.67 (3.0 - 29)	5.76 (3.2 - 19)
Sum of four skinfolds	(mm)	21.1 (11.7 - 81)	26.7 (11.9 - 76.5)
Body fat	(%)	12.5 (6.4 - 30.3)	19.9 (11.5 - 33.3)
FFM (fat free mass)	(kg)	25.13 (16 - 39.4)	24.33 (14.9 - 36.1)
$FEV_{1.0}$	(l)	1.67 (1.02 - 2.76)	1.61 (1.02 - 2.8)
FVC	(l)	1.93 (1.13 - 3.11)	1.81 (1.07 - 3.08)
FEV x 100/FVC	(%)	86.2 (65 - 95)	88.4 (74 - 96)

The normal ranges of static FVC (l) were plotted against standing height (cm) in Fig 2 and show regression lines of boys (1), girls (2) and the total subject group (3). The regression lines of the boys and the girls can be seen to be parallel, but as the intercept was different the boys' group was treated separately from the girls. The boys' lung capacities were standardised to a standing body height of 133.6 cm using a regression coefficient of 0.034. The girls' values used for standardisation were 134.7 cm for standing height together with a regression coefficient of 0.033 (for standardisation procedure see Appendix 5).

In order to obtain a rectilinear relationship of lung function on stature, all figures were converted into natural logarithms as shown in the regression relationship in Fig 3: $\log_e$ $FEV_{1.0}$ (l) on $\log_e$ height (cm), and Fig 4: $\log_e$ FVC (l) on $\log_e$ height (cm). Regression lines of boys (1) girls (2) and the total subject group (3) are shown. After logarithmic transformation of the data, the correlation coefficient improved from 0.78 to 0.79. See over page for figures 2, 3 and 4.

$FEV_{1.0}$ and FVC multiple regression analysis

Multiple regression analysis of $FEV_{1.0}$ and FVC showed that ventilatory capacity was related to stature, but the inclusion of age did not reduce significantly the variability about this regression line. However, by including FFM a significant improvement was obtained. The $FEV_{1.0}$ multiple regression on stature and FFM was significantly improved by the inclusion of habitual activity (grades 1 - 9), whereas the FVC multiple

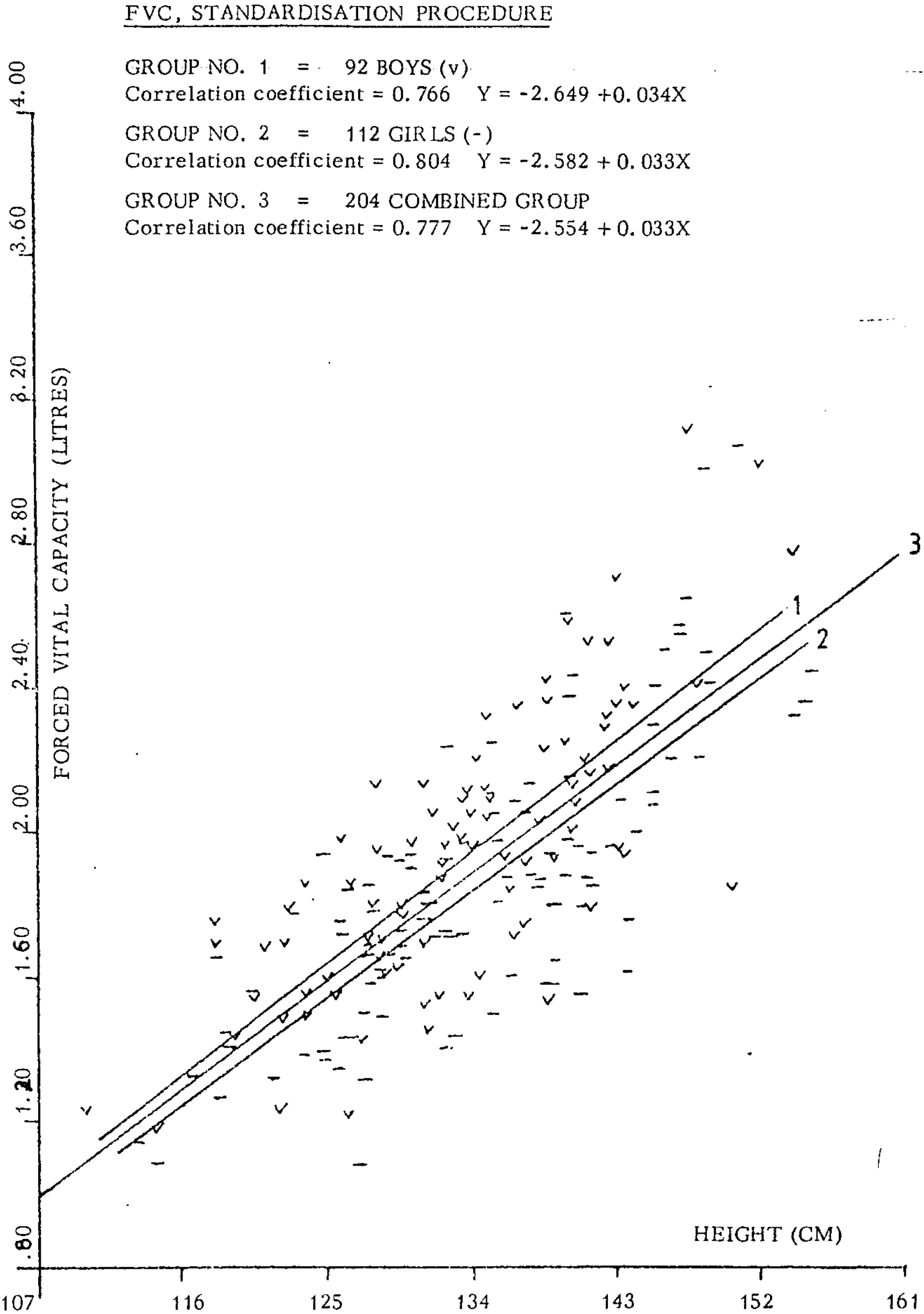


FIG 2 REGRESSION OF FVC (l) ON HEIGHT (CM)

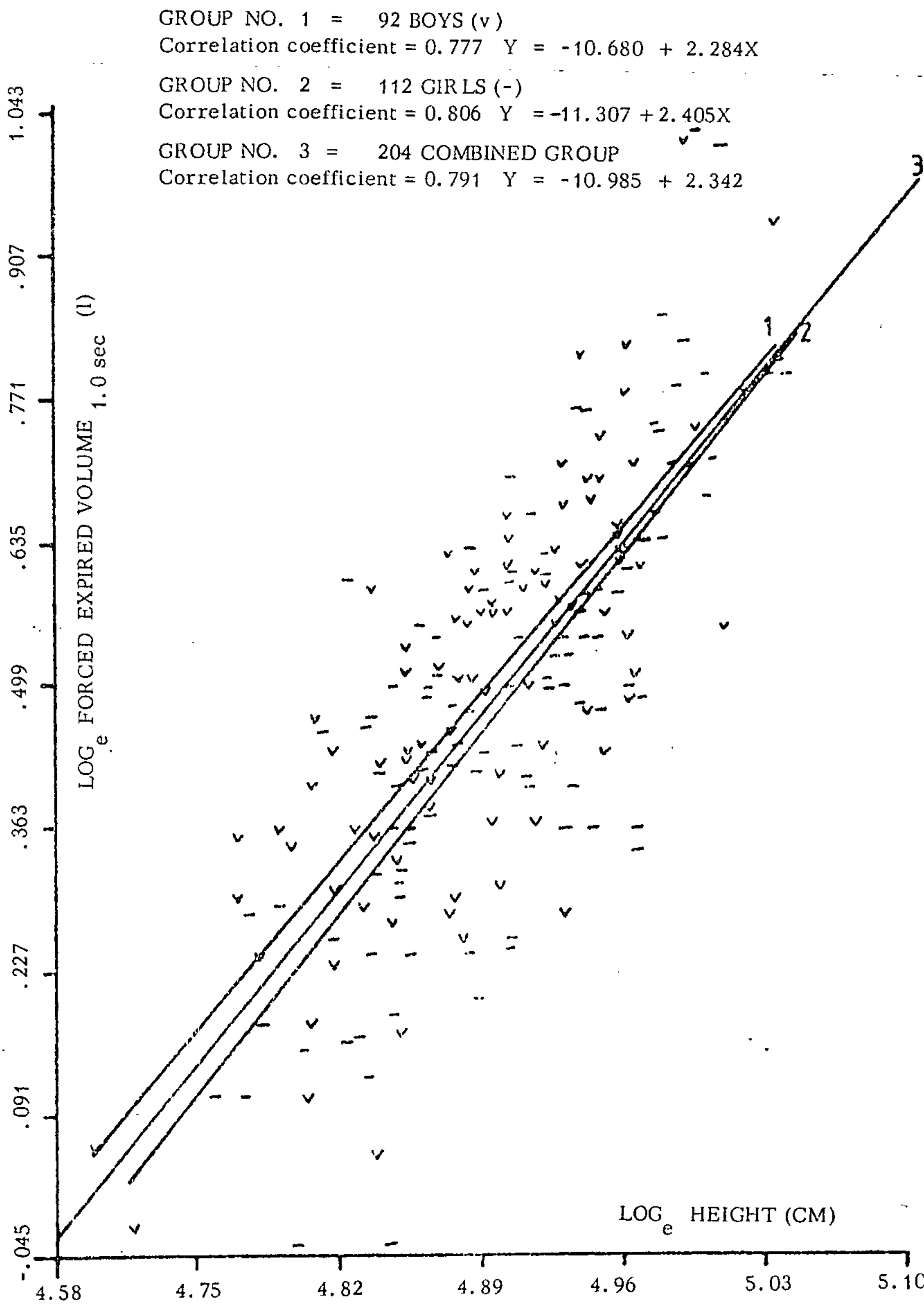


FIG 3 REGRESSION OF LOG_e $FEV_{1.0}$ (l) ON LOG_e HEIGHT (CM)

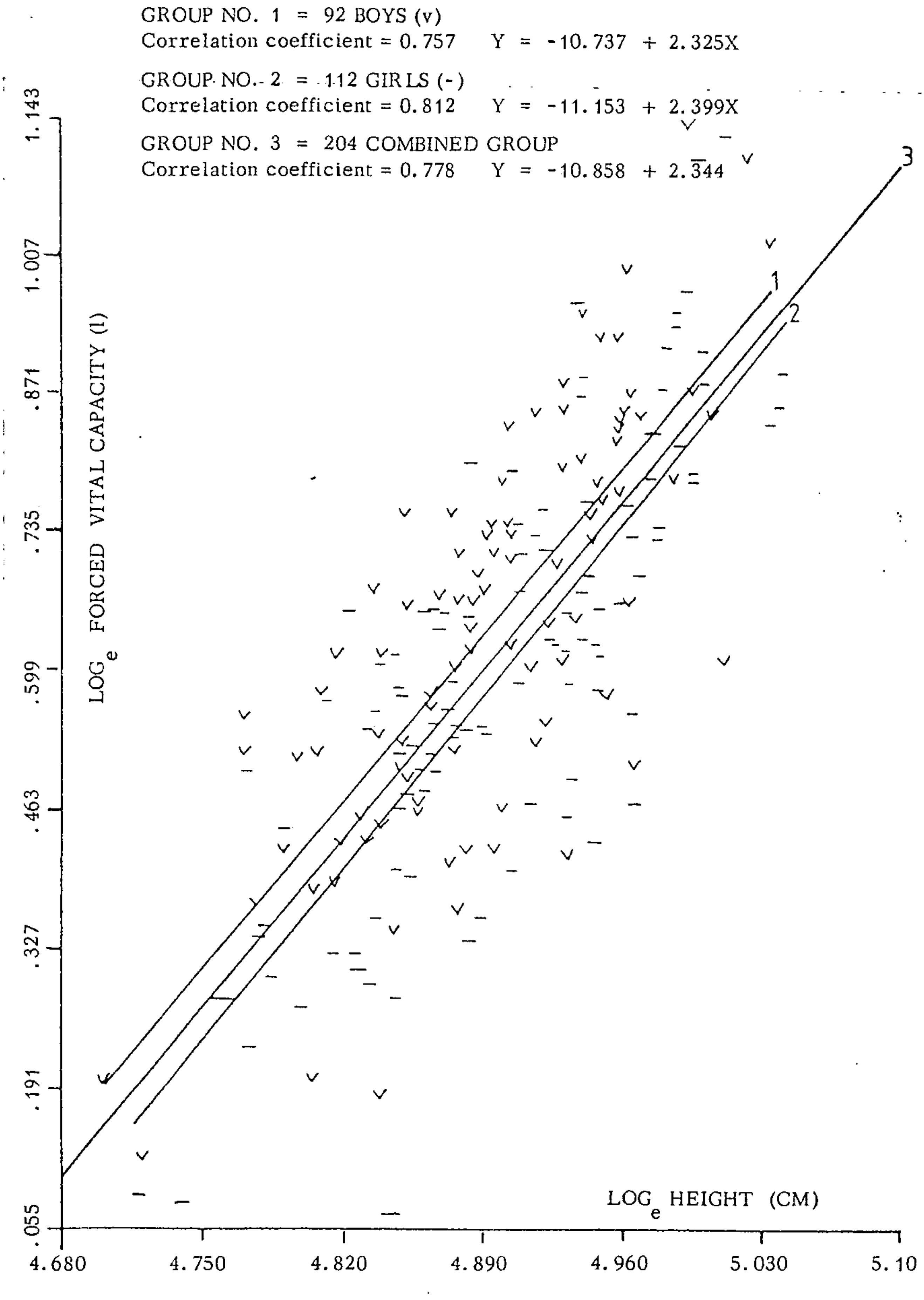


FIG 4 REGRESSION OF LOG$_e$ FVC (l) ON LOG$_e$ HEIGHT (CM)

regression on stature and FFM was significantly improved by the inclusion of sex.

Table 5: Regression relationships of ventilatory capacity on stature, fat free mass, habitual activity scale 1 - 9 and sex. Figures in brackets show regression relationships with the habitual activity scale reduced to grades 1 - 3.

Regression parameters	$\log_e$ $FEV_{1.0}$	$\log_e FVC$
$\log_e$ stature (cm)	1.48 (1.53)	1.45 (1.45)
FFM (kg)	0.014 (0.013)	0.015 (0.015)
activity grades 1 - 9 (1 - 3)	0.009 (NS)	NS (NS)
sex boy = 1 girl = 2	NS (NS)	-0.039 (-0.039)
constant term	-7.15 (-7.34)	-6.81 (-6.81)
standard error	0.120 (0.121)	0.122 (0.122)

N = 204 boys and girls   R = 0.810

After allowing for stature and activity (1 - 9) on the $FEV_{1.0}$ regression, and stature and sex on the FVC regression, the ventilatory capacity showed that there was a 10.4% improvement by the inclusion of FFM (i.e. antilog$_e$ of 0.014 and 0.015 shown in Table 4). After allowing for stature and FFM, the habitually active children showed a 10% improvement in $FEV_{1.0}$ (i.e. antilog$_e$ of 0.009, see Table 5). After allowing for stature and FFM the FVC of the boys was significantly greater than that of the girls by 11% (i.e. antilog$_e$ of -0.039, see Table 5).

The multiple correlation of R = 0.81 can be regarded as a high correlation.

With reduced activity grades (1 - 3) multiple regression analysis revealed that stature, sex and FFM still made a positive improvement to FVC, whereas activity no longer significantly contributed to the improvement of stature and FFM on $FEV_{1.0}$. However the multiple correlation coefficient remained at R = 0.81 (see 0.121).

Having the total group of subjects placed in Activity Grades 1, 2 or 3 (see Table 5, figures in brackets), direct comparisons could be made with regression relationships of ventilatory capacity of Chinese children from Hong Kong (Jones et al., 1977) (see Discussion p. 102). These children were also graded 1, 2 or 3 according to their degree of habitual activity.

FOUR DWELLING GROUPS

This section of results shows the subjects divided into four groups, namely Flat Boys (FLBO), House Boys (HOBO), Flat Girls (FLGI) and House Girls (HOGI). The capital letters in brackets may be used in the script in future, when referring to the different groups.

Details and comparison of measurements

Anthropometric and ventilatory capacity values are shown in detail in Tables 6 and 7. Variables for Table 6 were selected when a 't' test revealed a significant difference between the Dwelling Groups of either or both sexes. Table 7 contains the rest of the variables measured that showed no significant differences.

Table 6: Mean $\pm$ S.D. of measurements that revealed a significant difference according to home dwelling

Variable		Boys (n = 92) Flat Boys (46) Mean	S.D.	House Boys (46) Mean	S.D.	t	Girls (n = 112) Flat Girls (56) Mean	S.D.	House Girls (56) Mean	S.D.	t
Body mass	(kg)	29.6	8.3	28.4	5.1		31.85	8.01	29.46	5.90	*
Biceps skinfold	(mm)	4.5	2.4	3.8	1.4	*	5.5	2.67	4.70	2.18	*
Triceps skinfold	(mm)	8.0	3.4	6.8	2.2	*	9.9	3.58	8.2	2.67	***
Subscapula skinfold	(mm)	5.2	4.3	4.1	1.00	(NS)	6.2	3.08	5.3	2.35	*
Supra iliac skinfold	(mm)	5.8	5.9	4.0	1.3	*	7.7	3.84	5.9	2.78	***
Sum of above 4 skinfold	(mm)	23.5	14.4	18.7	4.7	*	29.3	12.24	24.1	9.25	**
Anterior thigh skinfold	(mm)	11.1	6.6	9.2	3.3	*	14.9	5.79	12.3	4.34	***
% Body Fat	(%)	13.5	5.3	11.6	2.9	*	21.0	4.30	18.9	3.94	***
†Six minute run	(m)	1069.3	140.1	1107.2	106.2	(NS)	970.6	99.7	1013.1	75.0	**
†Activity category (1 = Inactive, 3 = Very active)	(1-3)	1.95	0.59	2.39	0.58	***	1.70	0.60	2.41	0.53	***
†Health category (1 = below average, 3 = above average)	(1-3)	1.85	0.55	2.07	0.44	*	1.91	0.58	1.95	0.48	

* $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$

† These variables although listed here, are mentioned in greater detail later in the study.

Table 7: Mean ± S.D. of measurements that revealed NO significant difference according to home dwelling

Variable		Boys (n = 92) Flat Boys (46)		House Boys (46)		Girls (n = 112) Flat Girls (56)		House Girls (56)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Age	(a)	9.29	1.37	9.25	1.23	9.65	1.21	9.68	1.21
Stature	(m)	1.33	0.09	1.34	0.08	1.36	0.10	1.34	0.09
Sitting height	(m)	0.723	0.043	0.721	0.041	0.731	0.057	0.722	0.045
$\frac{1}{3}$ sub ischial	(m)	0.205	0.018	0.205	0.015	0.207	0.020	0.205	0.017
Thigh circumference	(cm)	38.27	6.35	36.77	3.18	39.87	5.41	38.14	3.79
Thigh muscle width	(cm)	9.00	0.84	8.89	0.68	9.34	0.75	9.16	0.58
FFM	(kg)	25.25	5.64	25.02	4.09	24.90	5.17	23.75	3.99
Expired chest circ.	(cm)	62.7	6.41	61.25	3.31	62.42	5.68	60.70	4.00
Inspired chest circ.	(cm)	68.45	6.59	67.02	3.51	68.03	5.82	66.66	4.23
Chest expansion	(cm)	5.72	1.67	5.75	1.34	5.60	1.39	5.94	1.40
†$FEV_{1.0}$	(l)	1.68	0.211	1.66	0.171	1.61	0.215	1.62	0.193
†FVC	(l)	1.93	0.27	1.92	0.21	1.80	0.22	1.83	0.23
FEV x 100/FVC	(%)	86.7	4.53	85.6	7.26	88.5	4.83	88.3	4.23

† $FEV_{1.0}$ and FVC were standardised to a mean height of 1.34 m (boys) and 1.35 m (girls)

Six Minute Run

The results of the Six Minute Run test are shown with the boys and girls placed in their home dwelling groups.

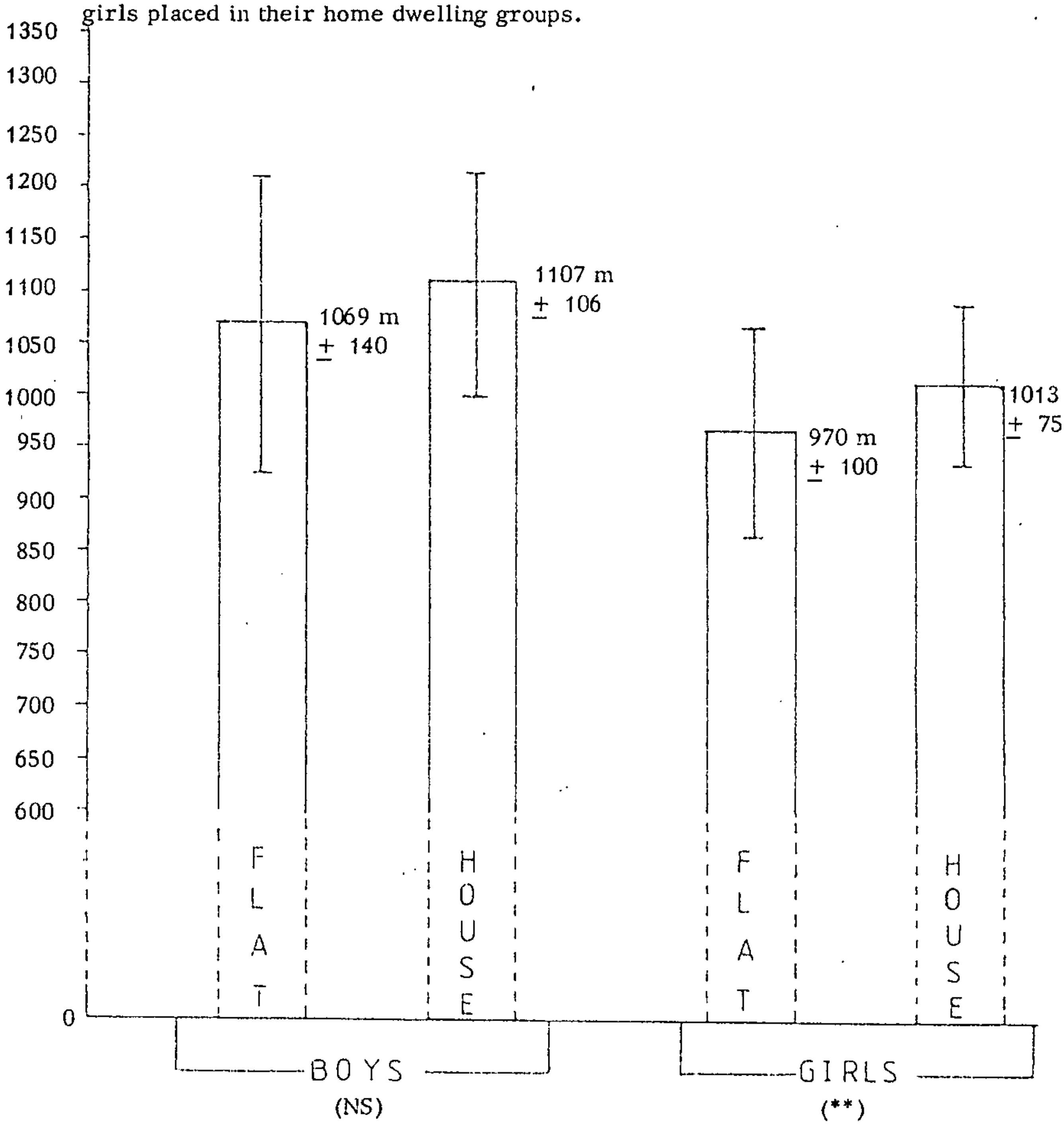


FIG. 5 MEAN AND S.D. OF THE DISTANCE (m) RUN IN 6 MINS.

** $P < 0.01$

Six Minute Run

In order to establish the significance of difference between means a 't' test for independent samples was used. The H_o stated that there was no difference in the distance run between FLBO and HOBO groups, or between FLGI and HOGI groups. As the histogram in Fig 5 shows the expected direction, a one-tailed test was appropriate.

The boy's value of $t = 1.469$ was smaller than that shown at the 0.05 level ($t = 1.675$) one-tailed. The girl's value of $t = 2.578$ was larger than that shown at the 0.01 level ($t = 2.37$) one-tailed. In the case of the boys, their t value approached significance but the wide range of scores recorded by the FLBO group militated against this. The size of samples used was barely adequate statistically and the use of larger samples (100+) might well have led to a clear cut statistical difference. The boys' H_o cannot therefore be accepted with confidence and it must be concluded that statistically there is no difference in the flat and house boys' Six Minute Run results. In the case of the girls the H_o was rejected and it was concluded that there was a significant difference in the distance run between FLGI and HOGI groups.

Activity Scale

The scores of selected items from both parent and teacher questionnaires (see Page 51) were used to place each child on the Activity Scale 1 - 9.

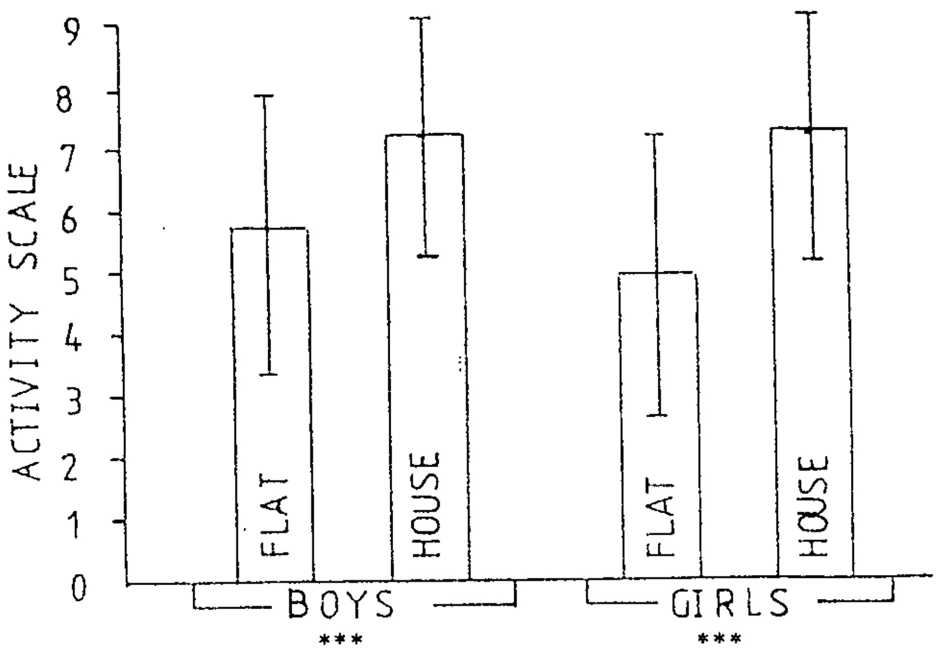
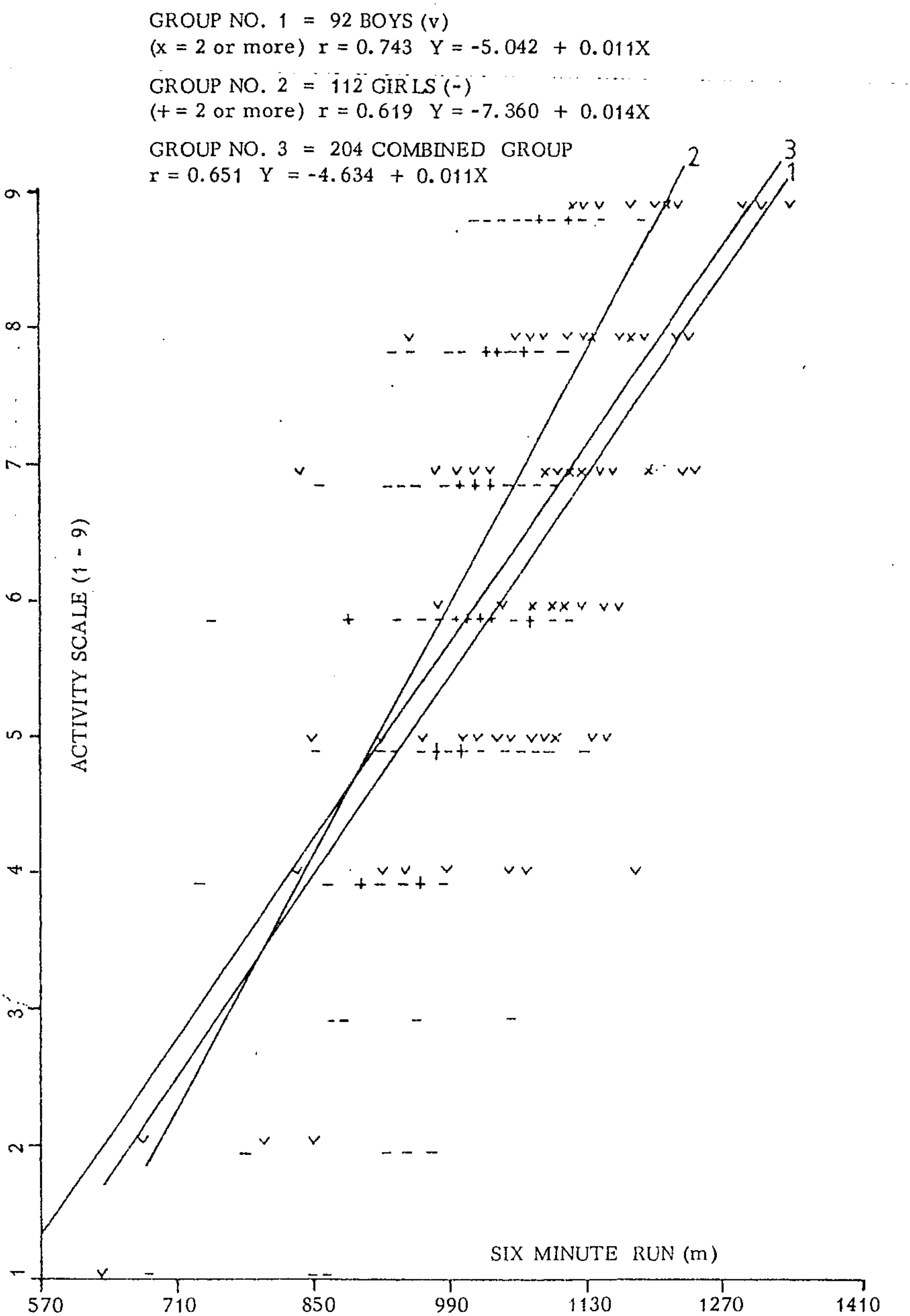


FIG 6 ACTIVITY SCALE (MEAN AND S.D.) OF EACH DWELLING GROUP

*** P <0.001

A t test for independent samples to establish the significance of difference between means was used. The H_o stated that there would be no significant difference in activity scale attained between FLBO and HOBO, or between FLGI and HOGI. As the above diagram shows the expected direction, a one-tailed test was appropriate. The boys'value of t = 4.05 was larger than that shown at the 0.001 level (t = 2.63). The girls' value of t = 7.82 was also significantly larger than that shown at the 0.001 level (t = 2.66). The H_o was rejected and it was concluded that there was a significant difference between the Activity Scale of the FLBO and HOBO and of the FLGI AND HOGI.

Simple linear regression analysis of Activity Scale on the Six Minute Run is shown in Figure 7. A correlation coefficient of r = 0.651 was found between the two parameters when the combined group was considered. The standard error of the estimate about the regression line was 1.449 with a coefficient of variation of 23%. The boys' correlation coefficient of 0.743 can be deemed a high correlation whereas the girls' figure of 0.619 is recognised to be only of modest correlation.



Boys (v and x) identified on the scale line, girls (- and +) identified immediately below

FIG 7 REGRESSION OF ACTIVITY SCALE (1 - 9) ON SIX MINUTE RUN DISTANCES (m)

Play Activity and Facilities

Activity Preferences

In the questionnaire the child's most vigorous activity was stated. These activities were entered in classes which ranged from 1 - 8. Class 1 contained the most vigorous individual activities, then as the activities were deemed less vigorous they were entered progressively down the scale (see page 53 for examples). The results were totalled with the subjects placed in their four home dwelling groups.

Table 8: Percentage figures of the child's most vigorous activity

	Group	Class 1	2	3	4	5	6	7	8
Boys	(FLBO	62.9	20.0	5.7	2.9	-	-	2.9	5.6
	(HOBO	24.4	48.8	19.5	4.9	-	-	2.4	-
Girls	(FLGI	51.9	13.5	15.4	3.8	3.8	1.9	3.8	5.9
	(HOGI	40.4	10.6	27.7	10.6	2.1	2.1	2.2	4.3

In order to compare the frequency of preferred activity chosen by the four separate groups (FLBO, HOBO, FLGI, HOGI) a Chi Square (χ^2) Test (2 x 5) was applied. The H_o was that outdoor activity preferences and type of home dwelling were not related.

The number of classes were scaled down to five columns viz:

Class 1	=	Column 1
Class 2	=	Column 2
Classes 3 & 4	=	Column 3
Classes 5 & 6	=	Column 4
Classes 7 & 8	=	Column 5

- The Chi Square Test

$$\chi^2 = \Sigma \frac{(O-E)^2}{E}$$

Flat and House Boys:

$$\frac{(O - E)^2}{E}$$

Group	Column 1	2	3	4	5
FLBO	8.65	6.02	3.78	-	1.78
HOBO	8.38	6.03	3.78	-	1.67

$$\chi^2 = \Sigma \frac{(O-E)^2}{E}$$

$$= \underline{40.09} \quad (d.f. = 3)$$

$$\chi^2 \text{ for } p < 0.01 = 11.34 \quad (d.f. = 3)$$

The obtained value exceeded this by a wide margin showing the differences in choices of activity to be highly significant. Therefore the H_o was rejected and it was concluded that boys activity preferences were related to their home dwelling.

Flat and House Girls:

$$\frac{(O-E)^2}{E}$$

Group	Column 1	2	3	4	5
FLGI	0.703	0.174	3.172	0.118	0.316
HOGI	0.728	0.175	3.205	0.114	0.316

$$\chi^2 = \Sigma \frac{(O-E)^2}{E}$$

$$= \underline{9.021} \quad (d.f. = 4)$$

$$\chi^2 \text{ for } p < 0.05 = 9.49 \text{ (d.f. = 4)}$$

This value closely approximates significance at the 0.05 level conforming to the trends of the other groups but not as pronounced. Therefore the H_o cannot be rejected but neither can it be confidently held.

Flat Dwellers and House Dwellers:

$$\chi^2 \text{ for } p < 0.01 = 12.38 \text{ (d.f. = 4)}$$

The flat and house dwellers' obtained value was 18.75 showing that their choice of vigorous activity was significantly different at this level.

Boys and Girls:

$$\chi^2 \text{ for } p < 0.01 = 11.34 \text{ (d.f. = 3)}$$

The boys and girls obtained value was 15.50 showing that their pattern of choice of activity was significantly different at this level.

Table 9: Summary of Chi Square Test results on the activity preferences chosen by the different subject groups

Subject groups	d.f.	Subjects χ^2 score
Flat Boys + House Boys	3	40.09 ***
Flat Girls + House Girls	4	9.02 N.S. (C.R. ≈ 9.49)
Total Flat + Total House Dwellers	4	18.75 **
Total Boys + Total Girls	3	15.50 **

* P <0.05 ** P < 0.01 *** P < 0.001

- School Physical Education

The parent and child together were asked to indicate on the questionnaire whether they would like the child to have more, or less, or continue to have the same amount of Physical Education at school. For comparative purposes the results were percentaged.

Table 10: Percentage parent/child indications of whether more, or the same, or less time should be spent on Physical Education in School

Group	N	Time spent on Physical Education More	Same	Less
		%	%	%
FLBO	46	47	53	-
HOBO	46	51	49	-
FLGI	56	54	44	2
HOGI	56	51	47	2

Approximately half indicate that either the parent, or the child, or both wish that the child had more Physical Education in school.

- Outdoor Facilities for Play

The parent questionnaire asked two questions that were specifically related to outdoor playing facilities. One asked if the child had available outdoor facilities for play and the other asked whether or not the child used these areas often. The percentage results are shown in the following table.

Table 11: Availability and use of outdoor facilities for play

Subject groups		Percentage children having an available play area	Percentage children using this outdoor play area often
Boys	(FLBO	95	66
	(HOBO	88	69
Girls	(FLGI	92	50
	(HOGI	98	81

House boys are slightly less well catered for with outdoor play facilities. There is a marked difference between the use of the facilities by flat girls and house girls (50% and 81% respectively).

The children who were not using the available outdoor play facilities were also asked in the parent questionnaire to state the particular reason. A variety of answers were put forward and these were categorised into Groups 1 - 8 as shown in Table 12 overleaf.

Table 12: Reasons for children not using available outdoor facilities

		Valid observations	Child uses facilities	%	Site access difficulties	Hazards on site	Supervision problems	Danger from others	Site unattractive	Child too old	Child stays at home	Other problems
Groups			0		1	2	3	4	5	6	7	8
Boys	FLBO	36	25	69	3	1	-	2	1	2	2	-
	HOBO	39	29	74	1	2	-	1	1	-	2	3
Girls	FLGI	52	28	54	3	1	2	5	4	4	-	5
	HOGI	47	39	83	1	-	1	2	-	-	1	3
TOTALS					8	4	3	10	6	6	5	11

FLGI use the play areas least, followed by FLBO, 54% and 69% respectively. The HOBO and HOGI, 74% and 83% respectively, claim to make greater use of outdoor play facilities. FLGI stay away due to 'danger from others', 'site unattractive' and because of age restrictions. FLGI and FLBO appear to have greater access difficulties to the play area. Girls only appear to have supervision problems.

Health

Both questionnaires requested information on various aspects of the state of physical health of the child.

- Doctor Consultation

The number of consultations with a doctor when the child was suffering from upper respiratory infections were recorded. The appointments with the doctor may have been at the surgery, the clinic or in the child's house; the number recorded spanned over the past year. The number of doctor consultations in one year per child (mean and S.D.) were as follows:

Group	Mean	S.D.	Group	Mean	S.D.
FLBO	2.03	2.57	FLGI	1.788	2.04
HOBO	1.22	1.17	HOGI	1.294	1.84

The high value of the standard deviation in all the cases indicated an extremely wide spread of the scores about the mean giving a platykurtic profile. This departure from the normal distribution precludes the use of a 't' test. Instead a χ^2 test of significance was applied to the actual number of doctor consultations per child (see Table 13) and following text.

Table 13: Frequency of doctor consultations according to specific infection

Group	N	Type of upper respiratory infection							
		Cold	Throat	Cough	'Flu	Bron-chitis	Pneu-monia	Total	χ^2
FLBO	36	14	28	21	5	5	0	73	
FLGI	52	21	32	23	9	8	0	93	***
All FLAT children	88	35	60	44	14	13	0	166	**
HOBO	40	8	17	13	4	4	0	46	
HOGI	50	13	28	12	13	0	0	66	
All HOUSE children	90	21	45	25	17	4	0	112	
Total HOUSE + FLAT children	178	56	105	69	31	17	0	278	
‡ % FLAT consultations		100	100	100	85	100	0	100	
‡ % HOUSE consultations		59	73	56	100	30	0	66	

** $p < 0.01$ *** $p < 0.001$

‡ When comparing Flat and House children with regard to doctor consultation for specific respiratory infection, it can be seen that apart from 'flu, Flat children consulted their doctor considerably more often for upper respiratory ailments than did House children. An overall percentage comparison was made showing that House children consulted their doctor on only 66% of the occasions that Flat children felt the need for doctor attendance.

To find if there was a significant difference in the range of doctor consultations between FLBO and HOBO groups and between FLGI and HOGI groups, two Chi Square (χ^2) tests were used. The H_0 stated that the child's dwelling place and the pattern of doctor consultation during respiratory illness were not related. In the case of the boys, the obtained score exceeded the χ^2 value at the 0.01 level of significance. The girls' obtained score exceeded the χ^2 value at the 0.05 level of significance. Therefore the H_0 was rejected and it was concluded that boys and girls living in houses have a significantly different pattern of frequency of doctor consultation from that of boys and girls living in high rise flats.

It may be seen from Table 13 that the most common respiratory ailment requiring the doctor's attention was a throat infection followed by coughs, cold, 'flu and bronchitis. No children within the year had suffered from pneumonia.

- Days ill

Recorded on the questionnaire were the number of days during the past year that the parent and child together claimed that the child had suffered from a respiratory infection. This information contributed to the child's final Health Grade (1 - 3), but it is also displayed in the following table in order to see the relationship with the number of doctor consultations.

Table 14: Relationship (r) of the number of days ill on the number of doctor consultations

Group	N	Days Ill		Doctor Consultation		Correlation Coefficient	Dr. consult. x 100 / Days Ill
		Mean	S.D.	Mean	S.D.	r	%
FLBO	36	5.50	3.68	2.03	2.57	0.58 **	37
FLGI	52	4.92	3.71	1.79	2.04	0.64 **	36
HOBO	40	4.00	3.15	1.12	1.65	0.58 **	28
HOGI	50	4.55	2.92	.29	1.84	0.47 **	29

** $p < 0.01$ Significance of coefficients of correlation Table D Guilford, J. P., Fundamental Statistics in Psychology and Education (5th Edition), Tokyo, London. McGraw-Hill, 1973.

As the relationships of the four subject groups of days ill on the number of doctor consultations range from $r = 0.473 - r = 0.640$ this can be interpreted as a modest though significant correlation.

Flat children claim to be ill more days in the year and to consult their doctor more frequently, showing that they total a higher percentage of doctors' visitations when they are ill.

- Health Grade 1 - 3

Three items contributed to the final Health Grade. They were the number of days ill due to respiratory infection, the number of school absences due to ill health and the placement by the class teacher in an average, or above average, or below average Health Category (see details page 53). Boys and girls were grouped according to home dwelling and the percentage children calculated to be in Grade 1 - the less healthy than average, are shown in Fig 8. The percentage of children in Grade 3 - the more healthy than average, are shown in Fig 9.

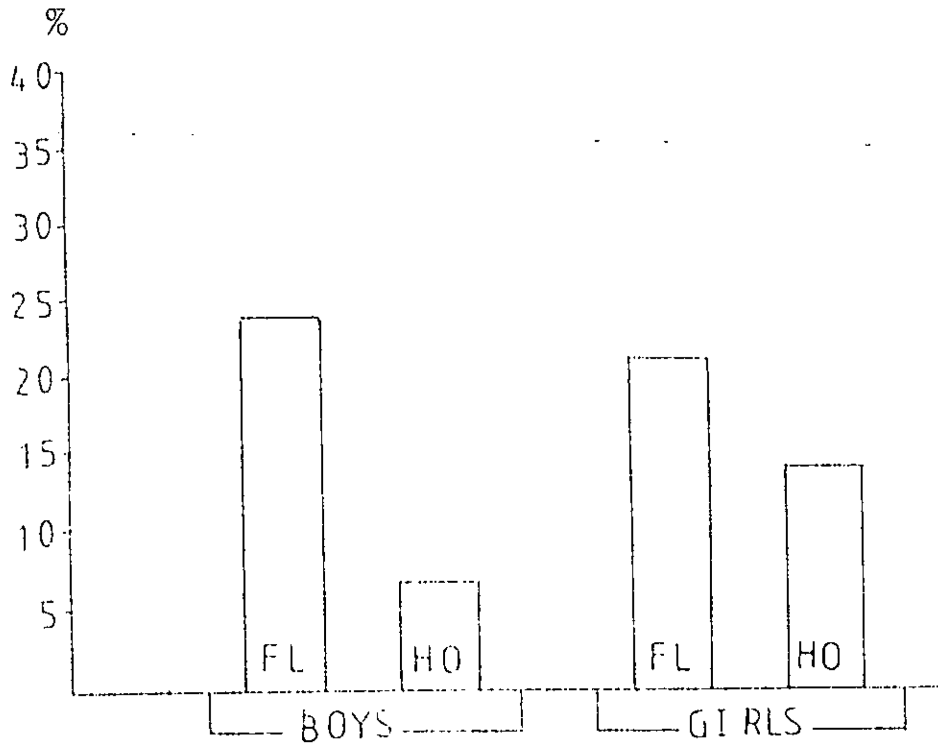


FIG 8 PERCENTAGE CHILDREN IN THE LESS HEALTHY THAN AVERAGE GRADE (1)

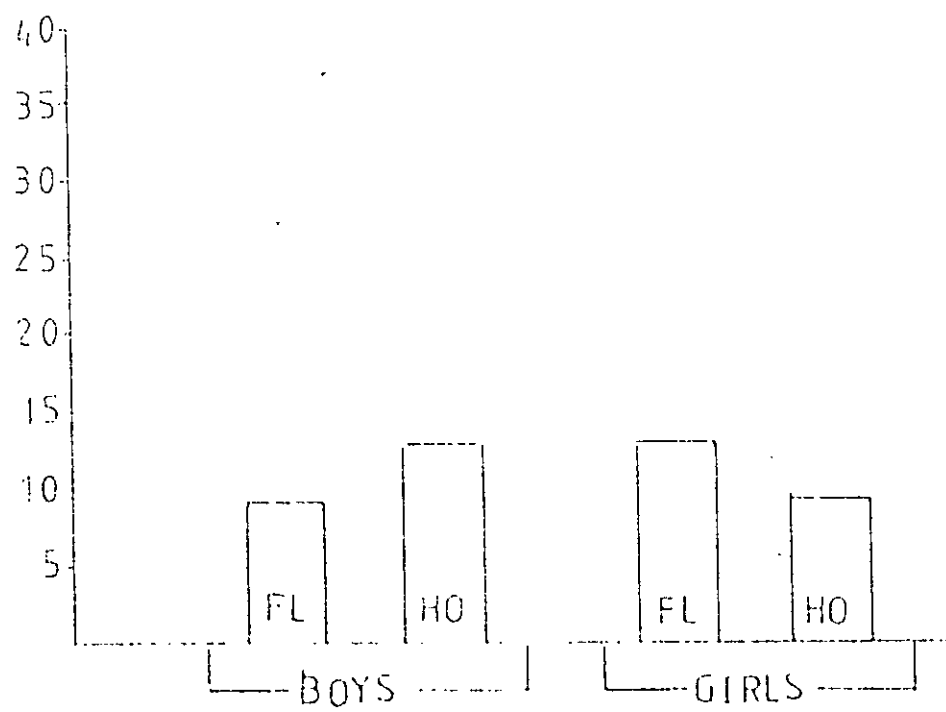


FIG 9 PERCENTAGE CHILDREN IN THE HEALTHIER THAN AVERAGE GRADE (3)

The placement of each individual on the Health Scale, although determined mathematically, it was initially dependent on a series of observed occurrences which were frequency distributions. Thus as a test of significance a χ^2 test was appropriate. The figures used were the actual number of children falling into each Health Grade. Boys and girls were combined to form a single flat group and a single house group as it was considered acceptable not to differentiate between the sexes in the grading of health. The following figures show the number of children placed in each Health Grade.

	Health Grades		
	1 (less healthy)	2 (average health)	3 (healthier than average)
Flat children	23	68	11
House children	11	80	11

The H_0 stated that there was no difference in the Health Grade frequency between flat children and house children. A χ^2 value of 5.99 was required for significance at the 0.05 level; the obtained score was 5.22. This value approaches significance, but the H_0 cannot be rejected in this case. However, it can be seen from Fig 8 that a higher percentage of flat children fall into the less healthy than average category. Although not statistically supported, there does seem to be a definite trend that Flat children fall into a lower health category than do children who live in Houses.

TWO ACTIVITY GROUPS

Activity Grouping

After reducing the Activity Scale 1 - 9 to Activity Grades 1 - 3, the Grade 2 subjects (deemed to be of average habitual activity) were removed from the group. The following figures refer to the Activity Grade 3 children who will henceforth be known as the Very Active group of 55 children, and the Activity Grade 1 children will be referred to as the Inactive group of 33 children.

The Very Active group (55) consisted of:

7 FLBO,	20 HOBO
4 FLGI,	24 HOGI

i.e. 25% of the total group lived in flats.

The Inactive group (33) consisted of:

9 FLBO,	2 HOBO
21 FLGI,	1 HOGI

i.e. 90% of the total group lived in flats.

Anthropometric, test run and lung capacity values

Details of the values (mean and s.d.) of just the Very Active and Inactive groups are shown in Table 15. A 't' test was used to determine whether or not there was a significant difference between the mean variables of the boys in the different activity groups and the girls in the different activity groups (see Table 15 and following text).

Table 15: Details of measurements (mean and S.D.) of 88 children placed in habitual activity groups

		VERY ACTIVE (55)				INACTIVE (33)					
		Boys (27)		Girls (28)		Boys (11)		Girls (22)		Boys	Girls
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	t	t
Age	(a)	9.5	1.4	10.1	1.14	9.1	1.6	9.3	1.37		*
Height	(m)	1.34	0.08	1.37	0.09	1.31	0.11	1.31	0.10		*
Weight	(kg)	28.36	4.64	30.82	6.82	28.64	10.98	30.60	7.6		
Thigh muscle width	(cm)	8.94	0.58	9.32	0.63	8.60	0.86	9.26	0.74		
Fat Free Mass	(kg)	25.2	4.06	25.0	4.6	24.0	6.8	23.6	4.8		
Body Fat %	(%)	11.0	2.0	18.4	3.8	13.8	6.9	22.2	4.8	F test**	**
Insp. chest circ.	(cm)	66.8	3.49	68.1	4.6	68.1	9.0	67.6	5.8		
Chest expansion	(cm)	5.1	1.33	6.2	1.65	5.7	1.66	5.3	1.35		*
‡ $FEV_{1.0}$	(l)	1.61	0.18	1.73	0.18	1.66	0.18	1.64	0.22		
‡ FVC	(l)	1.86	0.23	1.95	0.20	1.93	0.27	1.85	0.23		
$FEV_{1.0}$ x 100/FVC	(%)	86.5	6.4	88.4	4.1	85.5	6.2	87.9	5.1		
Six minute run	(m)	1177.8	85.1	1062.4	57.0	903.5	167.6	896.9	83.0	***	***
Health Grade (1 - 3)	(1-3)	2.15	0.53	1.96	0.51	1.73	0.65	1.77	0.53		

‡ Lung capacities standardised to the mean height of 1.34 m

* $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$

The Very Active girls were older and taller than their Inactive counterparts and they also managed a larger chest expansion ($P < 0.05$).

The Inactive girls had a higher % body fat ($P < 0.05$). Due to the small number of subjects involved plus the wide variance shown in the % body fat of the Inactive Boys (S.D. 6.9), an F test was used to compare the variances of the two groups of boys. The ratio of variance gave a value of 11.9 which was highly significant ($F = 4.33$ (0.01) for d.f. 26 x 10). This underlines the great difference in % body fat between Very Active and Inactive children selected initially on the basis of home dwelling.

The greater distance that the Very Active boys and girls ran in the six minute run test was highly significant ($P < 0.001$).

Multiple regression analysis

Table 15 shows that no significant differences were revealed in ventilatory capacities within the same sex but between Very Active and Inactive groups. Multiple regression analysis of the Very Active and Inactive group of 88 children revealed that ventilatory capacity was related to stature. The only significant reduction to the variability about the regression line was when fat free mass was added to stature on FVC. However the multiple correlation coefficient improved to $R = 0.84$ (SEE = 0.120). Turn overleaf to Table 16.

After allowing for stature on FVC, there was a 10.2% improvement in FVC by the inclusion of FFM (i.e. antilog_e of 0.013). Although FFM did not make a significant contribution to the improvement of $FEV_{1.0}$, it can be seen from the following figures that there is a high correlation of

Table 16: Regression relationships of ventilatory capacity on stature and fat free mass. Very Active and Inactive groups (N = 88 boys and girls) R = 0.84

Regression parameters	$\log_e$ FEV$_{1.0}$	$\log_e$ FVC
$\log_e$ stature (cm)	2.29	1.92
fat free mass (kg)	(NS)	0.013
constant term	-10.85	-9.07
standard error	0.120	0.120

FFM on FEV$_{1.0}$ within all the subject activity groupings. An even higher correlation of FFM on FVC is evident. See Table 17 below.

Table 17: Correlation of FFM on FEV$_{1.0}$ and FVC

Group		FEV$_{1.0}$	FVC
Inactive	Boys	.821	.873
	Girls	.793	.814
Very Active	Boys	.747	.741
	Girls	.794	.824

Health Grade

The Health Grades of the Very Active and the Inactive groups were treated in the same way as were the four dwelling groups (previously described on page 89). A χ^2 test of significance was used. The H_0 stated that there was no difference in the frequency of Health Grades between Very Active boys and girls and Inactive boys and girls.

Table 18: Health Grades of Very Active and Inactive children
Boys and Girls combined (88)

Group	Health Grades			
	1	2	3	Total
Very Active	6	40	9	55
Inactive	10	21	2	33
TOTAL	16	61	11	88

Health Grades: Grade 1 less healthy than average

Grade 2 of average health

Grade 3 healthier than average

The χ^2 test rejected the H_o and concluded that there was a significant difference ($P < 0.05$) in the frequency of Health Grades between the Very Active and the Inactive children.

DISCUSSION

DISCUSSION

Selecting subjects from this particular population presented the opportunity to make a two-fold comparison. This was done by dividing the group according to their home dwelling and then redividing the subjects into habitual activity groups.

All subjects were from the West Midlands and each matched pair lived on the same estate; thus it was thought that differences in socio-economic background would be minimal. However, 10 yearsago (and today) the rent of a high rise flat was slightly cheaper than a comparably sized house. But, offsetting this trend, tenants seeking an immediate home often had no choice, for the waiting list for houses has always been longer.

In working and talking with the children, there were no subjective observable differences between the flat and house children except perhaps that an overweight, only child appeared to come more often from a high rise flat.

Anthropometric characteristics

The children exhibited relationships of age to stature and sitting height, which were very similar to those representative of British children as studied by Tanner, Whitehouse and Taikaishi (1966). The boys' stature was also almost identical to London boys as found by Eveleth and Tanner (1976), whereas the girls were found to be marginally taller than the London girls. Both boys and girls were slightly heavier

† <u>Omission</u>

($P < 0.05$) showed by the FLBO. This was apparent at all the limb skinfold sites plus the suprailiac site, but was less noticeable in the subscapular skinfold. FLGI showed an even greater % body fat ..

than their London counterparts. The age to sitting height relationship was indentical with the London group. In this study although the girls were 0.4 of a year older and on average 1 cm taller, their average sitting heights were exactly the same as the boys. This could be due to their slightly advanced age and expected earlier girls' growth spurt, plus the fact that the trunk grows more slowly than the legs at this age (Eveleth and Tanner, 1976). Only triceps skinfold as an estimate of limb fat and subscapular skinfold as an estimate of trunk fat are shown in Table 3. The London children averaged slightly higher skinfolds (approx 1 mm) at both these sites for boys and for girls.

Considering FLBO and HOBO, no significant differences were found in age, stature or body mass; the main contrast lay in the significantly higher % body fat† ($P < 0.001$) compared with HOGI. The sites of greatest difference were triceps, anterior thigh and supra iliac. The FLGI were significantly ($P < 0.05$) heavier than their house counterparts. This was explained in that they were 0.02 m taller, they had extra % body fat and they also had slightly higher values in both TMW and FFM.

As the Very Active girls were on average significantly older (0.8 yrs) than the Inactive girls, it was to be expected that they would be significantly taller (0.06 m); they also produced a larger chest expansion. This could explain their higher (though not significant) lung capacities. Although both groups of girls averaged a similar body weight, that of the Inactive group constituted a significantly higher % body fat. The only anthropometric difference between the two activity groups of boys was that the Inactive boys were significantly ($P < 0.01$) fatter.

Ventilatory Capacities

The relationship of FVC to stature was found to be lower by 0.17 litres for boys and by 0.14 litres for girls than averages obtained by Polgar and Promadhat (1971) for children of European descent. The relationship was also marginally lower than results obtained by Cotes, Dabbs, Hall, Heywood and Laurence (1979) for healthy British boy and girl twins. This perhaps could be due to the inclusion of a number of 7 year olds in this study whose alveolar system was not as yet complete (Cotes, 1975). Alternatively, the findings agree with Cotes (1979) when he acknowledges that the less active urban children, particularly those living in high rise flats, appear to have up to 7% lower vital capacities in relation to stature, than physically active children.

When the lung capacities were standardised to a standing height of 1.20 m, it was then possible to directly compare the capacities of these British West Midland children with the findings of studies undertaken in different countries, which were a part of the UK's contribution to the International Biological Programme on Human Adaptation.

As can be seen from Table 19* the lung values obtained in this study lie below the British Cardiff children (Cotes et al, 1973), but above the Nepalese children (Bangham and Veale, 1976) living at 2000 m. This placing is to be expected as European children have in general larger lung capacity values than children from other ethnic groups living at a similar altitude (Cotes, 1975).

* overleaf

Table 19* : Mean forced expiratory volume ($FEV_{1.0}$, st, l) and forced vital capacity (FVC, st, l) at height 1.20 m of children in different parts of the world

	BOYS		GIRLS		Sex difference(%)		
	$FEV_{1.0}$, st	FVC, st	$FEV_{1.0}$, st	FVC, st	$FEV_{1.0}$, st	FVC	Source
New Guineans (1800 m)	1.49	1.76	1.41	1.65	6	6	Anderson et al. (1974)
British (Cardiff)	1.38	1.66	1.30	1.50	6	10	Cotes et al. (1973)
British (W. Midlands)	1.30	1.50	1.25	1.40	4	7	This study (1980)
Nepalese (2000 m)	1.29	1.48	1.20	1.37	8	8	Bangham and Veale (1976)
Chinese (Hong Kong)	1.31	1.48	1.18	1.31	10	12	Jones et al. (1976)
New Guineans (Coastal)	1.19	1.37	1.11	1.29	7	6	Anderson et al. (1974)
Jamaican (Negroes)	1.11	1.29	1.05	1.20	6	7	Miller et al. (1977)

* Table reproduced by kind permission of Dr P. R. M. Jones (from Jones, Baber, Heywood and Cotes, 1977)

In comparison, a smaller percentage difference occurs between the lung capacities of the boys and girls in this study (namely $FEV_{1.0}$ 4% and FVC 7%). However, the greater difference found in FVC is in agreement with Cotes et al (1973). These authors also reaffirm that the sex difference is apparent from the age of 8 years. Again the inclusion of 7 year old children in this study might have diminished the sex difference in lung values. Also it could be that there is a present day trend for living styles to offer equal opportunity for boys and girls of this age to lead equally active lives. It has been expressed by several authors that habitually active children have been found to obtain greater lung capacity than inactive children (Cotes, 1976; Jones et al., 1976; Miller et al., 1977).

Standardised ventilatory capacities of the same sex were not found to be significantly different, either between Dwelling groups, or between Activity groups (Tables 7 and 15 respectively). However, following logarithmic transformation of the data, multiple regression analysis revealed that activity made a significant contribution to $FEV_{1.0}$ (Activity Grades 1 - 9) and improved the description of $FEV_{1.0}$ by 11%. A summary of the multiple regression analysis of $FEV_{1.0}$ and FVC of the different Activity groupings of the subjects can be seen in Table 20 overleaf.

$FEV_{1.0}$ and FVC were significantly related to stature, but the regression coefficient was independent of age. With the reduced activity scale (Grades 1 - 3) the regression coefficient became independent of activity. The scale of 1 - 9 allows for demonstration of intergroup variability which appears to be lost when condensing data into fewer

Table 20: Activity groupings multilinear regression analysis of $FEV_{1.0}$ and FVC (significant at 0.05 level)

	Activity 1 - 9 n = 204	Activity 1 - 3 n = 204	Activity 1 + 3 n = 88
$FEV_{1.0}$	stature activity fat free mass r = 0.81 see 119 ml c of v 24.7%	stature fat free mass r = 0.81 see 120 ml c of v 24.8%	stature r = 0.84 see 119 ml c of v 24.2%
FVC	stature sex fat free mass r = 0.81 see 1.22 ml c of v 19.8%	stature sex fat free mass r = 0.81 see 122 ml c of v 19.8%	stature fat free mass r = 0.84 see 119 ml c of v 19%

groups (1 - 3 and 1 + 3); responses tend to favour a regression towards the mean at the expense of the extremes. The non-significance of activity (1 - 3) could also be due to an overlap in the 1 - 9 scale areas of 4 and 5, and 7 and 8, which were the dividing lines for the Activity Grades 1, 2 and 3 (i.e. Scale 1 - 4, 5 - 7, 8 - 9 inclusive). "Unreliability of the assessment of habitual activity" (Bassey, Bryant, Clarke, Fentem, Jones, MacDonald and Patrick, 1979), could be yet a further reason for the non-significance of activity in this study. FFM brought about the only improvement on the prediction of FVC when the smaller group of Very Active and Inactive children were considered.

When comparing the multilinear regression analysis of this study (Table.5..) with the Hong Kong study reproduced below:

Table 21*: Regression relationships of ventilatory capacity on stature, sex and habitual activity

Regression parameters	$\log_e$ $FEV_{1.0}$	$\log_e$ FVC
$\log_e$ stature (cm)	2.69	2.88
sex boy = 1, girl = 2	-0.12	-0.12
activity grade (1 - 3)	-0.049	-0.046
constant term	-12.38	-13.16
standard deviation	0.124	0.132

it can be seen that after stature, sex makes a common contribution to FVC. FFM significantly contributes only to the West Midland children's lung capacities, but this is in accordance with recent reports from Cotes et al., (1979). These authors found that for the description of lung volumes which involved inspiratory capacity, additional precision was secured by adding to the regression equation on stature, a term for FFM. With regard to the Hong Kong study it can be seen that habitual activity contributes significantly to lung function. Maybe habitual activity features more positively in the Chinese study because not only would activity have been a necessity from an early age, but the daily work and play activities would

* Reproduced by kind permission of Dr P. R. M. Jones (from Jones, Baber, Heywood and Cotes, 1977).

likely have been more strenuous due to the surrounding hilly terrain. It was acknowledged that the hillside children spent much time in the open air.

Although FLGI were generally bigger girls, this was not reflected in lung capacity measurements. No differences were to be found in lung function between the girls or between the boys when volumes were looked at within house dwelling and within activity groupings. As the major determinant of lung function is genetic (Cotes et al. 1977), this could point to a certain background homogeneity of the parental group of these children. This is likely, for high rise living has only become widespread over the past 25 - 30 years. Furthermore, the different environmental influences exerted on these separate groupings of children were of insufficient strength to bring about any real differences in lung capacity measurements.

Six Minute Run

Using the mean value HOGI ran 42 m further ($P < 0.01$) than FLGI, and HOBO ran 38 m further than FLBO ($P > 0.05 < 0.1$). The Very Active boys and girls exceeded on average their Inactive counterparts by 274 m and 166 m respectively ($P < 0.001$). Thus the House dwelling children and the Very Active children showed a considerably greater capacity for endurance running.

The total % body fat must be considered with regard to the run scores. Buskirk and Taylor (1957) emphasised the metabolic influence of

% body fat on prolonged running performance due to the increased energy cost of running at a given speed. It appeared likely that the significantly fatter Flat and Inactive children also experienced this extra energy cost militating against a high six minute run score. Later Cureton, Boileau, Lohman and Misner (1977) actually quantified that $\frac{1}{3}$ to $\frac{1}{2}$ of the negative influence of body fat on 7 - 12 year old children's 600 yd and 1 mile run performances occurred,because the body fat reduced the aerobic capacity, expressed relative to body weight. These authors concluded that % body fat and running speeds were the most important determinants together with cardiovascular respiratory capacity and body size, all of which accounted for 71% and 66% of the variance in the 600 yd and 1 mile run respectively. In this study running speeds of the children were not assessed, but there was a clear indication that % body fat was an important determinant in accounting for the low running scores of Flat and Inactive children.

It was found by Cureton, Hensley and Tiburzi (1979) that the sex difference in % body fat accounted for 25% of the mean sex difference in performance in the 12 minute run. Body fat is therefore one characteristic that could partly explain why the girls in this study when undergoing a physical performance test requiring movement of the body weight (e.g. the six minute run) produced considerably lower scores than their boy counterparts. (Both FLGI and HOGI only achieved 91% of the FLBO and HOBO performances). All the correlations indicated that body fat was negatively related to the six minute run for boys and girls, however, the relationships were not high enough ($P > 0.05$) to predict with a low SEE a run score from knowledge of % body fat. For comparison with American Six Minute Run, see Appendix 8.

Habitual Activity

It was clearly evident that House children rate significantly higher ($P < 0.001$) on the habitual activity scale than their Flat counterparts (Fig 6). These results were reinforced when it was seen that high rise flat children represented 90% of the Inactive group, but only 25% of the Very Active group. There is this definite trend for house dwelling children to be habitually active for longer periods of time. But the degree of this activity is likely to be submaximal and therefore not particularly stressful to the respiratory system, hence the findings that no significant differences appeared in lung capacities between flat and house groups or between Very Active and Inactive groups. These findings agree with Anderson et al., (1978) who do not support that habitual activity accounts for an increased FVC. It is possible however that because the house dwelling children were habitually more active, this had some conditioning effect on their cardiovascular system. It follows that this could have been a determinant (along with a low % body fat) which contributed to their superiority in the six minute run test.

The constituent parts of the Activity Scale were quite independent of the Six Minute Run. However, it can be seen from Fig 7 that there was a firm relationship between the Activity Scale (1 - 9) and the Six Minute Run ($r = 0.65$); thus giving an added validity to the Activity Scale. This scale was based on time spent participating in different activities. Although an attempt was made to grade the energy demands of each activity the individual intensity with which each child participated was not assessed. However it was encouraging to see a substantial relationship between these two variables.

Health

Flat children claimed to suffer from respiratory disorders for more days in the year than did house children. They also consulted their doctor on significantly more occasions (ratio of 10 : 6.6) when they were ill. Although the overall pattern of Health Grade only approached a significant difference ($P < 0.06$) the marked contrast between the two groups lay in the larger number of flat children falling into the Less Healthy than average category. This outcome, plus the fact that these children were significantly less active, however did not lead to a consistent correlation of Health Grades on Activity throughout the four Dwelling groups.

That upper respiratory tract infections are more common in flat dwellers agrees with the work of Hird (1966) and Fanning (1967). The number of doctor consultations in this study were in the ratio of 10 : 6.6 whereas the two general practitioners found a 10 : 5 ratio. This could be that less children now live up on the higher floors, for Dr Fanning claimed that there was a steady increase of respiratory disorders as the height of the flat increased. Dr Beatson Hird has not published further work, but he continues to be very concerned by the lack of incentive and listlessness of flat children which militates against mental and physical health and well being (personal communication, 1980).

The Inactive group of children fell into significantly lower Health Grades than did the Very Active group. It is not surprising to find that habitually active children are freer from respiratory ailments than inactive children. This points to the fact that children will suffer less with respiratory infections if they spend more time being active out in the open air.

Play Activity

It was not unexpected to find that the types of vigorous activity chosen by the girls differed significantly ($P < 0.01$) from those chosen by the boys. Also it appeared that choice of activity was related significantly ($P < 0.01$) to home dwelling; the greater contrast being found between the the two groups of boys. Flat boys showed a marked preference for individual activities, whereas house boys firmly selected team games (mostly football!). This information parallels much of the literature which observes that high rise flat dwellers may suffer from social isolation, but in this case one can only say that clearly house children have opted to indulge in the more social team games.

It is encouraging and in line with current thinking in Physical Education that consistently half the children from each dwelling group requested to have more time spent on Physical Education in school, (boys and girls equally). The other half were content with their existing P.E.

programme, except for one House and one Flat girl who requested less. These indications could have been stated by the parent, or the child, or both.

Play Facilities

Most children claimed to have available outdoor play facilities, but the least well catered for were the HOBO; presumably they lacked a garden. However not all children used this facility, there being a marked difference between the FLGI (50%) and HOGI(81%) who admitted to using these outdoor areas often. The major reason given for not using the play areas was 'danger from others' which includes bullying by older children and undesirables on the site. Here it appeared that more girls were at risk than boys. The second deterrent came under the heading of 'site access difficulties'. Specifically this meant that either a busy road had to crossed, or the area was too far from home for a parent to keep an eye on them or walk and stay with them to supervise. Only girls however declared supervision to be their main problem.

When visiting the estates on fine days, one saw more children playing together in gardens than one saw playing in the designated play areas. It does seem that children of this age group use well the safe convenient play areas to facilitate their natural spontaneity, but find it difficult to arrange play times that require effort and planning.

CONCLUSIONS

CONCLUSIONS

HYPOTHESIS

The H_0 is upheld and there were no significant differences found in ventilatory capacities between House children and Flat children. However, Activity (Scale 1 - 9 in which House children featured significantly ($P < 0.001$) more active), did improve the multiple regression relationship ($P < 0.05$) of $FEV_{1.0}$ on stature and FFM. The H_0 is also upheld in the case of the Very Active and Inactive children where no significant difference was found between the two groups ventilatory capacities.

The H_0 was rejected and it was concluded that a significant difference was found between Flat children and House children in anthropometric characteristics, in the Six Minute Run Test, in habitual activity and in Health Grades. Similarly the H_0 was rejected and it was concluded that a significant difference was found between Very Active and Inactive children in anthropometric characteristics, the Six Minute Run Test and Health Grades.

LISTED CONCLUSIONS

Conclusions are listed below in further detail:

1. FLBO and Inactive boys had a significantly ($P < 0.05$) higher % body fat than HOBO and Very Active boys. FLGI and Inactive girls had a significantly ($P < 0.01$) higher % body fat than HOGI and Very Active girls.

2(a) FFM significantly contributed to the regression of stature on $FEV_{1.0}$ and FVC for the total subject group and for the Activity groups 1 + 3 on FVC, but not on $FEV_{1.0}$.

(b) Sex significantly contributed towards the description of FVC of the total subject groups (Activity Grades 1 - 9 and 1 - 3).

(c) $FEV_{1.0}$ (Activity Scale 1 - 9) multiregression showed that activity was a significant term in the regression equation and that it improved the description of $FEV_{1.0}$ by 11%. However it should be borne in mind that this equation advantages that it was a better fit for all values. In reducing the Activity Grades to 1 - 3, group variability was lost and activity no longer featured as a significant term.

3. No significant differences were found in standardised ventilatory capacities between Dwelling groups or Activity groups. Environmental differences were of insufficient intensity or duration to bring about any significant changes in ventilatory capacity.

4. On average HOBO ran 38 m further than FLBO (NS) in the Six Minute Run Test and HOGI ran 42 m further than FLGI ($P < 0.01$).

The Very Active boys and girls exceeded their Inactive counterparts by 274 m and 166 m respectively ($P < 0.001$). This suggests that the Very Active House children gained a cardiovascular conditioning effect which contributed towards the superior run score. Also it was thought that the higher % body fat found in Flat and Inactive children was a determinant which militated against a high Six Minute Run score.

5. House children featured significantly higher ($P < 0.001$) on the Activity Scale. The Very Active group consisted of 90% House children, whereas the Inactive group consisted of only 25% House children.

6. A modest relationship was found ($r = 0.65$) between Activity Scale and the Six Minute Run score.

7(a) Flat children claimed to suffer more often from respiratory infections; also they consulted the doctor on more occasions than House children (10 : 6.6 ratio).

(b) Twice the number of Flat (as opposed to House) children fell into the Less Healthy than Average category. The Health Grades of the Inactive group were significantly ($P < 0.05$) lower than those of the Very Active group. It is likely that habitually active children are freer from respiratory infections because they spend more time out in the open air.

8(a) Choice of vigorous activity was significantly ($P < 0.01$) related to home dwelling. FLBO showed a marked preference for individual sport whereas HOBO firmly selected team games.

(b) Between 46% and 54% of the children in each dwelling group requested that more time be spent on Physical Education in school.

(c) The major reasons why children do not use outdoor play areas are, "Danger from others"and "Site access difficulties".

9. There was a marked similarity between the findings of the House Group and the Very Active group. This was particularly noticeable in the lower % body weight as fat, in the high Six Minute Run score, in the superior Activity Grades and in the better Health Grades.

10. In all the measurements except two, Flat and Inactive children showed a larger standard deviation from the mean, demonstrating that overall they were a more heterogenous group of children than were the House and Very Active groups.

THE FUTURE FOR HIGH RISE FAMILIES

THE FUTURE FOR HIGH RISE FAMILIES

High rise flats are here to stay for some time for the accommodation is modern and it is more freely available than other homes in the same rent bracket. Over the past few years, City Housing Departments have endeavoured to improve the standard of families living 'high off the ground'. In the Birmingham area there are 473 multi storey blocks of flats, but the City Council have decided that no more should be built, except possibly on prestige City Centre sites. Of the present blocks, 136 have now been designated as "no go" areas for children, i.e. children will not be allocated to these blocks of flats. However, if children are born in this type of accommodation, the Housing Department has no commitment to transfer such a family. Additional points on the transfer scheme have been given to young families to help them to move from high rise accommodation. In 1979, the City of Birmingham Housing Department recorded that 1,787 families were transferred from high rise flats and maisonettes to a house; 1,484 of these families had children under 12 years of age. These factors,together with a policy of not housing children above the eighth floor in high rise blocks, is resulting in a decline in the number of applications for entry to nearby nursery schools. (In one school over the past year there has been a drop of 40% which markedly exceeds the fall in birth rate).

Other Housing Department innovations are the installation in some blocks of internal telephones and intercommunication systems which allow only the entry of bona-fide visitors. Community flats have also been made available for residents to use as association meeting places. Within the Birmingham District 37 Council tenants' halls exist on the housing estates which are run by local residents.

The Department of the Environment continue to research into high rise living and the present unpublished investigation is in three parts:

1. To obtain a reliable estimate of the number of families with children living 'off the ground'.
2. To assess the possibility of rehousing such families in ground-level dwellings.
3. For children remaining in high rise flats; to explore the possibilities of compensatory provision to enable children to mix and play more freely and safely.

The Leverhulme Project (to be published sometime in 1980) has focused its attention on motor deprivation in young children. It was concluded that children who lived above ground level had significantly poorer language and gross motor development, but significantly more mature fine motor development. The language and gross motor development decreased with increasing height above ground. Therefore there will be expected differences in these children, related to their home dwelling, when they arrive at their first school. This allows for positive curriculum planning in schools.

It is interesting that these two recent studies have recognised the lack of play involvement of high rise children and each are putting forward

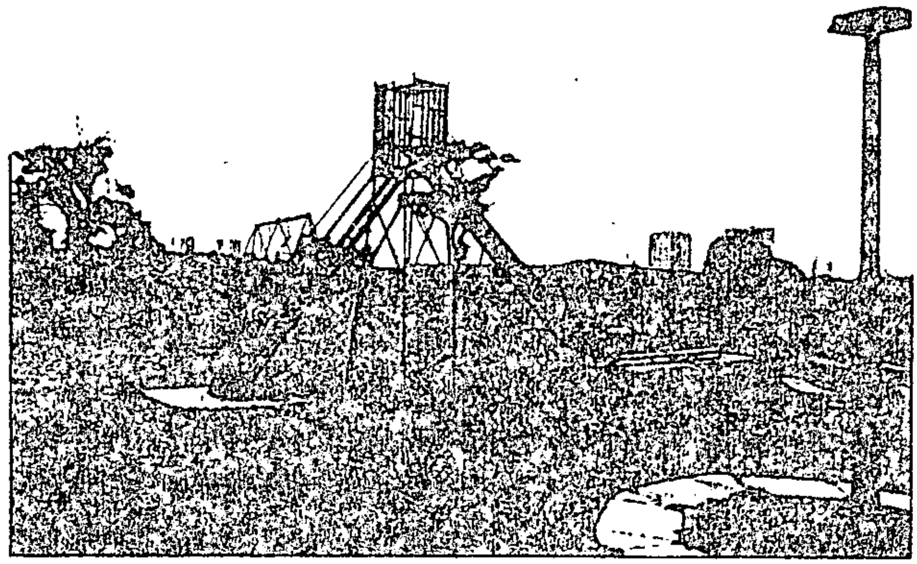


PLATE 4(a) : A vandalised play area, hidden from houses and set between road and river

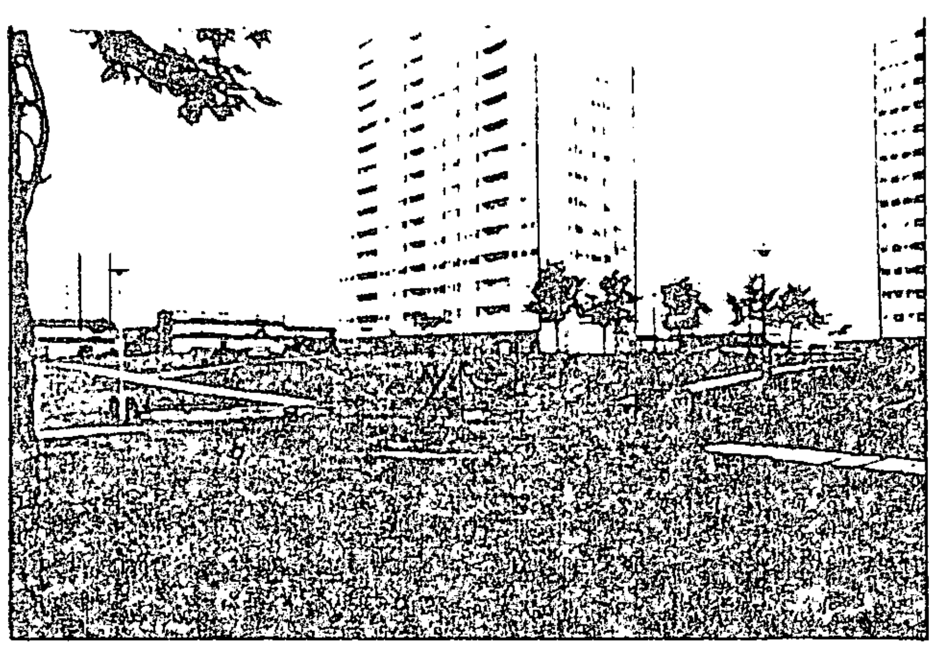


PLATE 4(b) : A well placed play area by the paths from two blocks of flats

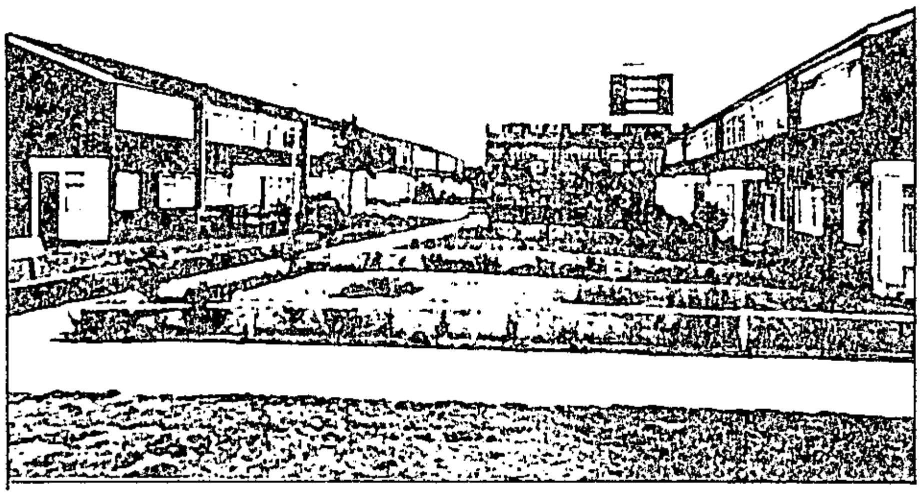


PLATE 5(a) : Houses with well tended gardens

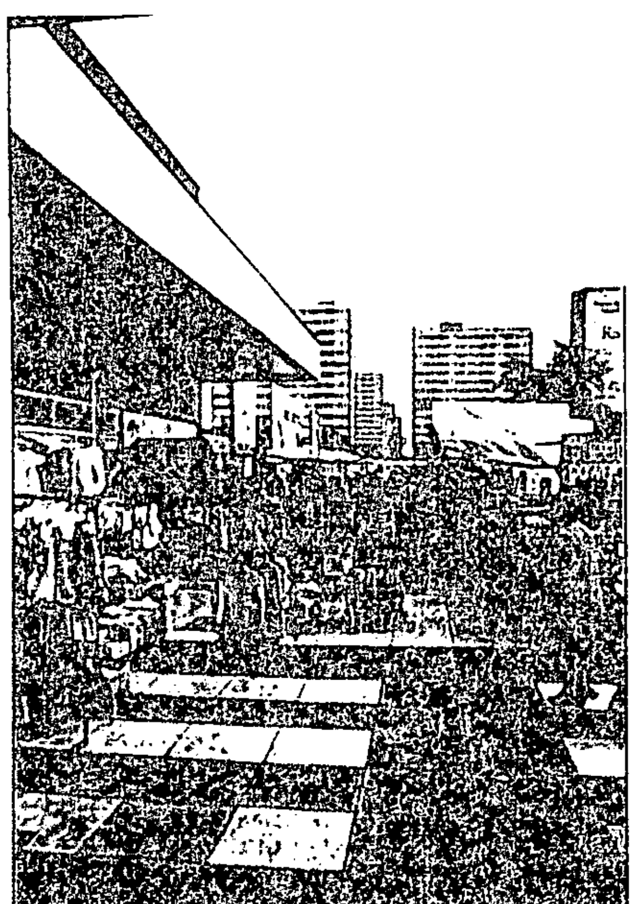


PLATE 5(b) : Market day in the shopping centre positive suggestions. Already in this West Midlands area improvements are evident. Provisions have been made by the City Housing Department and together with the Council's policies of encouraging residents to help themselves, the future for high rise living looks far brighter.

Play areas have now been provided adjacent to most high rise blocks; strategically sited away from ground floor windows, yet under the eye of Mother from the flat. It is very apparent that children enjoy using designated play areas, but the major proviso is that they must be appropriately supervised. The Nursery School playground with knowledgeable teacher supervision is a hive of activity and fun. In contrast, a poorly sited play area, hidden from the houses and situated between river and major road, is constantly vandalised and has been monopolised by youths with motor bikes. All City Councils (not just in high rise areas) are aware of the acute need to constructively direct the energies of teenagers' leisure time.

Pockets of social life are now seen to be developing. The schools have done much to attract children back to school in the evenings for clubs and recreational activities. Parents have become involved and organise both family and adult social occasions. Churches, residents' halls and public houses are all now established and provide attractive meeting places. Fashionable and convenient shopping centres are now busy places, the event of the week being Market Day; visitors bringing their wares into the estate must be an added source of interest. So for the high rise dwellers there are local places to go where they can be with other people and socialise if they choose. This means that children also have a chance to meet and are likely to get spells of supervised play on the way out and back to home; surely leading to greater contentment within the family.

Although some compensatory provision for high rise children is evident, the final answer to the many problems is that ideally all children should be housed at ground floor level. This study has exposed some of the advantages for children living in two storeyed houses. One of the major gains was that house children chose to spend more time on outdoor play activities which is so vital for their full physical, social, intellectual and emotional development. They also achieved a physical capacity that enabled them to run further in a given time. It was noticeable that boys from houses particularly preferred to engage in the more social type team games. High rise flat children who spend less time outdoors being active, would also appear to eat more food for they total a significantly higher % body fat which hinders their running performance. House children suffer less from respiratory infections and also feel less need to consult their doctors; they appear to enjoy better health. The pattern of results recorded for House children was similar to that of the Very Active group and likewise, the results recorded for Flat children resembled those of the Inactive group.

There appears to be ample evidence to convince the authorities who plan, construct and manage the residential environment, that high rise living is unsuitable for young children. Certain areas claim increasing numbers of young families being rehoused to ground level. High rise flats appeal to many adult households and also to single people of working age. Therefore, it should be urged that all authorities give priority to implementing effective rehousing plans, demonstrating their concern for children.

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APPENDIX

APPENDIX 1

COVENTRY COLLEGE OF EDUCATION

Junior School Activity Level Project

School ....

Dear Parent of ....

A study is being carried out in various schools in the midlands to try to find out the present activity level of children and to consider if this is related to their general health. This school is willing to take part in this project and I am writing to ask if your child may also join in?

This will involve taking measurements at school of height, weight and measurements round the trunk and limbs, plus the capacity of the lungs. The children will then be asked to run and/or walk over a short period of time.

Later on a simple questionnaire will be sent to you and we should find it very helpful if you would complete it with the help of your child.

We realise that this will take up a little time and effort on your part, but I think that your child will find it interesting and quite enjoyable to take part. We in turn shall be most grateful for your help in assisting us to assess the general level of activity of present day children and to see if this has any bearing on their general health.

If you agree that your child should be included, please sign below and return this letter to school, if possible within the week.

Please include my child whose name is ....

Signature of Parent ....

E.P. Bragg, Lecturer.

APPENDIX 2

Loughborough University. Department of Human Sciences.

Lung Function in Children from Different Types of Residence.

Surname................ Forename.............. Storey.......

School.................. D O Ex................ D o B.........

Race 0= European
1= Other.

Sex 1= Male
2= Female.

Subject No.
Flat Boys=100-199
Girls=200-299

House Boys=300-399
Girls=400-499.

Room Temp. C

BTPS factor.

Race, Sex.	1
Subject No.	3
Exam. Date.	6
Birthday.	11
Age (years)	16
Weight (kg)	21
Stature (cm)	24
Sitting Height (cm)	28
½ sub ischial height (cm)	31
Thigh circumference (cm)	34
Predicted TMW. (cm)	37
Expired chest circumference (cm)	40
Inspired chest circumference (cm)	43
Expansion (cm)	46
Left Skinfold Thicknesses.	
Anterior thigh (mm)	49
Biceps (mm)	52
Triceps (mm)	55
Subscapular (mm)	58
Suprailiac (mm)	61
Total 4 thicknesses (mm)	64
FEV_1 (litres)	67
FVC (litres)	70
$\frac{FEV_1}{FVC} \frac{100}{} = \%$	73
6 minute distance run (metres)	75
Activity level	79
Health Category.	80

APPENDIX 3

Fat Frée Mass Calculation

Skinfold measurements were made at the four sites of triceps, biceps, subscapular and suprailiae and totalled.

Body density was calculated from the regression equations of Durnin and Rahaman (1967) for adolescents:

Boys density = 1.1533 - 0.643 x log sum of the 4 skinfold thicknesses

Girls density = 1.1369 - 0.0598 x log sum of the 4 skinfold thicknesses

Calculation of the body fat was based on the equation given by Siri (1956):

$$\text{Body fat \% of weight} = \left\{ \frac{4.95}{\text{Body density}} \right\} - 4.5 \quad \times 100$$

Fat free mass (kg) was obtained by subtracting the adipose tissue mass from the body weight.

APPENDIX 4

Thigh Muscle Width Calculation

Thigh muscle width (TMW) was estimated using an empirical linear regression on thigh circumference (TC) and anterior thigh skinfold thickness (AF).

$$\text{TMW} = \text{TC (cm)} - \text{AF (cm)} + \text{C}$$

Boys: TMW = 0.243 (TC) - 0.891 (AF) + 0.775

The coefficient of variation = 6.6%

Girls: TMW = 0.202 (TC) - 0.769 (AF) + 2.432

The coefficient of variation = 5.6%

All measurements in cm.

ref. Jones, P. R. M., Cotes, J. E., Knibbs, A. V. and Burkinshaw, L. W. (1970)

APPENDIX 5

Standardisation of Lung Capacity on Stature

Formula used: Std FVC = (std Ht - Ht) x Coefficient + FVC

Boys: Std. Ht = 133.6 cm

regression coefficient = *0.034

Girls: Std Ht = 134.7 cm

regression coefficient = *0.033

* regression coefficients obtained from Fig 2

Worked example: Subject No: 103

Sex: Male

Height: 132.4 cm

FVC: 1.95 litres

Std FVC = (133.6 - 132.4) x 0.034 + 1.95

= 1.99 litres

In Figs 3 and 4 all figures were converted to natural logarithms ($\log_e$) before working the formula.

Activity Level Project. Coventry College of Education.

School: ....

Dear Parent of ....,

This is the second letter in connection with the study taking place in various schools in the midlands to try to find out the present level of activity of the children and to assess their general health.

We have now successfully carried out tests in the school with the cooperation of your child. As previously mentioned we are now sending you the questionnaire and we would be most grateful if you and your child would kindly take the time to fill in the information together.

Please return the questionnaire within the next few days to your child's class teacher.

---

1) In travelling to and from school does your child walk or cycle more than 500 yards ? ....

2) On a typical schoolday

Between arriving home from school and breakfast time the following morning please indicate as well as you can the time that your child spends;-

	Hours	Minutes
a) In bed.	....	....
b) Sitting. (e.g. reading, watching T.V., eating etc.)	....	....
c) Moving (e.g. helping in the house, or indoor games that involve movement)	....	....
d) Walking outdoors (e.g. shopping, visiting, walking etc)	....	....
e) Running outdoors or cycling, or swimming or playing active games.	....	....

3) On a typical Saturday or Sunday.

Is Saturday or Sunday the most active day usually for your child? ....

Between getting up on this day and getting up on the following morning please indicate the time that your child spends;-

	Hours	Minutes
a) In bed.	....	....
b) Sitting.(e.g. reading, watching T.V., eating etc.)	....	....
c) Moving.(e.g. helping in the house or indoor games involving movement)	....	....
d) Walking outdoors.(e.g. shopping, visiting, walking)	....	....
e) Running outdoors (e.g. cycling, swimming or playing active games.	....	....

f) What is the child's most vigorous activity ? ....

g) How long does this activity usually last ? ....

h) How often does your child go upstairs on this day? Write the number of actual steps climbed (e.g.7 times 12 steps = 84.) ....

Would you please indicate below how many times your child has had the following ailments and show if medical treatment was given.

...lment.	How many times during the last 12 months ?	How long did the illness last ?	How many times was the doctor consulted.?
...ld	....	....	....
...re throat.	....	....	....
...ugh.	....	....	....
...lu.	....	....	....
...onchitis.	....	....	....
...eumonia.	....	....	....

) How many years has your child lived in a high rise flat ? ....

If you live in a high rise flat, does your child use the lift- hardly ever, sometimes or mostly ? ....

How many years has your child lived in a house ? ....

) Is there an outdoor playing area for your child nearby, or garden, park or field etc. ? ....

Does your child use it often ? ....

If not, please state why. ....

Is there an indoor community playing area that your child uses ? ....

) Would you like your child to have more, the same or less Physical Education at school ? ....

In which of the following three categories would you place your child;- very active
average
not very active. ....

Thank you very much for your time and cooperation.

E.P.Bragg. Lecturer.

Please return this form to your class teacher.

COVENTRY COLLEGE OF EDUCATION

ACTIVITY LEVEL PROJECT

SCHOOL QUESTIONNAIRE

SCHOOL ....

SUBJECT NUMBER [ ][ ][ ]

NAME ....

Please place the child in one of the following categories by putting a ✓ in the appropriate box opposite.

Is this child:-

During P.E. lesson times	(Very active	...	[ ]
	(Active	...	[ ]
	(Average	...	[ ]
	(Inactive	...	[ ]
	(Very inactive	...	[ ]

During school play-time	(Very active	...	[ ]
	(Active	...	[ ]
	(Average	...	[ ]
	(Inactive	...	[ ]
	(Very inactive	...	[ ]

1.	More healthy than average	[ ]
2.	Average ...	[ ]
3.	Less healthy than average	[ ]

Please assess the number of absences from school, due to genuine illness, over the past year (½ day = 1) ... [ ]

14.6.76.

APPENDIX 8

Comparison with American Six Minute Run

The Physical Performance Test for Californian (revised 1971) comprising six test events was adopted by the State Board of Education for use in public schools for children aged 10 - 18 years. The selected test for cardiorespiratory endurance was the Six Minute Jog-Walk. Teachers in California are advised to train their children before testing, for a minimum period of one month in the case of the Six Minute Jog-Walk. The children in this West Midland study had no formal training, but they did perform a brief warm-up prior to the Test Run.

The Californian raw scores are interpreted with the use of published Percentile Tables; these are given for 10 year olds and upwards. The West Midland children were younger on average by 0.7 years (boys) and 0.3 (girls). However their average group results would have featured in the Californian percentiles as follows:

Group	Flat	House	Inactive	Very Active
Boys Percentile	50	60	20	65
Girls Percentile	50	58	35	65

The boys and girls noticeably fall into similar percentiles according to their groups.

Since the American children were older and also trained for the Six Minute Run, it would seem that the House and Very Active children in this study, show good potential by comparison.