Physical Activity During the Early Years

A Systematic Review of Correlates and Determinants

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Context: Being physically active during the early years (age 0–6 years) is vital for healthy development. Identifying correlates and determinants of physical activity (PA) is crucial to guide effective interventions. This systematic review synthesized studies investigating potential correlates and determinants of PA during the early years, accounting for different types of PA assessment.

Evidence acquisition: Nine electronic databases were searched from inception year (1900) until September 2014; data were analyzed/interpreted in April 2015. Inclusion criteria were: written in English, published in peer-reviewed journals, participants not in statutory/school education, and an observational design investigating associations between an exposure/variable and a quantitative measure of PA. Correlates/determinants of total, moderate to vigorous, and light PA were reported using an ecological model.

Evidence synthesis: Of 22,045 identified studies, 130 were included. All took place in high-income countries and few (6%) were of high quality. Correlates of total PA were sex (male, ++), parental PA (+), parental support (+), and time outdoors (+). Determinants of total PA were sex (+) and time spent playing with parents (+). The only correlate of moderate to vigorous PA was sex (male, ++). No determinants of moderate to vigorous or light PA were found. PA correlates/determinants were relatively consistent between objective and subjective PA measures.

Conclusions: Numerous studies investigated potential correlates and determinants of PA, but overall quality was low. A small number of demographic/biological and social/cultural factors were associated with PA. There is a need for high-quality studies exploring correlates/determinants across all domains of the ecological model.

Context

Physical activity (PA) is a key influence upon health across the life course.[1–4] The "early years" is an umbrella term for an age range that encompasses infants (0–2 years), toddlers (2–4 years), and preschoolers (4–6 years).[5] During this period, PA is reported to be associated with multiple health outcomes.[5] Evidence suggests PA levels track from early to later childhood,[6] and into adulthood,[7] so establishing optimal levels of this health-related behavior early in life is crucial.[8,9] Whether children during the early years are sufficiently active is unclear. Some studies have reported that children largely fail to meet current PA guidelines,[10] and spend most of their time inactive,[11,12] whereas others have reported sufficient activity levels in this age group.[13,14] Given the link between PA and health, it is important to understand correlates and determinants of PA to enable the development and implementation of effective interventions,[15] particularly as previous interventions have had limited efficacy.[16]

In this review, the term "correlate" is used when an independent variable is found to be associated with PA in cross-sectional studies and thus causality cannot be determined. The term "determinant" is used when an association is found between an independent variable and PA in longitudinal studies[17] where temporal associations over time may be observed, although there is still a risk of bidirectional or reverse causality pathways.[18] It is essential for researchers to have an understanding of the correlates and determinants of PA to identify possible at-risk demographic groups and mediators to be targeted in future intervention studies.[17]

Physical activity is a multidimensional behavior with correlates and determinants present across different levels of the ecologic model (e.g., individual, social, and physical environments).[10,19–23] Identifying variables associated with PA at different levels of the

ecological model allows researchers to intervene at various levels to attempt to increase young children's PA.[10,19–23] Two previous systematic reviews,[19,24] which adopted the use of the ecological model, reviewed the correlates of PA in children during the early years. Neither review investigated the correlates or determinants of the different intensities of PA (light-intensity PA [LPA], moderate to vigorous–intensity PA [MVPA]). Physical activity guidelines for children during the early years place an emphasis upon the promotion of total PA (TPA). However, identifying correlates and determinants of MVPA is also of public health importance as time spent in MVPA has been associated with benefits to bone/skeletal development,[25] adiposity,[26] and metabolic status.[27]

Young children's PA is sporadic and intermittent.[28,29] Because of these patterns, subjective and objective measures of PA capture different behaviors/constructs. Subjective measures typically require parents to recall children's PA (e.g., active play and walking), which are susceptible to recall errors and bias, such as social desirability bias.[30–32] Objective measures directly capture parameters of PA such as movement, acceleration, and heart rate.[28] Objective monitoring avoids the biases associated with subjective measures and is more sensitive to sporadic patterns of PA.[30–32] Thus, the type of measure used by studies should be considered when investigating correlates and determinants. Therefore, the purpose of this systematic review was to synthesize studies investigating potential correlates and determinants of TPA, MVPA, and LPA in children during the early years and investigate potential differences in associations by measurement method.

Evidence Acquisition

Search Strategy

The search and review process followed guidance from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.[33] A systematic literature search was conducted within nine electronic databases: Web of Science, SCOPUS, SPORTDiscus, PubMed, Cochrane, ProQuest, PyscINFO, Embase, and CINAHL. Each database was searched from the year of inception (i.e., the earliest was Web of Science, 1900) until September 2014. Data extraction and interpretation took place between November 2014 and April 2015. Key words relating to behavior(s) (i.e., *physical activity*, *exercise*, *play*, *physical fitness*, *physical inactivity*, *sedentary*, *sport*, *health behavior*, *motor movement*) in conjunction with population (i.e., *child*, *children*, *kindergarten*, *preschool*, *early years*, *infant*, *toddler*) were used for the search. Authors' bibliographies and papers that had cited the De Craemer et al. (2012)[19] and Hinkley and colleagues (2008)[24] reviews were also searched.

Inclusion Criteria

To be included, studies had to:

1. have an observational design;
2. be written in English;
3. be published in a peer-reviewed journal;
4. explore potential associations between PA as a quantitatively measured outcome variable and independent variable/s; and
5. have a sample (or subgroup) aged 0–6 years not in statutory/school education.

Reporting of Results

If more than one instrument measured the same PA outcome (e.g., parent-reported and accelerometer-measured MVPA) in a study, only data from the most valid instrument were included. If validity data were not reported, the result from the most objective method was

chosen. If two measures were used for separate outcomes, separate associations were included. Studies that used different PA contexts (e.g., recess, physical education) are highlighted in Appendices. Similar to a previous review,[24] this review found no difference in the percentage of null associations per study using multivariate analysis compared with results from bivariate analyses (*t*-test, p=0.20); therefore, results taken from bivariate and multivariate analyses were included together and marked accordingly. If potential correlates and determinants of moderate-intensity PA and vigorous-intensity PA were reported separately but in the same direction, the results were combined for one overall association with MVPA. This same process was used to report associations of potential correlates/determinants with TPA: If associations of a variable with LPA, moderate PA, and vigorous PA were reported separately, but in the same direction, the results were combined. If an association was found for one intensity of PA (e.g., vigorous PA) but not the other (e.g., moderate PA), associations were reported separately. Result tables report the number of studies in each direction of association (positive, negative, or null). Tables also report the overall summary of associations for each variable, along with the separate summaries of studies using an objective or subjective outcome measure. Tables within the Appendices provide a detailed overview of the variables included in individual studies.

Search Process

One author (DDB) undertook the initial search of article titles. Two researchers (DDB and KAS) then independently screened the article abstracts. Any discrepancies between the reviewers were discussed until consensus was achieved. If consensus could not be achieved, further discussion was undertaken with a third reviewer (SEB) to achieve consensus. This process was repeated when reviewing the full articles. Data extraction was undertaken using standardized forms.

Selection of Variables

Categories of potential correlates/determinants were:

1. demographic and biological;
2. psychological, cognitive, and emotional;
3. behavioral;
4. social and cultural; and
5. physical environment.

The overall strength of association between PA and each potential correlate/determinant was assessed by examining the percentage of studies reporting an association in a given direction.[21] For correlates, if the association with PA was tested four or fewer times, no classification was graded. If four or more studies had tested an association, and 0%–33% reported significant associations in a positive/negative direction, the result was categorized as no association (0). If 34%–59% reported significant associations in a consistent direction, the result was categorized as inconsistent (?). If 60%–100% reported a significant association in a consistent direction, the result was coded as (+) for positive or (–) for negative associations.

For determinants, a classification was graded even if the potential association was assessed four or fewer times. This decision was made because of the greater importance of determinants compared with correlates. The following coding procedure was used to incorporate the quality assessment outlined by Costigan et al. (2013)[34] and Lubans and colleagues (2010)[35]: If 60%–100% of high-quality studies reported consistent findings (positive, negative, or null association), the result was coded as strong evidence in that direction (++, – – ,00). A potential correlate/determinant was considered a correlate/determinant when a positive or negative association (+, ++, –, – –) was found.

Study Methodologic Quality

Two authors (DDB and KAS) independently assessed study quality using criteria adapted from the CONSORT[36] and STROBE[37] statements, used in previous systematic reviews.[33,34] A score for each study was completed on a 6-point scale by assigning a value of 0 (absent or insufficiently described) or 1 (present or clearly described) to the following questions:

1. Did the study describe participant eligibility criteria?
2. Were participants randomly selected?
3. Did the study report the sources and details of PA assessment and did the instruments have acceptable reliability for the specific age group (e.g., an intra-class correlation coefficient of 0.70 or Pearson correlation of 0.80 was considered acceptable)?
4. Did the study report the sources and details of assessment of correlates/determinants and did all instruments have acceptable reliability?
5. Did the study report a power calculation and was the study adequately powered to detect hypothesized associations?
6. Did the study report the numbers of participants who completed each of the different measures?

Studies scoring 0–2 were regarded as low quality/high risk of bias; studies scoring 3–4 were considered moderate quality/risk of bias; and studies scoring 5–6 were considered high quality/low risk of bias.

Evidence Synthesis

Review Process

Figure 1 outlines the flow of articles through the review. A total of 22,045 articles were identified and screened; 19,385 were excluded based on the title (mostly because of their

sample's age falling outside the inclusion criteria), and a further 1,733 were identified as duplicates and excluded. Of the remaining 927 abstracts, 490 were excluded. Four hundred thirty-seven full articles were screened and 332 excluded, leaving 105 articles. A further 25 articles were included from hand searching and authors' private libraries, leaving 130 articles for data extraction. Details of the included studies are outlined in Appendix 1.

Study Design

The majority of studies were cross-sectional (*n*=115, 88%), 11 (9%) were prospective,[38–48] three (2%) were intervention studies,[49–51] (baseline data only), and one was an intervention study reporting no intervention effect; therefore, data from the control and intervention groups were combined and a longitudinal/prospective analysis reported.[52] Of the 12 prospective studies, three studies[46–48] had a follow-up period that went beyond the early years, meaning only baseline data were included. Therefore, nine studies[38–45,52] investigating potential determinants were included. In total, 114 studies investigated potential correlates of TPA, 73 investigated correlates of MVPA, and 25 investigated correlates of LPA. For those studies that investigated potential determinants, all nine investigated associations of those potential determinants with TPA, two with MVPA, and one with LPA.

Study Quality and Methodologic Risk of Bias

The intra-class correlation coefficient between the reviewers' quality scores was 0.97. Appendix 2 outlines the quality score (low, moderate, high) for each study. A total of 122 (93%) adequately described eligibility criteria, 103 (79%) adequately described their process of randomly selecting participants, 25 (19%) adequately described their assessment of PA, and 38 (29%) adequately described their assessment of correlates/determinants. No studies

reported the use of a power calculation, whereas 90 (69%) reported the number of participants with complete measures.

Nine (6%) studies were identified as high quality,[10,41,53–60] two of which were determinant studies[43,54]; 78 (60%) were classified as moderate quality,[11,26,28,38,40,42,44,45,47,48,50–52,61–122] of which six were determinant studies[38,40,42,44,52]; and 43 (33%) were classified as low quality,[13,14,39,46,49,123–160] with only one determinant study[39] (Appendix 2).

Description of Included Studies

A large number of studies were conducted in the U.S. (*n*=52, 40%). The age of participants within studies ranged from 0.5[90] to 5.95 years[89] (mean, 4.3 years). Four studies (3%) investigated potential correlates of PA with infants, 35 (27%) with toddlers, and 92 (70%) with preschoolers. Sample sizes ranged from 20[61] to 10,694[53] (median, 208). Studies investigated between one and 51[79] potential correlates (median, 3).

Most studies (*n*=104, 80%) used objective measurements of PA, including: accelerometers (*n*=80, six determinant studies), direct observation (*n*=13, two determinant studies), pedometers (*n*=7), doubly labeled water (*n*=2), and heart rate monitoring (*n*=1). Twenty-four studies (one determinant study) used parental proxy–report. Of the nine high-quality studies, six (67%) used accelerometers,[10,41,54,56,57,161] one (11%) used doubly labeled water,[55] one used proxy-report,[53] and one used accelerometer plus proxy-report.[43]

Demographic and Biological Variables

Thirty potential correlates of TPA were identified (Appendix 3), ten of which were investigated four or more times (Table 1). Six high-quality studies investigated differences of

TPA by sex, and overall found boys to be more active than girls. BMI (five high-quality studies, 40% with negative associations) was found to be inconsistently associated with TPA. The strength of the associations/the presence of an association between sex, ethnicity, and parental education and TPA varied between studies using objective and subjective measures of TPA. Nine potential determinants were identified for TPA (Table 1 and Appendix 4). The most frequently investigated potential determinants were sex (three studies) and age (four studies). All other variables were investigated once and showed no associations, apart from maternal depressive symptoms, which showed a negative association with TPA.

A total of 19 potential demographic and biological correlates were investigated for associations with MVPA (Appendix 5), nine of which were investigated four or more times (Table 2). Four high-quality studies (75%, strong association) investigated differences in MVPA by sex and found boys were significantly more active than girls. Seven potential determinants of MVPA were identified (Table 2); only sex was investigated more than once and the association inconsistently associated with MVPA.

Fourteen potential demographic and biological correlates were investigated for associations with LPA (Appendix 5). Only three variables were investigated four or more times (Table 3); all had no association with LPA. Four potential demographic and biological variables (sex, ethnicity, BMI, and parental education) were investigated as potential determinants of LPA (Table 3) in one study.[52] The study found boys took part in significantly more LPA than girls; all other variables had no association with LPA.

Psychological, Cognitive, and Emotional Variables

Eleven potential psychological, cognitive, and emotional correlates were investigated for associations with TPA, nine were investigated for associations with MVPA, and three were investigated for associations with LPA. None of the potential correlates were investigated frequently enough (four or more times) to attribute a grade. No potential psychological determinants were identified for any PA category (Appendices 4 and 6).

Behavioral Variables

Seven potential behavioral correlates were investigated for associations with TPA, eight were investigated for an association with MVPA, and one was investigated for an association with LPA (Appendices 2–6). The only variable investigated four or more times for both TPA and MVPA was TV viewing (Tables 3 and 4), which was classified as inconsistent for both types of PA. No potential behavioral determinants were found for any PA category.

Social and Cultural Variables

Twenty-seven potential social and cultural correlates were investigated for associations with TPA (Appendix 3); six were investigated four or more times (Table 1). Differences in associations of independent variables with subjectively and objectively measured TPA were found for parental PA (objective, ?; subjective, +) and parental support (objective, 0; subjective, +) (Table 1). There were no other associations with either objectively or subjectively measured TPA. Seventeen potential determinants of TPA were identified (Table 1); parental PA had no association and time spent playing with parents (four models from one study,[44] 75% positive) had a positive association with TPA. No associations were found with the remaining potential determinants (Table 2, Appendix 4).

Thirty-seven potential social and cultural correlates were investigated for associations with MVPA (Appendix 5) and 18 for LPA (Appendix 7). Two variables (parental PA and parents' work status) were classified as being inconsistent with MVPA (Table 2). For LPA, no variables were investigated four or more times. No potential determinants of MVPA or LPA were identified.

Physical Environment Variables

Seventy-eight potential physical environment correlates (Appendix 3) were investigated for associations with TPA; eight were investigated four or more times (Table 1). Time outdoors in play spaces and the individual attended preschool were found to have positive associations. There were no differences between studies using subjective and objective measures. Four potential determinants were investigated (time outdoors, play equipment in the home, time of day, TV in the home) (Table 1); all showed no association.

Ninety potential physical environment correlates were investigated for associations with MVPA (Appendix 5). Five variables were investigated four or more times (Table 2). The individual preschool/child care setting (type: faith, private, state ran) was positively associated with MVPA (four studies, 75%), whereas the amount of time spent outdoors in play spaces had no association (six studies, 33%) with MVPA. Only one potential determinant of MVPA was investigated (Table 3): The number of hours a child spent at preschool was found to have no association with MVPA. No high-quality studies investigated any potential physical environment correlates or determinants of MVPA.

Ten potential physical environment correlates were investigated for association with LPA (Appendix 7). No variables were investigated four or more times. One potential determinant

of LPA (hours spent at preschool) was identified and showed no association (Table 3, Appendix 8).

Discussion

This systematic review identified a large number of observational studies that examined the correlates and determinants of PA in the early years. Few studies were of high quality and the numbers of identified correlates and determinants were small. All correlates and determinants found for each of the PA intensities (TPA, MVPA, and LPA) were either demographic and biological variables, social and cultural variables, or physical environment variables. Boys were found to participate in more TPA, MVPA, and LPA than girls. The correlates and determinants found in this review can aid in identifying potential efficacious mediators for the use in interventions aiming to promote TPA, MVPA, and LPA of children during the early years, which to date have had little effectiveness.[16]

There have been two known systematic reviews conducted specifically within early years children.[19,24] Like the previous reviews,[19,24] this review reported findings according to an ecologic model, to highlight different levels of influence on PA.[21,162] Some findings differ between these previous reviews and the current review (e.g., sex, ethnicity, and time outdoors).[19,24] Differences may be due to the current review including more published studies over a longer period of time (Bingham et al.,[163] 1900–2014; Hinkley and colleagues,[24] 1980–2007; De Craemer et al.,[19] 1990–2010) and applying a larger age range (Bingham and colleagues,[163] 0–6 years; Hinkley et al.,[24] 2–5 years; De Craemer and colleagues,[19] 3–6 years). Like Hinkley et al.[24] for TPA and De Craemer and collegues[19] for MVPA, this review found sex to be a correlate (with boys more active than girls). Furthermore, sex also was found to be a determinant of LPA, but not MVPA; however, this was based on a small

number of studies. Given PA varies between the sexes across the life course, with boys and men mostly being reported to be more active than girls and women,[23] and correlates of PA differ between boys and girls during the early years,[79] identifying sex-specific strategies to increase PA in future interventions is recommended. The necessity for sex-specific strategies is further strengthened by higher obesity prevalence in girls throughout childhood.[26,163,164]

Like Hinkley et al.,[24] this review also found time spent outdoors in play spaces was positively correlated with TPA, but was not a determinant (two studies). It is unclear if young children are more active outside because specific outdoor environments may be more conducive to PA (e.g., green space, playgrounds, and rural/urban areas). This finding suggests that time spent outdoors in play spaces could be a suitable behavior to target in future interventions promoting TPA. Interestingly, this review found no association between time outdoors and MVPA. This could be because young children may need specific support and encouragement from parents/adults to engage in more intensive activity.[139] Attendance at preschool/child care was found to be a positive correlate of both MVPA and TPA. Studies exploring preschool/child care (all cross-sectional) found more PA took place within faith-based and private preschools compared with government preschools.[56,103,136,159] The study authors[56,103,136,159] speculated this difference was because faith and private preschools had greater space for children to play actively. With many children attending preschool/daycare/nursery (48.5% of U.S.[165] and 64% of United Kingdom children[166]), and with those environments providing prime opportunities to influence behaviors, it is highly recommended that more research be undertaken to clearly identify which characteristics of those environments are associated with children's PA.

This review is the first to summarize the determinants of children's PA during the early years. Determinants are considered more valuable than correlates because they show associations over time and are from stronger study designs.[17] Only sex has been previously identified as a determinant of PA in childhood.[23] This review also found sex to be a determinant of TPA, and maternal depressive symptoms and the time a parent plays with their child were additionally identified as determinants. However, caution must be taken when interpreting these results owing to the small number of studies (*n*=9) investigating determinants. Many of the potential determinants were investigated in only one study[44]; therefore, more high-quality, longitudinal/prospective research is needed to consistently identify determinants and better inform interventions.

A benefit of the large number of studies included in this review is that the findings could be stratified by the type of measure used for PA (objective or subjective). Subjective and objective measures ultimately measure PA differently. Generally, larger errors exist with subjective measures that can falsely inflate the proportion of variance a variable can account for within the outcome (e.g., habitual PA). Despite these differences, there were few differences found between the correlates of subjectively and objectively measured PA across most domains of the ecologic model. This is an important finding, as consistency between the measures strongly supports the direction (or lack thereof) of an association. However, different associations for sex, ethnicity, parental education, parental PA, physical health, and parental support were found between objectively and subjectively measured PA. Because few high-quality studies were identified and only one used both objective and subjective measures with the same sample[43] (measured tracking [age] no difference between measures was found), the authors cannot say whether the inconsistencies in associations were due to the way PA was measured or other inconsistencies between study methodologies. The majority

of studies within this review did use objective measures. Future studies using both objective and subjective measures are warranted to further investigate differences between factor associations with PA, between measurement types.

Despite the large number of studies identified in the present review, few (*n*=9) were of high quality. It may be that it is the reporting of studies that is poor, rather than the study itself. Therefore, a recommendation from this review is that the STROBE guidelines are followed when reporting studies to ensure necessary information is included. Improving the quality and reporting of future studies could lead to more consistency across studies and greater confidence in the identified correlates and determinants of PA.

Gaps in the Research

The studies reported in this review focused primarily on potential demographic/biological and social/cultural correlates/determinants of PA. Future research needs to explore potential correlates across the whole spectrum of the ecologic model within one study to clearly identify the relative influence of individual correlates/determinants within the broader context of children's lives. The majority of studies included in this review were conducted in high-income Anglo/European nations, with little research conducted in low- to middle-income countries.

Limitations

A limitation of this review is the small number of identified longitudinal studies, with findings largely based on cross-sectional research. Most peer-reviewed literature was published in English, which means the exclusion of non-English publications may in part account for the lack of studies found in low- and middle-income countries.

Conclusions

Although a large body of research investigating potential correlates/determinants of PA in the early years has been published, few studies are of high quality. Studies included in this review focused predominantly on demographic/biological and social/cultural correlates and determinants. Future research should focus on:

1. improved reporting of measurement methods so study quality can be accurately assessed;
2. longitudinal/prospective studies to assess temporal associations (determinants);
3. additional ecologic domains relevant for PA early in life (e.g., policies, macroeconomics); and
4. the inter-relationship of constructs within and between domains.

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List of Figures

Table 1. Summary of Potential Correlates and Determinants of Total Physical Activity

	Related to TPA		Unrelated to TPA		
	Positive association	**Negative association**	**No association**	**Summary code**	
Demographic and biological variables	**No. studies (No. HQ*)**	**No. studies (No. HQ*)**	**No. studies (No. HQ*)**	**n/N (%) Association[a]**	**High quality summary[b]**
Correlates					
Age					
- Overall	14(2HQ)	5	20	**14/39 (36%) ?**	~
- Subjective	1	1	4	**1/6 (17%) ?**	~
- Objective	13 (2HQ)	4	16	**13/33 (39%) ?**	~
Sex (male)					
- Overall	42(6HQ)	~	35	42/77 (55%) ?	**6/6(100%)++**
- Subjective	5(1HQ)	~	10	**5/15 (33%) 0**	~
- Objective	37(5HQ)	~	25	37/62 (60%) +	**5/5(100%)++**
Ethnicity (white)					
- Overall	6	1	11(1HQ)	**6/18 (35%)?**	~
- Subjective	2	1	7(1HQ)	**1/10(10%) 0**	~
- Objective	4	0	4	**4/8 (50%) ?**	~
SES					
- Overall	~	~	7	**0/7(0%) 0**	~
- Subjective	~	~	5(1HQ)	**0/5 (0%) 0**	~
- Objective	~	~	4	**0/4 (0%) 0**	~
Parental education					
- Overall	~	4(1HQ)	14	**4/18(22%) 0**	~
- Subjective	~	3(1HQ)	6	**3/8 (38%) ?**	~
- Objective	~	1	8	**1/9 (11%) 0**	~
Parental age					
- Overall	~	~	7	**0/7(0%) 0**	~
- Subjective	~	~	4(1HQ)	**0/4(0%) 0**	~
- Objective	~	~	3	**0/3(0%) 0**	~
Adiposity - overall/objective	1	3	4(1HQ)	**3/8(38%) 0**	~
BMI					
- Overall	5(1HQ)	6(2HQ)	26(3HQ)	6/37(16%) 0	**2/5(40%) ?**
- Subjective	1(1HQ)	2(2HQ)	5	**2/8(25%) 0**	~
- Objective	4	4	21(2HQ)	**4/21(19%)0**	~
Gross motor skills					
- Overall	9(2HQ)	1	13	**9/23(37%) ?**	~
- Subjective	1(1HQ)	~	~	1/1(100%) #	~
- Objective	8	1	13	**8/22(37%) ?**	~
Parents BMI					
- Overall	~	3	9	**3/12(25%) 0**	~
- Subjective	~	1	3	**1/4(25%) 0**	~
- Objective	~	2	6	**2/8(25%) 0**	~
Physical health					
- Overall	~	3	7	**3/7(42%) ?**	~
- Subjective	~	~	4	**0/4(0%) 0**	~
- Objective	~	3	4	**3/7(43%) ?**	~
Family structure					
- Overall	~	~	8	**0/8(0%) 0**	~
- Subjective	~	~	5	**0/5 (0%) 0**	~
- Objective	~	~	3	**0/3(0%) 0**	~
Siblings (no. and order)					
- Overall	2	~	6	**2/8(25%) 0**	~
- Subjective	0	~	2	**0/2 (0%) #**	~
- Objective	2	~	4	**2/6(33%) 0**	~
Determinants					
Age – overall/objective	1	2	1	**2/4(50%) ?**	~
Sex (male) – overall/objective	2	~	1	**2/3(66%) +**	~
Maternal depressive symptoms					
- Overall/subjective	~	1	~	**1/1(100%) -**	~
Ethnicity (white)					
- Overall/subjective	~	~	2	**0/2(0%) 0**	~
Parents education	~	~	1	**0/1(0%) 0**	~
Adiposity – overall/objective	~	~	1	**0/1(0%) 0**	~
BMI					
- Overall/subjective	~	~	2	**0/2(0%) 0**	~
Aerobic fitness					
- Overall/subjective	~	~	1	**0/1(0%) 0**	~
Gross motor skill performance					
- Overall/subjective	~	~	1	**0/1(0%) 0**	~

Behavioral variables					
Correlates					
TV viewing					
- Overall	~	7(1HQ)	9	**7/16(44%) ?**	~
- Subjective	~	4(1HQ)	4	**4/8(50%) 0**	~
- Objective	~	3	5	**3/8(38%) 0**	~
Social and cultural variables					
Correlates					
Parental PA/family interactions					
- Overall	10(2HQ)	1	8	**10/17(59%) ?**	~
- Subjective	4(1HQ)	1	0	**4/5(80%) +**	~
- Objective	6(1HQ)	0	6	**6/12(50%) ?**	~
Parental support					~
- Overall	7	~	7	**7/14(50%)?**	~
- Subjective	5	~	0	**5/5(100%) +**	~
- Objective	2	~	7	**2/9(22%) 0**	
Parent(s) work status					
- Overall	2(2HQ)	4	9(3HQ)	4/15(27%) 0	**2/5(40%) ?**
- Subjective	1(1HQ)	2	5(3HQ)	**2/8(25%) 0**	1/4(25%)*
- Objective	1(1HQ)	2	4	**2/7(29%) 0**	~
Parenting practices					
- Overall	4	1	14	**4/19(21%) 0**	~
- Subjective	2	~	4	**2/6(33%) 0**	~
- Objective	2	1	10	**2/13(15%) 0**	~
Parents perceptions and beliefs					
- Overall	5(1HQ)	~	4	**5/9(56%) ?**	~
- Subjective	4	~	4	**4/8(50%) ?**	~
- Objective	1	~	~	1/1(100)% #	~
Parents barriers					
- Overall	~	4	3	**4/7(57%) ?**	~
- Subjective	~	2	2	**2/4(50%) ?**	~
- Objective	~	2	1	2/3(66%) #	~
Social and cultural variables					
Determinants					
Parental PA/family interactions					
- Overall/objective	1(1HQ)	~	5(1HQ)	**1/6(20%) 0**	~
Parental PA knowledge					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Parental PA views					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Parental PA optimism					
- Overall/objective	1	~	2	**1/3(33%) 0**	~
Parental PA self-efficacy					
- Overall/objective	~	~	2	**0/2(0%) 0**	~
Parental PA future expectations					
- Overall/objective	~	~	2	**0/2(0%) 0**	~
Parental floor concerns					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Parental TV knowledge					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Parental TV use					
- Overall/objective	~	~	2	**0/2(0%) 0**	~
Parental TV self-efficacy					
- Overall/objective	~	~	2	**0/2(0%) 0**	~
Parental screen time					
- Overall/objective	~	~	2	**0/2(0%) 0**	~
Time spent playing outside with adults					
- Overall/objective	~	~	2	**0/2(0%) 0**	~
Tummy time					
- Overall/objective	~	~	2	**0/2(0%) 0**	~
Time spent on the floor					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Time spent playing with parent					
- Overall/objective	3	~	1	**3/4(75%) +**	~
Time spent playing with peers similar age					
- Overall/objective	~	1	4	**1/5(20%) 0**	~
Time spent with older toddlers or children					

- Overall/objective			2	**0/2(0%) 0**	~
Physical environmental variables Correlates					
Time outdoors/in play spaces					
- Overall	7	~	1	**7/8(88%) +**	~
- Subjective	-	~	1	**0/1(0%) #**	~
- Objective	7	~	~	**7/7(100%) +**	~
Attend childcare					
- Overall	1	1	3	**1/4(20%) 0**	~
- Subjective	~	~	1	0/1(0%) #	~
- Objective	1	1	2	**1/4(25%)0**	~
Season (summer)					
- Overall	5	2(1HQ)	3(2HQ)	**5/10(50%) ?**	~
- Subjective	~	1	~	1/1(100%) #	~
- Objective	5	1(1HQ)	3(2HQ)	**5/9(56%) ?**	~
Weekday vs weekend (weekday)					
- Overall					
- Subjective	4	6	5(1HQ)	**6/15(33%) 0**	~
- Objective	~	2	~	2/2(100%) #	~
	4	4	5(1HQ)	**4/13(31%) 0**	~
Time of day (afternoon)					
- Overall/objective	2	~	2	2/4(50%) **?**	~
Month of PA data collected					
- Overall/objective	1	~	5	1/6(17%) **0**	~
Frequency of visits to active play spaces (per week)					
- Overall/objective	1	1	2	1/4(25%) *	~
Individual preschool					
- Overall	6(2HQ)	~	~	**6/6(100%) +**	~
- Subjective	1	~	~	1/1(100%) #	~
- Objective	5(2HQ)	~	~	**5/5(100%) +**	~
Physical environmental variables Determinants					
Time outdoors/in play spaces					
- Overall/objective	~	~	2	**0/2(0%) 0**	~
Play equipment at home					
- Overall/objective	~	~	2	**0/2(0%) 0**	~
Time of day (afternoon)					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
TV in home					
- Overall/objective	~	~	2	**0/2(0%) 0**	~

* = All associations were derived from the same study, so no code was awarded.
~ = No data.
a = association codes: 0 = no association, ? inconsistent, - negative , + positive, # = insufficient data to derive an association.
b = association codes for high quality studies (≥4 studies required): 00 = strong no association, ? inconsistent, ++ strong positive, -- strong negative.
Bold associations are the final grading for each exposure/variable.
TPA, total physical activity; HQ, high quality studies; PA, physical activity; Overall, combined subjective and objective measures; Subjective, subjective outcome measure; Objective, objective outcome measure; Overall/objective, only objective measures were applied by studies exploring exposure; Overall/subjective, only subjective measures were applied by studies exploring exposure.

Table 2. Summary of Potential Correlates and Determinants of Moderate- to Vigorous-Intensity Physical Activity (MVPA)

Demographic and biological variables	Related to MVPA: Positive association No. studies(No. HQ*)	Related to MVPA: Negative association No. studies(No. HQ*)	Unrelated to MVPA: No association No. studies(No. HQ*)	Summary code n/N (%) Association[a]	High quality summary[b]
Correlates					
Age – Overall/objective	8(1HQ)	2	11(1HQ)	**8/21(30%) ?**	~
Sex (male) – Overall/objective	33(3HQ)	1	20(1HQ)	33/54(61%) +	**3/4(75%) ++**
Ethnicity (white)					
- Overall/objective	1	2	4	**2/7(28%) 0**	~
Parental education					
- Overall/objective	1	1	11(1HQ)	**1/13(8%) 0**	~
Adiposity – Overall/objective	~	3	5	**3/8(38%) ?**	~
BMI					
- Overall	3	4(1HQ)	23(1HQ)	**4/30(14%) 0**	~
- Subjective	~	~	1	**0/1(0%) #**	~
- Objective	3	4(1HQ)	22	**4/29(14%) 0**	~
Gross motor skills					
- Overall/objective	11	2	13	**11/26(42%) ?**	~
Parents BMI					~
- Overall/objective	~	1	6	**1/7(14%) 0**	
Physical health					
- Overall	1	4	4	**4/9(44%) ?**	~
- Subjective	~	~	1	**0/1(0%) #**	~
- Objective	1	4	3	**4/8(50%) ?**	~
Determinants					
Sex (male) - Overall/objective	1	1	2	**1/2(50%) ?**	~
Ethnicity(white)					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Parents education (degree)					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Adiposity - Overall/objective	~	~	1	**0/1(0%) 0**	~
BMI					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Aerobic fitness					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Gross motor skills					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Behavioral variables					
Correlates					
TV viewing					
- Overall	1	1	2	**1/4(25%) 0**	~
- Subjective	~	~	1	**0/1 (0%) #**	~
- Objective	1	1	1	**1/3 (33%) #**	~
Social and cultural variables					
Correlates					
Parental PA/family interactions					
- Overall/objective	4(1HQ)	~	4(1HQ)	**4/8(50%) ?**	~
Parent(s) work status					
- Overall/objective	3		3	**3/6(50%) ?**	~
Physical environmental variables					
Correlates					
Time outdoors/in play spaces					
- Overall/objective	2	1	3	**2/6(33%) 0**	~
Attend childcare center					
- Overall/objective	2	~	3	**2/5(40%) ?**	~
Season (summer)					
- Overall/objective	3	1	4	**3/8(38%) ?**	~
Weekday vs weekend (weekday)					

- Overall/objective	2	~	4	**2/6(33%) ?**	~
Individual preschool					
- Overall/objective	3	~	1	**3/4(75%) +**	~
Physical environmental variables					
Determinants					
Hours spent at preschool					
- Overall/objective			1	**0/1(0%) 0**	~

* = All associations were derived from the same study, so no code was awarded.
~ = No data.
a = association codes: 0 = no association, ? inconsistent, - negative , + positive, # = insufficient data to derive an association.
b = association codes for high quality studies (≥4 studies required): 00 = strong no association, ? inconsistent, ++ strong positive, -- strong negative.
Bold associations are the final grading for each exposure/variable.
HQ, high quality studies; Overall, combined subjective and objective measures; Subjective, subjective outcome measure; Objective, objective outcome measure; Overall/objective, only objective measures were applied by studies exploring exposure; Overall/subjective, only subjective measures were applied by studies exploring exposure.

Table 3. Summary of Potential Correlates and Determinants of Light-Intensity Physical Activity (LPA)

Demographic and biological variables	Related to LPA: Positive association No. studies(No. HQ*)	Related to LPA: Negative association No. studies(No. HQ*)	Unrelated to LPA: No Association No. studies(No. HQ*)	Summary code n/N (%) Association[a]	High quality summary[b]
Correlates					
Sex (male)					
- Overall	5	~	9	**5/14(35%) 0**	~
- Subjective	~	~	1	**0/1(0%) #**	~
- Objective	5	~	8	**5/13(38%) ?**	~
Parental education					
- Overall/objective	~	~	5	**0/5(0%) 0**	~
BMI					
- Overall/objective	~	~	7	**0/7(0%) 0**	~
Demographic and biological variables Determinants					
Sex (male)					
- Overall/objective	1	~	~	**1/1(100%) +**	~
Parental education					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
BMI					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Ethnicity(white)					
- Overall/objective	~	~	1	**0/1(0%) 0**	~
Physical environment variables Determinants					
Hours spent at preschool	~	~	1	**0/1(0%) 0**	~

* = All associations were derived from the same study, so no code was awarded.

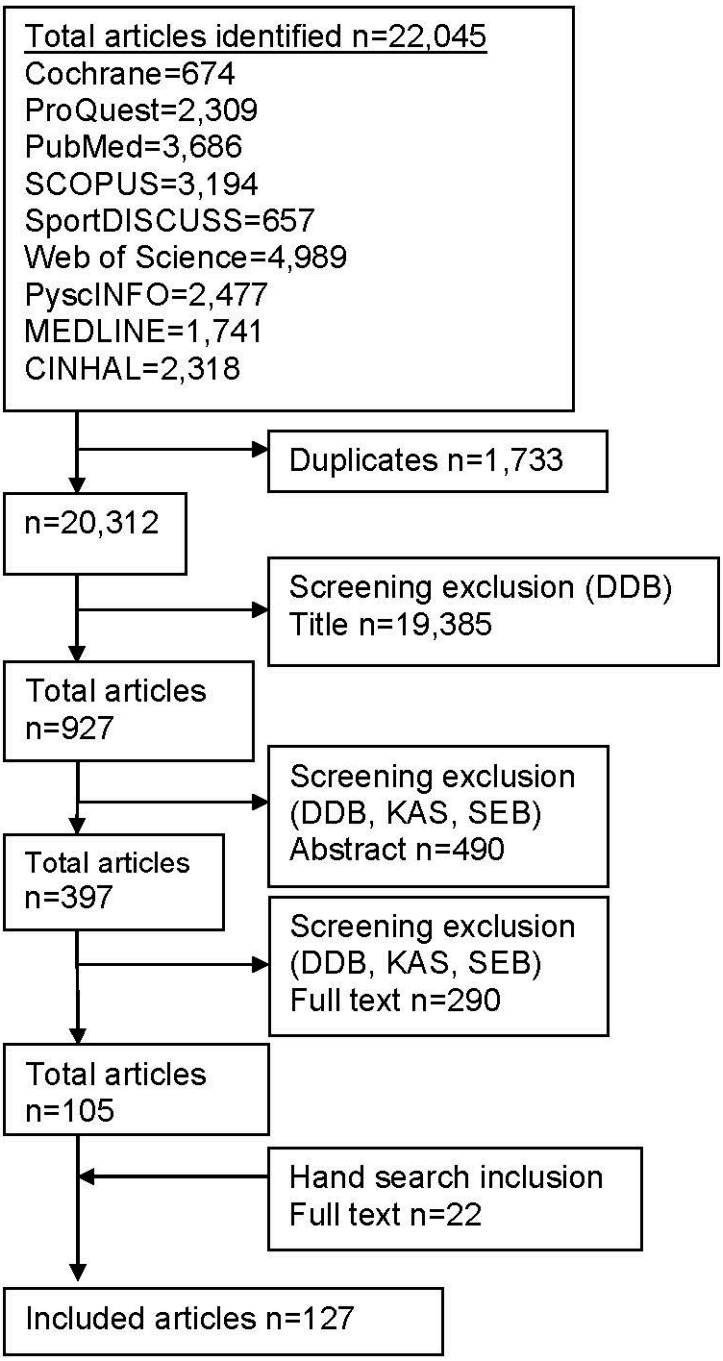
~ = No data.

a = association codes: 0 = no association, ? inconsistent, - negative , + positive, # = insufficient data to derive an association.

b = association codes for high quality studies (≥4 studies required): 00 = strong no association, ? inconsistent, ++ strong positive, -- strong negative.

Bold associations are the final grading for each exposure/variable.

HQ, high quality studies; Overall, combined subjective and objective measures; Subjective, subjective outcome measure; Objective, objective outcome measure; Overall/objective, only objective measures were applied by studies exploring exposure; Overall/subjective, only subjective measures were applied by studies exploring exposure


Total articles identified n=22,045
Cochrane=674
ProQuest=2,309
PubMed=3,686
SCOPUS=3,194
SportDISCUSS=657
Web of Science=4,989
PyscINFO=2,477
MEDLINE=1,741
CINHAL=2,318
Duplicates n=1,733
n=20,312
Screening exclusion (DDB)
Title n=19,385
Total articles
n=927
Screening exclusion
(DDB, KAS, SEB)
Abstract n=490
Total articles
n=397
Screening exclusion
(DDB, KAS, SEB)
Full text n=290
Total articles
n=105
Hand search inclusion
Full text n=22
Included articles n=127

Appendices

The correlates and determinants of children's physical activity during the early years (aged 0-6): a systematic review.

Appendices key: Study number and first author, **BOLD** refers to high quality studies. Determinant studies *(D)*.

1	Sallis, et al.	48	Cliff, et al.	95	Sundberg, et al.
2	Adams, et al.	49	Cox, et al.	96	Tanaka, et al.
3	Anderson, et al.	50	Dowda, et al.	**97**	**Taylor, et al.** *(D)*
4	Yamamoto, et al.	51	Eriksson, et al.	98	Temple, et al.
5	Williams, et al.	52	España-Romero, et al.	99	van Rossem, et al.
6	Tanaka, et al.	**53**	**Finn, et al.**	100	Verbestel, et al.
7	Vorwerg, et al.	54	Firrincieli, et al.	101	Worobey, et al.
8	Vasquez, et al.	55	Fisher, et al.	102	Zecevic, et al.
9	Vale, et al.	**56**	**Gagne, et al.**	103	Barkley, et al.
10	Vale, et al.	57	Grontved, et al.	104	Becker, et al.
11	Spurrier, et al.	58	Gubbels, et al.	105	Brasholt, et al.
12	Trost, et al.	59	Heelan, et al.	106	Cespedes, et al.
13	Hinkley, et al.	60	Iannotti, et al. *(D)*	107	Driessen, et al.
14	Hnatiuk, et al.	61	Jago, et al.	108	Edwards, et al.
15	Jackson, et al. *(D)*	62	Janz, et al.	109	Grzywacz, et al.
16	Kimbro, et al.	63	Janz, et al.	110	Hesketh, et al.
17	Sigmund, et al.	64	Kambas, et al.	111	Hesketh, et al.
18	Smith, et al.	65	Kelly, et al.]	112	Hnatiuk, et al. *(D)*
19	**Hinkley, et al.**	66	Klesges, et al.	113	Iivonen, et al.
20	Gunter, et al.	67	Kuepper-Nybelen, et al.	114	Laukkanen, et al.
21	Blaes, et al.	68	LaRowe, et al.	115	O'Connor, et al.
22	Cardon, et al.	69	Loprinzi, et al.	116	O'Dwyer, et al. *(D)*
23	Brown, et al.	70	Loprinzi, et al.	117	Olesen, et al.
24	Collings, et al.	71	Loprinzi, et al.	118	Ostbye, et al.
25	Dowda, et al.	72	Louie, et al.	119	Rice, et al.
26	Dwyer, et al.	73	Marino, et al.	120	Tanaka, et al.
27	Sallis, et al.	74	McKee, et al.	121	Taylor, et al. *(D)*
28	Benham-Deal	75	McKee, et al.	122	Vale, et al.
29	Gubbels, et al.	76	Metallinos-Katsaras, et al.	123	Vale, et al.
30	Grigsby-Toussaint, et al.	77	Mickle, et al.	124	van Sluijs, et al.
31	Fernald, et al. *(D)*	78	Montgomery, et al.	125	Vanderloo, et al.
32	Baranowski, et al. *(D)*	79	Moore, et al.	126	Wijtzes, et al.
33	**Beets, et al.**	**80**	**Niederer, et al.**	127	Jimenez-Pavon, et al.
34	Bellows, et al.	81	O'Dwyer, et al.	128	Tandon, et al.
35	Boldemann, et al.	82	O'Dwyer, et al.	129	Tandon, et al.
36	Bower, et al.	83	Oliver, et al.	130	Vanderloo, et al.
37	Brown, et al.	84	Pate, et al.		
38	Burdette, et al.	85	Pate, et al.		
39	Burdette, et al.	86	Pate, et al.		
40	**Burgi, et al.** *(D)*	87	Penpraze, et al.		
41	**Bürgi, et al.**	88	Pfeiffer, et al.		
42	Buss, et al.	89	Poest, et al.		
43	Cardon, et al.	90	Raustorp, et al.		
44	Caroli, et al.	91	Saakslahti, et al.		
45	Chuang, et al.	92	Schary, et al.		
46	Lawrence, et al.	93	Shen, et al.		
47	**Davies, et al.**	94	Sugiyama, et al.		

Appendix 1. Description of Included Studies.

Study	Design	Country	Aims	Correlates investigated	Analyses	Sample demographics	PA measurement	Measurement period	Validity and reliability of PA Measure	Reported PA level	Notes
Sallis et al. (1993)[1]	Cross-sectional	U.S.	Investigate the different correlates of children's physical activity.	Ethnicity, SES, sex, skinfolds, motor co-ordination, TV hours per week, play rules, mothers activity, familial interaction, parent activity control, convenient play spaces, availability of toys, frequency in play spaces.	Correlations, regression.	n=347; mean age 4.4 years (SD=0.5) 201 Mexican American; 146 Anglo-American.	Observation (BEACHES).	4 x 1 hour in home evening visit, 30 minutes prior to evening meal: coded 1 minute.	Inter-observer: agreement was 90%-95%. Reliability was reported for many different measures.	Not reported.	
Adams et al. (2010)[2]	Cross-sectional	U.S.	Examine the associations of age, sex, weight status and children's proxy reported physical activity levels.	3-4 year olds: sex differences of number of times a week playing outside.	T-tests.	n=421; mean age 6.4 years (SD 1.2); 3-4 year olds=21, 5-6=240, 7-8=138.	Proxy questionnaire.	One screening appointment to complete questionnaire and body measures.	Test-retest reliability was completed for 80 children, r=0.88.	Playing outside for the whole sample was reported 2-3 hours. For 3-4 year olds only number of times playing outside weekly was reported.	
Anderson et al. (2008)[3]	Cross-sectional	U.S.	Estimate the proportion of children aged 4 - 11 years who are participating in low levels of active play and high levels of screen time.	4-5 year olds sex, weight status (BMI) stratified by sex and ethnicity.	Wald-chi tests for univariant analyse.	Total sample n=2,964, mean age 8.9 years. Sample was stratified by age. 4-5 year old n=777, mean age 4.9 years.	Proxy questionnaire, number of occasions a week a child takes part in exercise that causes sweating and hard breathing.	One occasion completing a questionnaire.	Cited sources but no reliability or validity statistics.	Adjusted for study design. Boy's median 6.9 (percentiles 6.3-7.4) times a week active, girls 7.3 (6.2-8.3).	
Yamamoto et al. (2011)[4]	Cross-sectional	Germany	Examine variables associated with every day, objectively measured PA in preschool children.	Age, educational status of parents, immigrant background, number of siblings, child's BMI, Mothers BMI, Fathers BMI, child's general health, child's desire to be active, TV viewing, time spent outside, organized sports, environmental opportunities and parents PA.	Multivariate regression models stratified by sex.	n=1,134, age 3-6 years, recruited from 52 preschools.	Actiheart, MVPA.	Monitor worn for 4 days. Minimum requirement was 1 weekday and 1 weekend day. 13.4 mean hours wear time on weekdays, and 12.8 mean hours wear time weekends.	Not reported, no reference.	Not reported.	

Williams et al. (2008)[5]	Cross-sectional	U.S.	Examine the relationship between level of motor skills and PA.	Gross motor skill performance; locomotors skills and object control skills.	Correlations and ANCOVAs.	n=198, mean age 4.2 years (SD 0.5). 53.5% African American, 34.9% white.	Uniaxial Accelerometer (Actigraph model 7164) - 15 sec epoch, PATE cut point. %of intensity was used. %LPA, %MVPA, %VPA.	Monitor worn for 8-10 days. Mean 12.7 hours.	Accelerometer validity cited elsewhere. Reliability cited elsewhere. No statistics applied but laboratory work referred to shows near perfect reliability.	Total 90 min MVPA, no report for total PA.
Tanaka et al. (2009)[6]	Cross-sectional	Japan	Evaluate MVPA using tri-axial accelerometer.	Sex.	Student's T-Test.	n=212, mean age 5.8 years (SD 0.6).	Accelerometer-Tri-axial (ActivTracer), Uniaxial (Life order EX).	Monitor worn for 6 days.	This study is a validation study. Reliability not reported.	13,037 step counts/day; boys 13,650, girls 12,255. Time in MVPA min/day 102; boys 112.3, girls 88.8. Physical Activity Level (PAL) 1.54; boys 1.55, 1.51. Time in PAR ≥4 (Physical activity ratio, minutes/day) 19.9; boys 22.6, girls 16.4.
Vorwerg et al. (2013)[7]	Cross-sectional	Germany	Investigate different variable associations with objective PA.	Sex, weekdays vs weekends, obesity, more time outside, Preschool quiet activities, parent weight status, and screen time.	Wilcoxon test, spearman rank correlation, chi-square test.	119 children, only 92 met all measurement criteria. Boys mean age 5.3 years, girls mean age 5.0 years.	Sense Wear Pro 2 Accelerometer.	Worn for 7 consecutive days, included at least 1 weekend day. Mean daily wear time was, 21.8 hours/day.	Validity cited elsewhere. 1.7% error versus metabolic analyzer. Reliability not mentioned.	Mean daily PA was 4.4 hours.
Vasquez et al. (2006)[8]	Cross-sectional	Chile	Assess energy intake, energy expenditure and physical activity patterns of obese children at children's centers and at home.	Sex, times of day at children's center, at home and weekday.	Descriptive, difference tested or non-parametric alternative, Wilcoxon.	24 obese children (12 boys, 12 girls) were selected from first come first serve basis from a group of 252 children's centers. Boys mean age 4.3 years (SD 0.05), girls mean age 4.2 (SD 0.7).	Tritrac-RD Research Ergometer, axial accelerometer.	Three full days (2 weekdays) and 1 weekend day.	Not reported.	Not reported.

Vale et al. (2011)[9]	Cross-sectional	Portugal	Analyze differences in TPA and MVPA of preschool children during school days when children attend the PE class compared with school days without PE.	Sex, physical education class.	Independent t-tests and general linear model (GLM).	193 children, mean age 4.8 years (SD 0.8), from kindergarten.	Actigraph Uniaxial Accelerometer GTM1 model.	Five consecutive days. Monitor was placed and fitted by teachers when the children arrived at school, and removed when leaving.	Validity cited elsewhere. Cut points ranged from r=0.46-0.70 (Sirard cut-points). Heart rate vs accelerometer r=0.50-0.74.	Mean daily TPA on Physical education days (PED) was 66.40 (SD 22.08) minutes; boys 70.49 (SD 24.28) minutes, girls 62.28 (SD 19.38). Mean daily MVPA on PED days was 26.55 (SD 12.18) minutes; boys 29.39 (SD 13.14) minutes, girls 24.08 (SD 11.11) minutes. Mean daily TPA on non PED was 55.45 (SD 17.17) minutes; boys 59.14 (SD 17.25) minutes, girls 52.14 (SD 16.06). Mean daily MVPA on non PED was 20.16 (SD 9.12) minutes; boys 22.03 (SD 9.14), girls 18.27 (SD 8.28).	
Vale et al. (2010)[10]	Cross-sectional	Portugal	(1) Document differences in TPA and MVPA between sexes on weekdays and weekend days. (2) Assess compliance to physical activity recommendations.	Sex, weekdays vs. weekends.	Descriptive, independent samples t-test, general linear model, chi-square comparison tests.	245 preschool children, from kindergartens. Mean age 5.2 years (SD 0.8).	Uniaxial Accelerometer (GTM1-model).	Seven consecutive days, 10 hours of wear time per day. Three weekdays and 1 weekend day was used in the analysis.	Validity reported elsewhere.	TPA mean weekday daily minutes 143.8 (SD 43.3); boys 155.4 (SD 45.4), girls 128.2 (SD 34.8). TPA mean weekend day daily minutes 123.9 (SD 41.8); boys 131.59 (SD 45.7), girls 113.9 (SD 33.6).	
Spurrier et al. (2008)[11]	Cross-sectional	Australia	Describe the characteristics of preschool children's home environment, what may influence children's physical activity, sedentary behavior and dietary patterns.	Parental physical activity (frequency of walking >30 minutes per day-both paternal and maternal), Mother's frequency of organized sport, presence of playground near home, participation in organiaed sports, dog ownership.	Descriptive and multiple ANOVA's with Bonferoni multiple comparison technique.	Out of 516 parents screened during recruitment, 280 agreed to participate in the study (54% response rate). Child mean age 4.8 years (SD 0.21).	Parental questionnaire - outdoor physical activity play.	One home visit.	Validity cited elsewhere.	Not reported.	Only significant results were reported.

Trost et al. (2003)[12]	Cross-sectional	U.S.	Compare the physical activity levels of overweight and non-overweight 3-to-5 year old children while attending preschool.	Weight status.	Two-way ANCOVA, with sex and weight status as group variables. Parent education was the co-variant. Fisher exact tests and contingency tables were used in group differences.	281 children recruited. After deletions of missing data, sample was 245 children (127 girls; 118 boys) and parents (242 mothers; 173 fathers). 51.1% of parents did not have college education, and 60% were African American.	MTI 7164 uniaxial accelerometer (15 sec epochs). Direct observation system for recording activity in preschools (OSRAP).	Children were observed for 1 hour on 3 randomly selected separate days. Accelerometer was worn ranging from 1-11 days. Three days of wear time was selected.	Validity for accelerometer and OSRAP reported elsewhere. ICC for OSRAP was reported as 0.91-0.98. Percent agreement for five day activity categorizations was 75% - 99%.	Mean activity rating: males: overweight 2.40(0.20), not overweight 2.60(0.19). Females: overweight 2.50(0.19), not overweight 2.49(0.20). %Time in MVPA: males: overweight 39.0(12.5), not overweight 47.6(12.7). Females: overweight 42.2(12.8), not overweight 41.6(12.5). Total counts/h: males: overweight 50.5(14.4), not overweight 60.0(14.5). Females: overweight 42.2(12.8), not overweight 41.6(12.5).
Hinkley et al. (2012)[13]	Cross-sectional	Australia	Investigate possible correlates of pre-schoolers physical activity across all levels of the socio-ecological model, for boys and girls separately, and differences for weekdays and weekends.	Numerous correlates across the socio-ecological model (individual, behavioral, psychological, social, physical environment).	T-Tests. Generalized linear models (GLM) to test for correlates.	1,036 children age 3-5 years from 71 child care centers and 65 preschools. Sample with data completed were 1,004 children and parent(s). Final accelerometer sample once wear time was applied equaled 705 children.	Actigraph Uniaxial Accelerometer GTM1 model. 15 sec epoch.	Eight-day accelerometer measurement period. In this period questionnaire and measurements were taken.	Weekday and weekend days together equaled a reliability of (ICC) 0.7. Weekdays=0.7. Weekend days=0.61. Correlates survey was found to be reliable and is reported elsewhere.	Boys: total week 17.3% in TPA, weekdays 17% TPA, weekends 18.2%. Girls: total week 15.4% TPA, weekdays 15.3%, weekend days 15.8%. Wear time was at least 7 hours. Total week was any 3 weekdays and 1 weekend days.
Hnatiuk et al. (2012)[14]	Cross-sectional	Australia	Describe the current PA levels and patterns of toddlers and to determine compliance with existing Australian PA recommendations.	Sex, parent educational differences.	Descriptive statistics, one-way ANOVA and chi-square.	Consent from 542 parents was obtained. Complete data set were obtained (including wear time) from 295 children (158 boys, 137 girls) mean age 19.1(SD 2.3) months.	Actigraph Uniaxial Accelerometer GTM1 model. 15 sec epoch.	As part of an intervention, no statement of how long the measurement period was.	Reliability for LPA was 0.7 and MVPA and CPM were 0.80.	Total: LPA 184.5(30.7), MVPA 47.9(16.2), 90.5% met guidelines. Boys: LPA 186.5(31.6), MVPA 49.6(16.3) 91.1% met guidelines. Girls: LPA 182.3(29.7), MVPA 46(16), 89.8% met guidelines.

Jackson et al. (2003)[15]	Prospective	Scotland	Quantitatively describe levels of habitual PA in 3 to 4 year old children, describe normal developmental changes in PA longitudinally and assess tracking of PA over 1 year.	Sex, weekday vs. weekend, BMI, age, and SES.	ANOVA, student t tests and correlations.	112 subjects originally. Final sample of 104 (52 boys 52 girls) for cross-sectional sample age (boys mean age 3.8 years SD 0.4; girls 3.7 SD 0.4). 60 children (30 boys, 30 girls) were followed up after 1 year.	CSA WAM-7164 accelerometer.	Two weeks.	Cited previously reported.	Boys 777(207) CPM; girls 651(172) CPM.	Prospective
Kimbro et al. (2011)[16]	Cross-sectional	U.S.	Assess whether activity patterns are associated with weight status and are children's residential contexts associated with activity patterns.	Numerous correlates across the socio-ecological model (individual, behavioral, psychological, social, physical environment).	OLS regression and binomial regression models.	Sample derived from a birth cohort sample. 1,975 children with no missing home survey data were included in the analysis. Child mean age 63.5 months (5.3 years).	Self-report (proxy report).	One home visit.	Not reported.	Weekday hours of outdoor play=2.05(SD 1.89). Days per week mother takes child outside to play=3.78 (SD 2.18).	
Sigmund et al. (2007)[17]	Cross-sectional	Czech Republic	Examine the age and sex associated differences in PA using energy expenditure in preschool children, teenagers and young adults. To also compare the activity energy expenditure to PA recommendations.	Weekday vs. weekend, sex, and attending kindergarten or nursery.	MANOVA's and correlations.	122 children from 11 kindergartens were recruited. 104 (51 boys) had full complete data. Age 5-7. Data that was previously collected from a further 1.961 subjects' aged 12-24 years was used to make comparisons across age.	Uni-axial accelerometer to measure total and activity energy expenditure, along with parent/teacher report. Caltrac.	Seven-days.	Not reported.	Girls weekday activity energy expenditure=12(kcalkg-1day-1), weekend=12.3(kcalkg-1day-1). Boys weekday activity energy expenditure=13.4(kcalkg-1day-1), weekend=14.2(kcalkg-1day-1. Weekday leisure time activity expenditure vs. school activity expenditure (kcalkg-1day-1) was 8.2 vs. 3.8. Weekend leisure time activity expenditure vs. school activity expenditure (kcalkg-1day-1) was 9.5 vs. 3.9.	

Smith et al. (2010)[18]	Cross-sectional	Australia	To investigate how parental self-efficacy and perceived barriers are associated with children's PA and screen time and how these relationships differ according to children's age and house-hold socio-economic demographic characteristics.	Sex, age, parent's barriers, region of home, maternal education, and parental self-efficacy of influencing children to be active.	Bivariate analyses (chi-square), multivariate analysis (logistic regression models), Bonfronni adjustments were made for the number of comparisons.	16 preschools and 24 long day care centers were randomly selected. Small children centers with 20 or less children and those that cater for children with special needs were excluded. 764 preschool children, mean age 3.9 years (1.7-5.6 range), 50.3% were boys.	Parental questionnaire - pre-schooler participating in organized PA, participating in non-organized PA. Meeting PA guidelines (3 hours of TPA).	One meeting.	Cited elsewhere, Kappa agreement poor to moderate.	Not reported.
Hinkley et al. (2012)[19]	Cross-sectional	Australia	(1) Identify the percent of time a sample of Australian children spend being physically active (2) Investigate how much time preschool children spend in screen based behaviors (3) Investigate differences in physical activity and screen-based behaviors by sex and age (4) Determine the prevalence of adherence to published recommendations for physical activity and screen-based entertainment in preschool children.	Age, sex.	Generalized linear modelling.	1,004 children recruited from 16 child care centers and 16 randomly selected preschools. After wear time criteria the sample was reduced to 703 (388 boys, 315 girls). Mean age was 4.5 years (95% CL=4.5-4.6).	Actigraph Uniaxial Accelerometer GTM1 model.	Eight day period with some having greater.	Validity reported elsewhere. Reliability for wear time (3 weekdays, 1 weekend day) was 0.8.	CPM: total 708.3 (SD 182) ranges 318.3-1469.5. Boys=730.2 (SD 181.2) range 361.0-1415.0. Girls 681.4 (SD 179.6). %LPA: Total 11.7 (SD 2.4) boys=12.2 (SD 2.4). Girls 11.1 (2.4). %MPA: Total 3.4 (SD 1.9) boys=3.7 (SD 2.0). Girls 3.0 (1.6). %VPA: Total 1.4 (SD 0.9) boys=1.4 (SD 1.0). Girls 1.3 (0.9). %TPA: Total 16.4 (SD 4.2) boys=17.3 (SD 4.1). Girls 15.4 (4.0).
Gunter et al. (2012)[20]	Cross-sectional	U.S.	Determine the relationship between family child care homes characteristics and practices using objectively	Children's centers that provide 4 or more significant physical activity promoting polices/practices.	Mixed ANOVAs.	56 children's centers were recruited. 45 had completed data. 136 children from the 45 had valid data and took part.	Actigraph Uniaxial Accelerometer GTM1 model.	Wore accelerometers during time at children's centers.	Cited elsewhere.	A children's centers s=32.3(SE 1.1minute/hour; Non PPA children's centers=28.8(1.2).

			measured PA in 2-5 year olds.			73 boys, 63 girls.					
Blaes et al. (2011)[21]	Cross-sectional	France	Analyze changes in habitual PA of boys and girls from preschool to junior school and assess differences between school days and school free days with high frequency accelerometer.	Sex and PA levels during preschool days vs. school days.	Descriptive and multiple ANOVAs.	362 children for the whole sample. For the preschool children section 94 pre-schoolers (44 boys, 50 girls) mean age 4.4 years.	Actigraph Uniaxial Accelerometer GTM1 model.	Seven days.	Cited elsewhere.	Reported for whole sample only. Preschool children (minutes per day) LPA=762 (SD 20); MPA 50 (SD 18); VPA 17 (SD 10); VPA+VHPA (very high PA) 28 (SD 17); MVHPA 78 (SD 20).	Boys were more active (p<0.05) then girls across all intensities (LPA, MPA, MVPA, VPA), the sex difference has been reported as Total Physical for this study in the association table, and separately for LPA, and MVPA.
Cardon et al. (2008)[22]	Cross-sectional	Belgium	Determine which environmental factors contribute to PA levels during recess in preschool boys and girls.	Sex, recess variables: no. of children per m^2; no. of supervising teachers; aiming equipment; playing equipment; recess duration, type ground surface; playground markings; vegetation; height differences; and availability of toys.	Univariate regression analyses. Girls and boys were stratified with single-predictor two-level (school-pupil) model was used. Z Scores were calculated in order to test for significance of variance.	415 boys and 368 girls from 39 preschools were randomly selected. Boys mean age 5.2 years (SD 0.4); girls mean age 5.3 years (SD 0.4).	Pedometer-Yamax Digi-walker TYPE SW-200.	Each child wore the pedometer for a familiarization period 90-120 minutes before registration. Each child then wore the monitor (reset to zero) for the duration of recess.	Reported pedometer has 0.73 correlations with accelerometer data.	Boys 65 (36) steps per minute, girls 54 (28) steps per minute.	
Brown et al. (2009)[23]	Cross-sectional	U.S.	(1) Describe physical activity behaviors and accompanying social and environmental events to these behaviors using direct observation. (2) Determine which contextual conditions where predictors of MVPA and none	Preschool outdoor context- balls and objects, open space, fixed equipment, wheel toys, socio problems; indicator of activities-children, adults, groups comparison-solitary, one-to-one with peer, group without adults, adult present.	Logistic regressions.	476 children observed outside, 50% boys, 54% African American, 38% European American, mean age 4.2 years (SD 0.7). 372 children observed inside, 51% boys, 52% African American, 40% European American.	Direct Observation. Observational system for recording physical activity in children-Preschool version.	Indoor children were observed for a mean of 327.5 minutes. Outdoor children were observed 34 minutes per child.	80% Inter-observer agreement. Validation and development detailed elsewhere.	Indoor PA levels were 94% sedentary based, with 1% being recorded as MVPA. Outdoor PA 56% sedentary, 27% light PA and 17% MVPA.	

			sedentary PA (Total PA) for children during outdoor play during play periods at preschool.								
Collings et al. (2013)[24]	Cross-sectional	England	To examine independent associations between a range of accelerometer-derived PA intensities and sedentary time with body composition.	Sex.	Comparison tests (chi-square, ANOVA, Wilcoxon) correlation and linear regression.	398 preschool children; 202 boys, 196 girls; mean age 4.10 years (SD 0.08).	Actiheart, only accelerometer data is used.	Seven consecutive days.	Reported elsewhere.	TPA (minutes/day) 423.6 ± 63.0; MPA (minutes/day) 58.8 ± 28.2; VPA (minutes/day) 23.6 ± 21.3; MVPA (minutes/day) 84.7 ± 46.4.	
Dowda et al. (2009)[25]	Cross-sectional	U.S.	Examine polices and characteristics of preschools that may influence the time children spend in physical activity and sedentary behaviors.	Playground equipment, playground size, use of electronic media, physical activity promoting polices, number of field trips, number of community organization visits, teacher PA, time outside, teacher education level, PA opportunities, teacher PA training, children per classroom, and class room size.	Mixed model ANOVA.	20 preschools, 11 commercial, 6 faith based, and 3 head start (government funded for low SES). 299 children, 50% male, 49% black, 42% white.	Accelerometer Uniaxial, Actigraph model 7164.	Two weeks.	Cited elsewhere.	Not reported.	Child care setting, MVPA is outcome variable.
Dwyer et al. (2011)[26]	Cross-sectional, validation study.	Australia	Outline the development and socio ecological framework of the Preschool Physical Activity Questionnaire (PrePAQ) and to report its validity and reliability.	Sex and age.	Comparison tests, Bland-Altman plots and correlations.	67 children for the validity aspect of the study. 52% boys; 3 year olds 27%, 4 year olds 33%, 5 year olds 24% and ethnicity = white 91%.	Three days parent recall questionnaire and uniaxial accelerometer.	Three days with 6 hours accelerometer, uniaxial. Actigraph MTI 7164.	Reported elsewhere.	Reilly cut points=SED (minutes/hour) 46.3 (cl: 45.4 - 77.1); TPA (minutes/hour) 13.7 (cl 12.9-14.6). Sirard cut points=SED (minutes/hour) 48.9 (cl 48.0 - 49.6), LPA (minutes/hour.) 7.1 (cl 6.6 - 7.5), MVPA (minutes/hour) 4.1 (CL 3.6 - 4.6), TPA (minutes/hour) = 11.2 (cl 10.3 - 12.0).	LPA, MPA, VPA, MVPA.
Sallis et al. (1988)[27]	Cross-sectional	U.S.	Identify correlates of PA in very young children with an emphasis on family related variables.	Family CVD risk, parent VPA, father BMI, child BMI, mother BMI, and type A behavior.	Multiple regression.	33 children, 39% male, 3.9 years (SD 0.7); 45% black 27% Hispanic, 3% white.	Direct Observation - Fargo activity time sampling survey (FATS).	Thirty minute unstructured free-play sessions on the preschool playground during 2 consecutive days.	Cited elsewhere.	58% in light activity (sedentary based), 31% in moderate activity, 11% vigorous activity.	Light activity, moderate activity and vigorous activity were

											outcome variables in models conducted. But due to light activity meaning sedentary behaviors and vigorous calculations being "unreliable" only moderate results were conducted and hence only included in results table.
Benham-Deal (2005)[28]	Cross-sectional	U.S.	Examine characteristics of young children's physical activity patterns.	Weekday vs. weekend, and time of day (morning, afternoon, evening).	Paired T-test, repeated measures ANOVA.	39 children (20 girls, 19 boys) mean age 4.3 years (SD 0.7).	Heart Rate monitoring and parental log.	Three days, 2 weekdays and 1 weekend day.	Cited elsewhere, no r-value reported.	Weekday: morning 20.7% MVPA, afternoon 23.5% MVPA, evening 20.7% MVPA. Weekend: morning 23.2%, 23.8%, 15.5%.	
Gubbels et al. (2012)[29]	Cross-sectional	Netherlands	Examine the association of several physical activity facilities in the physical childcare environment with physical activity levels of 2-3 year old children during childcare.	Play equipment inside and outside in a childcare environment. Policy assessments.	Cohen's kappa, t-test, backward regression analyses and step-wise multilevel linear model analyses with 3 levels.	175 children from 9 preschools, 89 (50.9% -boys), mean age 2.6 years.	Direct observation - Observational system for recording physical activity in children - preschool version (OSRAC-P).	Fifteen second observations followed by 30 seconds recording multiplied by 4 over 3 minutes multiplied by 2 for each child.	Validity cited elsewhere, Inter-rater reliability=0.7.	5.5% of indoor PA=MVPA; 59.4% sedentary behavior indoor. Outdoor=21.3% MVPA, 31.2% sedentary.	Childcare setting.
Grigsby-Toussaint et al. (2011)[30]	Cross-sectional	U.S.	Examine whether living in neighborhoods with high levels of greenness is associated with PA levels of pre-schoolers.	Neighborhood greenness, sex, parental support (spending time playing with child), and parental education.	Linear regression.	33 day centers across five counties in central Illinois. 90% (30 centers) took part. Sample=365 children age 2-5 years.	Parental proxy report for outdoor PA.	Parents asked question once.	Reported elsewhere.	Mean average 60 minutes of outdoor play.	Childcare setting.

Fernald et al. (2008)[31]	Prospective	Mexico	Explore the associations between maternal depressive symptoms and physical activity of children aged 4 to 6 years.	Maternal depressive symptoms - depressed mood, loss of interest and/or pleasure in activities, fatigue, feelings of excessive guilt and/or worthlessness, sleep and appetite disturbances and social difficulties, child age, sex, mothers age, family SES, child TV viewing, maternal PA, child weight status, and maternal weight status.	Comparison tests, logistic regressions.	Mothers and children were originally recruited as part of a RCT. A sub sample of the RCT (n=242) was used with this study. The first measurements were taken at 15months of age and then again at age 4-6 years.	Parental proxy report - international physical activity questionnaire.	Questions answered at 15 months and then at 4-6 years of age of the child.	Cited elsewhere.	30% of mothers reported that children had low activity (less than 20 minutes) 7 days a week.	Prospective
Baranowski et al. (1993)[32]	Prospective	U.S.	Investigates whether physical activity varies by physical environment and other demographics.	Age, ethnicity, sex, and weather.	Mixed ANOVA.	191 children, 90 boys, 101 girls, age 3-5 years, Anglo-American, African American, and Mexican American.	Direct observation - Children activity rating scale (CARS).	Four days per year for 3 consecutive days.	Validity cited elsewhere. Reliability: 97% interobserver agreement in PE classes and 84% in open field observations.	Low 2 on scale of 1-5.	
Beets et al. (2008)[33]	Cross-sectional	U.S.	Examine effects of father-child involvement and neighborhood with young children's PA.	Sex, weight status, motor skills, parental education, family support for sports, father and child time, parental perceived neighborhood safety, ethnicity, TV viewing, mothers education, no siblings, poverty status, father work status, and mother work status.	Multi-level modelling.	10,694 children, boys=5,454, girls=5,240, age 5-6 years, white 67.1%, Hispanic 16.6%, African American 7.1%, Asian 4.5%.	Parental proxy questionnaire.	1998-1999 - national survey.	Cronbachs' reliability=0.74.	Four questions with rating scale being 0 to 7. 0 lowest 7 highest. Q1 - Structured activity=boys 2.2 (SD 0.50), girls 2.2 9 SD 0.50); Q2 Free activity boys 2.2 (SD 0.52), girls 2.2 (SD 0.53); Q3 Aerobic activity boys 2.1 (SD 0.51), girls 2.1 (SD 0.52); Vigorous activity boys 4.2 (SD 2.24), girls 3.7 (SD 2.24).	
Bellows et al. (2013)[34]	RCT - baseline	U.S.	To test the efficacy of the intervention.	Weekday vs. weekend day PA at baseline.	T-test.	201 children, age 4.4 years.	Pedometer.	Parents place pedometer on the child on 6 days (4 weekdays and 2 weekends).	Cited in reference section but no mention.	9,509 (SD 3,599) mean daily step count.	

Boldemann et al. (2006)[35]	Cross-sectional	Sweden	Study the impact of different preschool environments upon children's spontaneous physical activity and sun exposure.	Environment category, sex, and age.	T-test, correlations, linear mixed models.	11 preschools - 197 children, aged 4-6 years.	Pedometer - Yamax digi-walker SW-200.	Twelve days.	Cited elsewhere.	Step/minute 21.5; girl's step/minute range 8.9-30.0; boy's range 8.8-37.2.	Childcare setting.
Bower et al. (2008)[36]	Cross-sectional	U.S.	Determine the relationship between the social and physical activity environment in childcare centers.	Activity opportunities, port play environment, PA training and education, fixed play environment, and sedentary environment.	Correlations, ANOVA, ANCOVA, comparison texts, regression analyses.	20 children centers, 33% black, 59% white, 4% Hispanic, 80 children were enrolled across the 20 centers.	Direct observation - environment and policy assessment for childcare instrument (OSRAP).	Three day period.	Intra-class correlations between observers are 0.90; percent of agreement ranged from 75% to 99%.	15% of monitored period was MVPA; 55% classified as sedentary. Mean Activity level was 2.55 (0.22). Scale was 1=stationary/motionless, 2=stationary/movement of limbs, 3=slow/easy movement, 4=moderate movement, 5=fast movement.	Childcare setting.
Brown et al. (2010)[37]	Prospective	Australia	Assess if children's lifestyle behaviors at 4-5 years or 6-7 years are associated with their weight status	TV viewing.	Four path models.	Two waves. Wave 1 children 4-5 years, Wave 2 children aged 6-7 years. The study was an obesity outcome paper, but did test the association between PA and TV viewing, 2,560 children (4-5 years), boys 52.3%.	Parental diary.	Two 24 hour dairies for randomly selected weekday and weekends.	Not reported.	Wave 1 children aged 4-5 years=72 minutes (average), MVPA 2.1 hours/days.	
Burdette et al. (2005)[38]	Cross-sectional	U.S.	Expand whether higher prevalence of obesity, spend less time playing outdoors and spend more time watching TV when living in neighborhoods mothers perceived to be unsafe.	Weekday vs. weekend, and mothers perceived neighborhood safety.	T-tests, ANOVA.	Birth cohort study (n=3,141), 20 large cities. Mean age 39 months, 53% boys, 35% lived in low poverty households, 50% non-Hispanic black, 25% non-Hispanic white, 25% Hispanic.	Parental recall of outdoor play - 1 question on weekdays, 2nd question on weekends.	Survey.	Cited elsewhere.	Outdoor play weekday=156 (SD 120). Weekend=26 (SD 149).	
Burdette et al. (2004)[39]	Cross-sectional	U.S.	Compare direct measure of PA in preschool-aged childcare with 2 parental-report measures of children's outdoor play time.	Season, TV, and sex.	Correlations.	250 preschool children, 44 months, 87.7% white, 12.35 black, 57% boys.	Accelerometer Uniaxial and parental recall. Used accelerometer as more superior method. RT3 Triaxial.	Three days for every waking minute.	Cited elsewhere.	Total PA=667 (SD 186); Boys 693 (SD 184), Girls 630 (SD 183).	

Burgi et al. (2011)[40]	Prospective	Switzerland	Investigate the relationship of objectively measured PA with motor skills, aerobic fitness and %body fat in young children.	Sex, aerobic fitness, gross motor skills, and % body fat.	Mixed linear models.	217 children, 4-6 years (mean age 5.2 years (SD 0.6)), 48% boys.	Accelerometer uniaxial, GT1M Actigraph.	Three days of recording (2 weekdays, 1 weekend days) minimum 6 hours.	Reported r=0.82 between VO2 max + Actigraph counts/epoch 6 hr. validity was highly correlated with 10hr validity r=0.92 p<0.001.	Not reported.
Burgi et al. (2010)[41]	Cross-sectional	Switzerland	Assess the differences in adiposity, objectively measured PA, sedentary behavior and agility performance in preschool children according to different determinants.	Ethnicity, parental education, work status, and region of country.	Comparison tests, regression models.	40 preschools; (n=542) 20 in German speaking part of Switzerland, and 20 in French part of Switzerland.	Accelerometer uniaxial, GT1M Actigraph.	Three days of recording (2 weekdays, 1 weekend days) minimum 6 hours. Mean wear time=10.8 hour/day.	r=0.82 for validity between accelerometer and V02max.	German speaking preschool= PA 771 (SD 169); MVPA 400 (SD 100). French speaking preschool TPA=684 (SD 151); MVPA=361 (SD 101).
Buss et al. (1980)[42]	Cross-sectional	U.S.	(1) Examine the ordinal consistency of activity level across time using 2 different methods of measurement. (2) Examine the relationship of these two measurement methods.	Sex, IQ, and personality.	Correlations.	129 children (65 boys, 64 girls) 3-4 year olds.	Actometer modification of a winding watch.	Wore on wrist for two hours for 3 days.	r=0.86 at 3 years and r=0.62 at 4 years.	Not reported.
Cardon et al. (2008)[43]	Cross-sectional	Belgium	Describe accelerometer-based physical activity levels in 4 and 5 year old children.	Sex, age, weekday vs. weekend, and different preschools.	Comparison tests, ANOVA.	Five random preschools, 76 children; boys 37, mean age 5.01 years (SD 0.6); girls 39, mean age 4.95 years (SD 0.5).	Accelerometer uniaxial, Actigraph model 7164.	Four days, 2 weekends and 2 weekdays, minimum wear time 6 hours.	Cited elsewhere.	TPA=701 cpm (SD=74), 120min TPA.

Caroli et al. (2011)[44]	Cross-sectional	Denmark, Italy, Poland	Assess preschool children's physical activity habits in three different European countries.	Three different countries, Denmark, Italy, and Poland.	Comparison tests.	Denmark 325 - boys 171, girls 154 mean age 50.7 months (SD 10.8); Italy 471 - boys 261, girls 210 mean age 61.4 months (SD 10.4); Poland 298- boys 154, girls 144 mean age 57.8 months (SD 16.7); total sample was 1,094 children.	Parent proxy report.	Parents asked a series of questions on one occasion.	Not reported.	Playing outside home during weekdays and weekend, yes or no. Weekday=Denmark children 22.7% yes, Italy children 35.7% yes, Poland children 35% yes. Weekend=Denmark children 11.8% yes, Italy children 22.1% yes, Poland children 7.9% yes.
Chuang et al. (2013)[45]	Cross-sectional	U.S.	Evaluate ethnic differences in the home physical activity and screen time environment of pre-schoolers enrolled in head start.	Ethnicity.	Mixed model linear and logistic regression.	706 pre-schoolers, 54% Hispanic, 46% African-American.	Parental proxy report - health home survey.	Questionnaire completed once.	Validity cited elsewhere, reliability 55.6% - 95.6%.	0-2 a week PA over 30 minute=6.91%.
Lawrence et al. (1991)[46]	Cross-sectional	Gambia and Scotland	Determine whether Gambian children are relatively inactive compared to UK children in the UK and whether this is related to their poorer nutritional status.	Nationality/region, age, weight status, and illness.	Kruskal-wallis, mann-whitney U Test.	Gambia, 81 children (39 boys, 42 girls). Scotland, 21 boys and 32 girls. Measured children at 6month, 12 months and 18 months.	Activity diary and direct observation.	One day for Gambian children. Field worker every 2.5 minutes in Gambia. No field worker to assess PA in the Scottish children, mother did this role. Instead of 1 day, 5 days every measurement every 10 minutes by mothers.	Not reported.	Scotland children=5 hour/day playing; Gambian children spent 1.5-2.5 hour/day playing.
Davies et al. (1995)[47]	Cross-sectional	England	Investigate the relationship between levels of physical activity and body fatness in a group of preschool children.	Body fat.	Correlation, regression.	77 children, boys mean age 3.09 years, girls mean age 3.08 years.	Doubly labelled water.	Single urine sample was collected before the administration isotope. Urine samples taken every day for 10 days.	Validity was cited.	Boys PAL=1.44 (SD 0.31), Girls PAL=1.40 (SD 0.27).
Cliff et al. (2009)[48]	Cross-sectional	Australia	Examine the cross-sectional relationship between process-measured fundamental movement skills and objectively	Age, sex, BMI, object control scores, gross motor quotient. Stratified by sex.	Comparison tests, correlations and regression models.	138 children from 11 children's centers - final sample was 25 boys and 21 girls, mean age 4.3 years (SD 0.7).	Accelerometer uniaxial, Actigraph 7164 model.	Seven day monitoring, 3 days with minimum wear time of 6 hours.	Cited elsewhere.	MVPA=23 minutes for the whole sample.

			measured habitual PA, and if the relationship differs by sex and FMS sub domain, fundamental movement skills.								
Cox et al. (2012)[49]	Cross-sectional	Australia	Explore the relationships between preschool children's TV habits, physical activity and their BMI.	Energy intake whilst watching TV, servings of obsegenic foods, BMI, TV viewing weekday, TV viewing weekend, commercial viewing, and non-commercial viewing.	Correlation.	135 children, mean age 4.5 years (SD 0.84), 60% girls, 3.7% obese, 85.2% not overweight or obese.	Parental questionnaire – PrePAQ.	One of subjective measure.	Cited elsewhere.	Three day average - LPA 57.5 (SD 37.4), MVPA 104.1 (SD 60.4).	
Dowda et al. (2004)[50]	Cross-sectional	U.S.	Determine if physical activity levels of preschool children vary with differences in polices/practices and overall quality of preschools.	No. of field trips, teacher education, time outdoors, free time, type of preschool, class size, computer use, and preschool quality.	Mixed model ANOVA.	Nine preschools were randomly selected. Three types of preschool; private, church-related and head start (government funded). Three from each type were selected. 266 children were observed, 126 males, 140 females, 62.4% African-American, and 32.7% white.	Direct observation (OSRAP).	One hour - 2 to 3 days - 15 seconds observations.	ICC=0.91-0.98.	%MVPA in childcare=5-8%, %MVPA Outside=26-29%.	Childcare setting.
Eriksson et al. (2012)[51]	Cross-sectional	Sweden	Study the development of body composition during early childhood between physical activity and body fat.	Total body fat.	Comparison tests, correlations and linear regressions.	44 children, 23 boys and 21 girls mean age 1.5 years.	Doubly labelled water.	Two urine samples were collected and handed in by parents to a measurement session. Child given stable isotope and had seeping metabolic rate measured by indirect calorimetry.	Not reported.	Physical activity level SMR (total energy expenditure / sleeping metabolic rate)=1.44 (SD 0.77) girls 1.35 (SD 0.16) boys, and 1.39(SD 0.17) all.	

Espana-Romero et al. (2013)[52]	Cross-sectional	U.S.	Examine the association between objectively measured sedentary behavior and moderate to vigorous physical activity (MVPA) with BMI and waist circumference in preschool children.	Sex.	Comparison tests, linear regression (MVPA was used as an independent variable in regressing models).	357 children, 183 boys, mean age 4.5years (SD 0.4). 174 girls, mean age 4.6 years (SD 0.3), 44.8% African American, 37.7% white.	Accelerometer uniaxial, GT1M Actigraph, GT3 Actigraph.	Five days, 2 weekdays and 1 weekend day, at least 6 hours required.	Not reported.	Boys MVPA (minutes/hour)=8.2 (SD 2.2); Girls MVPA (minutes/hour)=7.3 (SD 2.0)
Finn et al. (2002)[53]	Cross-sectional	U.S.	Identify factors associated with physical activity in young children.	Age, childcare center, season, sex, BMI, preterm birth, participation in organized sports, parental BMI, and parental education.	Regression models.	214 children, 106 boys, mean age 3.95 years (SD 0.06). 108 girls, mean age 3.90 years (SD 0.06).	Accelerometer uniaxial, model AW16.	48 hour period.	Subsample of 40 was measured using direct observation CARS. Comparison between CARS and accelerometer was r=0.74.	Girls TPA (CPM)=26,000.3 (SD=0.7), girls day time PA (9AM-5PM)=14,000.1 (SD 0.5), girls %VPA=4.5 (SD 0.2). Boys TPA (CPM)=28,000.5 (SD=0.8), boys day time PA (9AM-5PM)=15,000.3 (SD 0.5), boys %VPA=4.5 (SD 0.2).
Firrincieli et al. (2005)[54]	Cross-sectional	U.S.	Investigate the association between physical activity and wheezing among a population of inner city children enrolling in head start.	History of wheezing.	ANOVA.	54 children, mean age 3.7 years, 61% girls, 77.8% African-American, 5.5% white, 4 Hispanic (7.4%).	Actiwatch.	Six-7 days.	Not reported.	Wheezers=607 Count (TPA), non-wheezers=695 counts (TPA).
Fisher et al. (2005)[55]	Cross-sectional	Scotland	To test the relationship between objectively measured habitual PA and fundamental movement skills.	Sex and fundamental movement skills.	Correlations, comparison tests.	482 children randomly selected from a cohort of 545. 394 children were the final sample. Mean age 4.2 years (SD 0.5).	Accelerometer uniaxial, 7164 Actigraph.	Six days.	Validity cited, reliability not reported.	CPM (TPA)=769 (SD 192); %LPA=20.3% (SD 5.3); %MVPA=3.4% (SD 2.2).
Gagne et al. (2013)[56]	Cross-sectional	Canada	Verify whether psychosocial variables of day-care workers influence pre-schoolers physical activity in day care centers and determine how these variables combine with	Day care workers theory of planned behavior variables (intention, perceived behavior, descriptive norm and past behavior), and sex.	Multi-level modelling.	242 children, 46 educators from 20 childcare centers. Median age is 4 (3-5), age of day care workers=35 (21-54).	Accelerometer uniaxial, 7164 Actigraph.	Four days measured. Children needed 2 days with at least 2 hours of data each day.	Validity cited elsewhere, reliability=2 days ICC=0.92, 4 hours=0.89.	53 minutes (SD 23.55) TPA during childcare.

			other factors to explain children's physical activity.							
Grontved et al. (2009)[57]	Cross-sectional	Denmark	Identify and distinguish independent associations between personal and demographic characteristics and physical activity levels in 3-6 year old children attending preschool.	Sex, age, individual preschool/childcare, location, and PA promoting polices.	Mixed models, multiple linear regression models.	146 children, 66 boys, 80 girls. Age 3-6 year olds.	Accelerometer uniaxial, 7164 Actigraph.	Five consecutive days at preschool.	Validity cited, reliability not reported.	MVPA boys=19.9% in child care, MVPA girls=15.7% in child care. TPA in child care boys=260.5 counts/15secs, girls 205 counts/15secs.
Gubbels et al. (2011)[58]	Cross-sectional	Netherlands	Examine the influence of the social and physical child-care environment on physical activity intensity in 2-3 year olds.	Age, positive prompts by staff, positive prompts by peers, sex, and group size.	T-tests, multilevel linear models.	175 children 89 boys (50.9%), 75 two year olds (42.9%), 100 three year olds (57.15%).	Direct observation during child care (OSRAC-P).	15 second observations followed by 30 seconds to record. This was repeated 4 times over a period of 3 minutes for each child.	Not reported.	5.5% of indoor time was spent in MVPA and 21.3% of outdoor PA was spent in MVPA.
Heelan et al. (2006)[59]	Cross-sectional	U.S.	Provide additional information on the associations between physical activity and body composition among children aged 4-7 years old.	BMI, Body %, fat free mass.	T-tests, correlations.	100 children (52 girls, 48 boys) 87% white, mean age 5.8 years (SD 1.3).	Accelerometer uniaxial.	Seven days, 3 weekdays, 1 weekend day, 8 hours.	Citations but not mentioned.	TPA (CPM)=820.6 (SD 219.1), MVPA=273.8 (SD 59.1).
Iannotti et al. (2005)[60]	Prospective	U.S.	Determine if there is a relationship between mother's PA and child's PA.	Mother's PA.	Autoregressive models.	149 children, mean age 4.4 years (SD 0.5) 82 boys, 67 girls (total n=149).	Direct observation.	60 minute observation period at home, 25 seconds observations and 35 seconds for recording.	Validity is cited, Inter-observer agreement for PA=average 95%.	Not clear.
Jago et al. (2005)[61]	Prospective	U.S.	Examine whether variables affect PA is a triathic-cohort over a 3 year period.	Sex, TV viewing, ethnicity, parental encouragement.	ANOVA, paired t-tests.	149 children, 73 boys 76 girls, mean age 4 years (SD 0.6) 37% African-American, 37% white, 26.6% Hispanic.	Direct observation - CARS, heart rate monitoring.	Six-12 hour observations same time as heart rate monitoring.	Reliability of heart rate cited elsewhere. The validity of heart rate and validity and reliability of direct observation tool not mentioned.	Baseline MVPA=7.6 minutes/hour (SD 4.2 minutes).

Janz et al. (2005)[62]	Prospective	U.S.	Examine the tracking of PA and sedentary behavior in relation to adiposity during middle childhood.	Sex.	ANOVA, correlations.	Baseline=378 children (176 boys, mean age 5.6 years (SD 0.5); 202 girls, mean age 5.7 years (SD 0.5).	Accelerometer uniaxial.	Four consecutive days including weekend days, at least 8 hours on 3 days.	Cited elsewhere.	Baseline: boys TPA (CPM)=782 (SD 164), boys VPA=37(SD 18) minutes day-1; boys MPA 267(43) minutes day-1. Girls TPA (CPM)=719 (SD 159), girls VPA=29 (SD 48) minutes day-1; girls MPA 262(43) minutes day-1.
Janz et al. (2004)[63]	Cross-sectional	U.S.	Investigate the association between physical activity and bone structural measure of proximal femur.	Sex.	T-tests, correlations.	218 boys, mean age 5.2 years (SD 0.4); 249 girls, mean age 5.3 years (SD 0.4); total group was n=467. 96% white.	Accelerometer uniaxial, questionnaire.	Four consecutive days including 1 weekday, 8 hours on 3 days.	Three day reliability r=0.67 (CL=0.59-0.74), validity is cited for accelerometer. Reliability for questionnaire was r=0.70 (CL 0.56-0.80), validity cited elsewhere.	MPA; boys=267 (SD 44) midway, girls 262 (SD 44) midway. VPA: boys 38 (SD 19) midway, girls 28 (SD 14) midway.
Kambas et al. (2012)[64]	Cross-sectional	Greece	Examine the relationship between motor proficiency and pedometer determined PA.	Gross motor skills and sex.	Correlations, ANOVA + post hoc tests.	232 children (114 girls. 118 boys) recruited from 30 randomly selected kindergartens in north Greece. Mean age 5.4 years (SD 0.28).	Pedometer, Omron walking Style Pro. HJ-720It-E2.	Wore pedometer for 7 consecutive days.	Cited elsewhere.	Aerobic walking time=12.8 (SD 17.5). Step.day-1=7676 (1,893), Aerobic steps days 1,486 (1,995).
Kelly et al. (2006)[65]	Cross-sectional	Scotland	Test the hypothesis that habitual PA is associated with SES in young Swedish children.	Age, sex, ethnicity, BMI, and SES.	ANOVA, ANCOVA, backward stepwise multivariate model.	339 children, mean age 4.2 years (SD 0.3), BMI 0.40 (SD 0.89).	Accelerometer uniaxial.	Six days, 6 hours of accelerometer over 6 days.	Cited elsewhere.	3% in MVPA (>3,200 CPM).
Klesges et al. (1990)[66]	Cross-sectional	U.S.	Examine demographic, environmental and parent -child correlates of physical activity.	Sex, BMI, familial interaction, time outdoors, parental OW, parental encouragement, and parental discouragement.	ANOVA, regression.	222 children, 3-6 years, 4.4 years (0.5) 46% upper-middle class, 35% overweight and 29% parents overweight.	Direct observation, SCAN CATS.	One hour late afternoon-early evening, 10 second observation followed by 10 second recording.	Inter-rater reliability was 0.91 (0.83-1.00). Validity not cited.	Not reported.
Kuepper-Nybelen et al. (2005)[67]	Cross-sectional	Germany	Investigate the prevalence of overweight according to nationality and establish determinants responsible.	Ethnicity.	Multiple logistic regressions, ORs.	1,974 children, 990 boys and 989 girls aged 5-6 years.	Parent proxy report - no. of times in organized sport/played outside.	Recall for 1 week.	Not reported.	58% of German children do sports or play outside at least once a week or less.

LaRowe et al. (2010)[68]	Cross-sectional	U.S.	Report the baseline dietary intake and physical activity in preschool aged children in rural American Indian communities.	BMI.	Comparison tests.	135 children, 52.6% boys, 47.45% girls, 94% American Indian.	Accelerometer – Tri-axial, Actical.	Waking hours for 5 days, mean wear time=4.0 (SD 1.9 days).	Not reported.	Two-3 year olds MVPA=14.5 (SD 1.6 minutes) minutes/day. Four-5 years olds MVPA=19.2 (SD 2.0) minutes/day.	LPA results for 2-3 years and 4-5 years were in the same direction so results were included as one sample.
Loprinzi et al. (2013)[69]	Cross-sectional	U.S.	Examine the influence of various hypothesized parental influence variables on children's physical activity.	Parental practices.	Correlations, multivariate regression.	176 children, mean age 4 years (SD 1.3). 46.8% boys, 89.1% white.	Online survey - parental proxy report. Physical activity and exercise questionnaire for children, PAEC-Q.	Recall.	Reliability is not reported. Validity for weekday PA=r=0.35; weekend PA=r=0.33 both $p<0.05$.	PA hours per week was reported as 8.2 (SD 2.6) hours a week.	If association of weekday and weekend were the same, one result was documented.
Loprinzi et al. (2013)[70]	Cross-sectional	U.S.	Examine adherence to current active play and electronic media use guidelines in a sample of U.S. preschool-age children and to examine differences across sex and parental education.	Sex, parental education level, and media use.	ANOVA, chi-square test, logistic regression – OR.	1,674 children, 44.5% boys. Mean age 4.0 years (SD 0.1).	Proxy reported, PAEC-Q.	Recall.	Reliability is not reported. Validity for weekday PA=r=0.35; weekend PA=r=0.33 both $p<0.05$.	Active play weekday (hours/day)=3 (SD 0.2), boys 3.0 (SD 0.2), girls 3.1 (SD 0.3). Active weekend (hour/day) 3.7 (SD 0.2), boys 3.6 (SD 0.3), girls=3.7 (SD 0.2).	
Loprinzi et al. (2010)[71]	Cross-sectional	Australia	Examine the hypothesis that parents with favorable orientations towards PA will provide level of support for PA which in turn results in greater participation in PA.	Parental support, parental perception of competence of child's ability, parent activity, age, and sex.	Observed variable path analysis.	156 children and parents, 51.9% boys, mean age 3.7 years (SD 0.8), BMI=16.8 (SD 2.2) 30.8% overweight/obesity.	Parental proxy report for home PA, accelerometer uniaxial for child care PA.	2.4 (SD 0.7) days of wear time and 5.5 (SD 0.5) average hours of wear time.	Validity cited, reliability not reported.	Home PA questionnaire (scale 1-7): boys 3.0 (2-5), girls 2.9 (2-3.6). Child care objective MVPA: boys 9.3 (SD 3.9) minutes/day, girls 9.0 (SD 3.2).	
Louie et al. (2003)[72]	Cross-sectional	Hong Kong	Investigate trends of physical activity among children aged 3, 4, and 5 using pedometry in preschools.	Age, sex, play space, BMI, and urban housing.	Descriptive, correlations comparison tests, ANOVA.	148 children (86 boys-62 girls), mean age 4.2 years (SD 0.9) from 3 different preschools, rural, Newtown, established town.	Pedometer and CARS.	PA is measured within a 25 minute physical activity class.	Subsample wore pedometers on both left and right hip, no significant difference was found. CARS inter-observer agreement was 96%.	Boys 1470 (SD 638) steps, girls 11147(SD 544) steps.	Child care setting.

Marino et al. (2012)[73]	Cross-sectional	U.S.	Determine the amount of time low income U.S. preschool aged children spend playing outdoors at home and at school.	Ethnicity, yard near home, region of preschool, playground, mothers education, sex, age, single parent, weight status, full day childcare, half day child care, and region of country.	Logistic regression, linear regression, comparison tests.	National representative survey – 2,529, mean age 4.4 years (4.3-4.5) 51.1% boys, 22% white, 35.7% Hispanic, 33.1% black.	Proxy report - parent interview for playing outside at home, teacher interview playing outside in childcare.	Both parents and teachers interviewed.	Not reported.	37.5% 2h<playing outside at home, 40.6% 1.2h<playing outside at home. Teacher reported that children spent 36.3 (33.5-39.1) minutes/day.	Home and child care setting separate.
McKee et al. (2005)[74]	Cross-sectional	Northern Ireland	Validate a pedometer using direct observation and investigate activity levels in young children.	Sex.	Comparison tests, linear regression, and multilevel modelling.	30 children (13 boys, 17 girls).	Pedometer (Digiwalker) and CARS.	One hour within childcare/preschool (61.4 minutes).	Reliability- each child was recorded and analysis of CARS took place. The agreement between observers was 83%. Validity was cited.	CARS score was 1.7 (SD 0.59), boys 66.8(SD 64.0) steps, girls 47.4 (SD 61.3) steps.	Child care setting.
McKee et al. (2012)[75]	Cross-sectional	Northern Ireland	Examine the influence of season and age on objectively measured PA.	Season, father's daily play, access to safe place to play, weekday vs. weekend, and sex.	ANOVA, t-tests, correlation.	85 children (52 boys) 3-4 years of age.	Pedometer, digiwalker DW-200.	Six days (4 weekdays and 2 weekend days) 9 hours of measurement on 3 weekdays and 1 weekend day.	Not reported.	Winter boys=9,790 steps, girls 8,656 steps. Spring boys=11,417 steps, girls 11,064 steps.	
Metallinos-Katsaras et al. (2007)[76]	Cross-sectional	U.S.	Determine the association between PA and BMI among diverse low-income pre-schoolers.	Sex and BMI.	Linear model regression, logistic regression, OR.	56 children, 30 girls 26 boys. 30.4% African-American, 32.2% Hispanic, 21% White, 23.2% BMI 95th<percentile.	Accelerometer.	Seven consecutive days, 4.5 days, Average wear time was 6.6 days.	Validity cited, reliability not reported.	TPA boys=685.5 (SD 62.8) minutes/daily, TPA girls 682.2 (SD 81) minutes/daily, VPA boys=29.5 (SD 15.1) minutes/daily, VPA girls=20.1 (SD 11.3).	
Mickle et al. (2011)[77]	Cross-sectional	Australia	Determine whether plantar pressure distributions generated by preschool children were correlated with objectively measured time spent in PA and sedentary behavior.	Sex and peak plantar pressure.	Comparison tests, correlations.	33 preschool children mean age 4.3 years (SD 0.6), 17 boys.	Accelerometer Actigraph 7164 uniaxial.	Seven days, 6 hours on at least 3 days.	Validity cited, reliability not reported.	TPA (CPM): boys 911 (SD 254), girls 809 (SD 133); %LPA: boys 13.1 (SD 4.2), girls 11.8 (SD 3.5); %MVPA: boys 6.0 (SD 4.5), girls 3.9 (SD 2.5).	

Montgomery et al. (2004)[78]	Cross-sectional	Scotland	Assess relations between total energy expenditure and physical activity level measured using doubly labelled water during engagement in different intensities of PA measured by accelerometer.	Sex, age, and sedentary behavior.	Correlations, multiple regression.	104 children, 52 boys, 52 girls, 4-5 years, 36 in preschool, 68 in school.	Accelerometer (CSA uniaxial) and doubly labelled water.	Waking hours, 3 days for preschool, 7-10 days for primary. Median 30.3 hours measured in preschool children, 78.3 hours in school children.	Reliability cited, validity not reported.	TPA (CPM): boys 848 (398-1,328); girls 719 (332-1,154); %MVPA: boys=4 %(1%-14%); girls 3% (0-8%).	
Moore et al. (1991)[79]	Cross-sectional	U.S.	Determine the relationship between activity levels of parents and children.	Parental PA.	Contingency table, OR.	100 children, 63 boys, 37 girls, 4-7 years.	Accelerometer uniaxial for both children's and parent's PA.	Ten hours/day for children 8.6 hours for 1 day. 8.3 hours for mothers and 7.7 hours for fathers.	Validity=r=0.35 and reliability is cited.	Not reported.	
Niederer et al. (2012)[80]	Cross-sectional	Switzerland	Investigate whether BMI-group related differences in physical activity fitness and PA were present in 4-6 year old children.	Age, sex, and BMI.	ANCOVA.	613 children, mean age 5.2 years (SD 0.06), 49.8% girls and 20.1% overweight.	Accelerometer uniaxial, GT1M Actigraph.	Two weekdays and 1 weekend day. Mean wear time was 10.9 hours/day.	Correlation between 6 hours wear time and 10 hours wear time was r=0.92 (p<0.0001). Validity reported as r=0.82.	TPA (CPM)=Age 4 years, normal weight 712 (SD 139); overweight 728 (SD 153). Age 5 years, normal weight 7,402 (SD 181); overweight 682 (SD 130). Age 6 years, normal weight 745 (SD 165); overweight 704 (SD 167).	
O'Dwyer et al. (2012)[81]	Intervention study-baseline	England	Investigate the effect of a family focused intervention on preschool children's physical activity.	Sex.	Correlations, step wise backward regression, multi-level modelling.	58 families from 24 sure-start children centers. Baseline – mean age 3.8 years (SD 0.6), 51.9% male.	Accelerometer uniaxial, GT1M Actigraph.	Three days including 1 weekend day, 521 minutes weekday, 483 minutes weekend.	Validity cited, reliability not reported.	TPA weekday=113.2 (SD 24.9), TPA weekend=101.6 (SD 30.1).	
O'Dwyer et al. (2011)[82]	Cross-sectional	England	Compare activity levels of overweight and non-overweight preschool children.	Weight status.	T-tests.	50 children, mean age 4.4years (SD 0.5), 54% Boys.	Accelerometer Uniaxial, GT1M Actigraph.	Seven days worn, wear time=3 days (2 weekdays, 1 weekend day).	Validity cited, reliability not reported.	MVPA weekday: OW boys 38.6 (SD 18.1); non-OW boys 45.2 (SD 20.3); OW girls 38.0 (SD 10.5); non-OW girls 43.3 (SD 17.0). MVPA weekend: OW boys 34.0 (SD 11.9); non-OW boys 58.0 (SD 10.4); OW girls 28.9 (SD 9.5); non-OW girls 42.2 (SD 26.4).	Weekday and weekend results were combined if in the same direction (MPA, VPA = MVPA).

Oliver et al. (2010)[83]	Cross-sectional	New Zealand	Examine the relationship between accelerometer derived PA in pre-schoolers and their parents.	Age, parent PA, BMI, waist circumference, attend an outdoor play ground, maternal BMI, maternal waist circumference, paternal BMI, paternal waist circumference, TV restrictions, encouragement, and being physically active with child.	Regression.	78 children 4-5 year olds, 62 mothers, 20 fathers. 23% overweight, New Zealand European 81%, Maori 6%, Chinese 4%.	Accelerometer Uniaxial, Actical.	6.5-7 days.	Validity cited, reliability not reported.	PA rates - Children 5.70 (1.27-17.64); Mothers - 3.19 (0.63-22.19); Fathers 3.00 (0.35-22.4).	
Pate et al. (2013)[84]	Cross-sectional	U.S.	Determine PA levels of preschool children following the transition from indoor to outdoor settings.	Sex, BMI, and outdoor play.	Linear regression models, growth analysis.	102 children, mean age 4.2 years (SD 0.7), BMI 17.5 (SD 4.4), 58.8% African American, 37.3% European, 36.6% BMI <85th% percentile.	Direct observation - outdoor setting, (OSCRAC-P).	30 minute observation session with each child observed for 10-12 sessions across 10 days.	Validity cited, reliability=0.82.	Outdoor mean activity=girls=2.5 (SD 0.5), boys 2.7 (SD 0.5), scale from 1 to 7, 1 sedentary and 7 most active.	
Pate et al. (2008)[85]	Cross-sectional	U.S.	Describe physical activity levels of children attending preschools and describe demographic correlates of physical activity in pre-schoolers.	Sex, BMI, ethnicity, age, preschool type.	ANOVA, regression.	438 children, 59% African American, 50% boys, 4.2 (SD=0.7) years, 41% 3 years old, 59% 4-5 years old.	Direct observation.	Five second observations - 25 seconds record. 30 minute sessions, each child measured 10-12 times.	Reliability assessed during 12% of the total observations Inter-observer = Kappa=0.82 (0-80-0-95).	MVPA=3.4% (SD 1.9); TPA=13.9% (SD 6.3).	Child care setting.
Pate RR (2004)[86]	Cross-sectional	U.S.	Describe the physical activity levels of preschool children, identify demographic variables and determine variation among preschools.	Sex, preschool attended, ethnicity, age, parent education, and sex.	ANOVA, linear regression, 2-step regression.	247 children, 115 boys, 132 girls, 3-5 years, 65% black, BMI=16.1 (SD 1.8).	Accelerometer uniaxial, 7164 Actigraph.	4.4 hour/day for 6.6 days.	Validity cited, reliability not reported.	MVPA=7.7 (SD 3.11) minutes/hour; VPA 1.9 (SD 1.1) minutes/hour.	Child care setting.
Penpraze et al. (2006)[87]	Cross-sectional	Scotland	Investigate the number of days and hours of monitoring required to obtain represented measures of PA of younger children.	Sex, weekday vs. weekend.	ANOVA.	76 children (40 boys, 36 girls) sub sample of a larger study, mean age 5.6 years (SD 0.4).	Accelerometer uniaxial, Actigraph.	Seven days.	Validity cited, reliability not reported.	TPA (CPM) boys=870 (SD 187), girls 771 (SD 161).	SPARKLE STUDY.

Pfeiffer et al. (2009)[88]	Cross-sectional	U.S.	Determine correlates of physical activity in a large diverse sample of preschool children using accelerometer as a measure of PA.	Ethnicity, miles to park, adults VPA, BMI z score, parent's perceived child athleticism competence, physical activity equipment at home, family support, park safety, attend a park, and family support.	T-tests, ANOVA's, linear mixed models (regression).	331 children, 51.4% African-American - 40.2% white, mean age 4.3 years (SD 0.6).	Accelerometer uniaxial.	Eight-10 days.	Validity cited as a measure.	MVPA=7.6 (SD 2.1), TPA=27.2 (SD 3.9).	
Poest et al. (1989)[89]	Cross-sectional	U.S.	Describe preschool physical activity.	Weather, sex, preschool, parents PA exercise, and teacher education.	Frequency distributions, Pearson's correlation coefficient, T-tests.	514 children, 269 boys, 245 girls. Nursery children=279, childcare children=235.	Parent and teacher proxy report.	Questions covering 1 week.	Not reported.	25.4 hours a week being active.	
Raustorp et al. (2012)[90]	Cross-sectional	U.S. & Sweden	Compare pre-schoolers PA in Sweden and U.S. settings to objectively examine the differences in preschool boys and girls indoor and outdoor PA regarding different intensity levels and sedentary behavior.	Outdoor vs. indoor, and nationality.	T-tests, Mann Whitney U tests.	50 children, 2 preschools from U.S. and 2 preschools from Sweden. Mean age 4.3 years (SD 5.8).	Accelerometer uniaxial, GT1M Actigraph.	Five days of activity. If 1 day was missing then the mean daily average was used.	Both cited elsewhere.	Total: TPA (CPM) outdoor=1,098; indoor=493. U.S. preschools TPA (CPM): outdoor=1,114, indoor=406; Sweden Schools TPA (CPM): outdoors=1,081; indoors=586.	Child care setting.
Saakslahti et al. (1999)[91]	Cross-sectional	Finland	Examine physical activity over 48 hours on one weekend.	Sex and movement skills.	Correlations, t-tests, Wilcoxon 2-sample test, multiple regression.	105 children, 55 boys, 50 girls, age 3-4 years, mean age 3.75 years (SD 0.6).	Parental observations, PA diary.	48 hours over one weekend from midnight Friday to midnight Sunday.	Previously reported.	Two hours 44 minutes (SD 2 hours 34 minutes).	
Schary et al. (2012)[92]	Cross-sectional	U.S.	Explore the link between parent style, support and preschool children's active play behavior.	Parental support, sex, age, and parenting style.	T-test, ANOVA, multiple linear regression.	195 children, mean age 4.0 years (SD 1.9) 46.3% boys.	Parental proxy report: PAEC-Q.	Ask parents to report no. of hours child spends in active play (running, jumping and climbing) during a normal weekday and weekend day.	Validity cited elsewhere, weekday=r0.35; weekend=r0.33.	8.2 hours per week.	
Shen et al. (2012)[93]	Cross-sectional	U.S.	Investigate the PA behavior of urban, African American children while they attend a	Sex, age, preschool, morning childcare sessions, and preschool.	ANOVA.	158 children, 80 boys, 78 girls, 3 years=58 children, 4 years=100 children.	Accelerometer, tri-axial accelerometer (RT-3).	2.3 hours on 3.9 days.	Both cited elsewhere. Intra-class correlation=0.90.	3.09 minutes/hour LPA; 0.89 minutes/hour MVPA.	Childcare setting.

			government funded child care program (Head Start).								
Sugiyama et al. (2010)[94])	Cross-sectional	Australia	(1) Examine organized attributes of children centers associated with pre-schoolers physical activity and sedentary behavior while in childcare (2) Examine what environmental attributes of outdoor play areas are associated with outdoor physical activity and sedentary behavior.	Child-staff ratio, staff training, fixed play equipment, natural outdoor surface, size of play area, outside vegetation, shadow and gradient of outdoor space.	Multi-level linear regression analysis.	89 children, mean age 4.1 years (SD 0.6), 46% girls.	Accelerometer uniaxial, GT1M Actigraph.	397.5 minutes/day (SD 81.1) on at least 3 days.	Not reported.	MVPA in childcare=23.3 minutes/day (SD 12.6); MVPA outside in childcare=13.5 minutes/day (SD 10).	Childcare setting.
Sundberg et al. (2012)[95]	Cross-sectional	Sweden	Examine if children younger than 7 years with type 1 diabetes are less active than healthy children.	Season, sex, age, type 1 diabetes, and BMI.	ANOVA, mixed linear models.	Diabetes group: 12 boys, mean age 4.3 years (SD 1.6), 12 girls, mean age 4.7 years (SD 1.9); non diabetic group: 12 boys, mean age 4.9 years (SD 1.4), 14 girls, mean age 4.4 years (SD 1.8).	Actiheart - accelerometers data only.	Two periods across the year. >120 minutes (>84%) per 24 hour period. Mean 12.3 days per child.	Validity cited; reliability not cited.	Reported in figures and difficult to replicate.	
Tanaka et al. (2012)[96]	Cross-sectional	Japan	Examine the potential relationship between health-related and skill-related physical fitness habitual PA in preschool childcare.	Sex and motor skills.	ANCOVA, correlation.	136 children, mean age 5.5 years (SD 0.6), 65 girls, 71 boys.	Accelerometer uniaxial, Activtracer.	Six days, 2 hours+ on 2 weekdays and 1 weekend day.	Both cited elsewhere.	LPA=160 (SD 30); MVPA=95 (SD 29).	Childcare setting.
Taylor et al. (2009)[97]	Longitudinal	New Zealand	(1) Investigate patterns of activity and inactivity in a birth cohort of children followed from 3 to 5 years. (2) Investigate whether changes in inactivity occur	Parental PA, age, days of the week, weekday vs. weekend day, sex, season, no. of hours in childcare, birth order, no of siblings, and weight status.	Intra class correlation, coefficient models.	244 children (44% female), age 3-5 years.	Accelerometer (Actical) and parental proxy questionnaire.	266-252 minutes/day.	Validity cited, reliability 3y 0.80(4.9days); 4y 0.79 (51. days); 5y 0.84 (6.1 days).	Reported in figures.	

			overtime.								
Temple et al. (2009)[98]	Cross-sectional	Canada	(1) Examine levels of physical activity in that setting. (2) Examine whether levels of physical activity and sedentary behavior differ between boys and girls.	Sex.	ANOVA.	65 children (32 girls, 33 boys) 79% age 3 to 4 years.	Accelerometer uniaxial, Actical.	Seven hours (SD 0.83).	Not reported.	TPA (CPM)=104.6 (SD 31.6); MVPA=1.76(SD 0.90).	Childcare setting.
van Rossem et al. (2012)[99]	Cross-sectional	Holland	Study associations between social disadvantage and indicators of sedentary behavior and physical activity at preschool.	Ethnicity, mothers education, single mother, financial difficulties, mother's job status, no. of days of child care, mother pre-pregnancy BMI, and breastfeeding.	Multiple logistic regression.	2,337, boys 49.9%, girls 3.01 years, 67.4% Dutch, 9.5% other western, 23.1% other western.	Questionnaire - playing outside.	Survey parent recalls over 1 week.	Not reported.	Playing outside: <36.4% 1hour/day, 1-2 hours/day 38.4%, 2-3hours/day 17%, >3 hours/day 8.1%.	
Verbestel et al. (2011)[100]	Cross-sectional	Belgium	Explore within-day variability of objectively measured physical activity during weekday and weekends.	Age, recess, time of day, sex, and weekday vs. weekend.	ANOVA and post hoc.	213 children, mean age 4.98 years (SD 0.88).	Accelerometer uniaxial, GT1M Actigraph.	Six consecutive days.	Both cited.	586.42 CPM/day (SD 147.36).	
Worobey et al. (2005)[101]	Cross-sectional	U.S.	Explore whether diet, physical activity or BMI differed across two-groups of preschool age children who attended different preschool programs.	Preschool type.	Not reported.	Forty; 4-7 years of age.	Accelerometer uniaxial, 7164 Actigraph.	Not reported.	Cited for ankle. Validity between ankle and waist=r=0.81.	Actometer-measured activity counts: 111,661 (61,235).	
Zecevic et al. (2010)[102]	Cross-sectional	Canada	Examine parents influence on their young children's physical activity.	Sex, age, TV/video, parental support, parental enjoyment, parental PA habit, parent age, married parents, income, education, linguistic group, and parents belief on the importance of physical activity.	Logistic regressions.	102 preschool-aged children, 54 boys, 48 girls. Mean age 3.75 years (SD 0.80). Parents age 34 years (SD 7.0).	Questionnaire - parents proxy report.	Interviewed once.	Not reported.	Not reported.	

Barkley et al. (2014)[103]	Cross-sectional	U.S.	Assess the effect of the presence of a friend or being alone on the intensity of and amount of physical activity.	Sex and playing with a friend or being alone.	T-tests and mixed-effects models.	20 preschool children, 10 girls, mean age 5.3 years (SD 1.1).	Accelerometer Uniaxial, GT1M Actigraph.	Children participated in 2 separate 30 minute sessions. Children were able to sample each activity before the 30 minute sessions. One session children were asked to play alone (solo). The other session the children were asked to play with a friend(s).	Not reported.	Boys CPM for solo play=1,892 (SD 1063); girls=1,522 (SD 972). Boys CPM for friend play=2,478 (SD 1,276), girls 2,780 (SD 884).	
Becker et al. (2014)[104]	Cross-sectional	U.S.	(1) Examine whether children's level of active play is related to self-regulatory skills. (2) Examine the direct connection between level of active play and academic achievement. (3) Examine whether self-regulation mediates relations between active play and academic achievement.	Emergent literacy achievement, Self-regulation (Heads-toes-knees-shoulders task), Math achievement Sex and age.	T-tests and bivariate correlates.	51 children preschool children, 22 girls, 29 boys. Mean age 4.8 years.	Accelerometer Uniaxial, GT1M Actigraph.	Correlates were measured in phase 1.2 months later active play (MVPA) was measured during one outdoor play session.	Not reported.	MVPA (Active play): 8.17 minutes (SD 4.30).	
Brasholt et al. (2013)[105]	Cross-sectional	Denmark	Examine levels and patterns in preschool children's physical activity and the effects of gender and BMI on activity.	Weekday vs. weekend; season, BMI, age, and sex.	Regression, T-tests and chi-square comparison tests.	411 children recruited. 253 children provided enough accelerometer data. Mean age 5.2 years (SD 0.7). 126 were boys (50%).	Uni-axial accelerometer, Actical.	Monitor placed on the ankle for 4 weeks. The monitor was asked not to be taken off for the 4 weeks.	Intra-monitor reliability 0.78 (95% CI: 0.68-0.85).	Total group=877±233 counts/minute. Boys=942±241 count/minute; girls=814±206 counts/minute.	Analysis was adjusted for child being asthmatic or not.

Cespedes et al. (2013)[106]	Cross-sectional. RCT, but only used baseline for analysis.	U.S.	Examine differences in obesity-related behaviors between native born parents and immigrant born parents.	Place of birth of parent (immigrant vs. non-immigrant).	Bivariate comparison tests and regression models.	57 children with U.S. born parents. 28 (49.1%) girls, mean age 4.04 years. 64 children with parents who were not born in the U.S. 36 (56.3%) girls and mean age 3.92 years.	Parental questionnaire (Active play).	One question, baseline of an RCT.	Not reported.	Native born parent group took part in 1.4 (SD 0.3) hours of active play a day. Non-native born parents group took part in 1.2 (SD 0.4) hours a day.	Active play was not defined as MVPA within the paper, so the Active play will be reported as total physical activity.
Driessen et al. (2013)[107]	Cross-sectional	Netherlands	Examine the link between physical activity and functional constipation.	Functional constipation.	Univariate and multivariate.	347 children, 182 boys (52%), mean age 3.34 years.	Uniaxial accelerometer. Actigraph.	One weekday, 1 weekend.	Not reported.	73 ± 23 minutes spent in TPA.	Generation R study.
Edwards et al. (2013)[108]	Cross-sectional	U.S.	Determine the extent of PA tracking between ages 3 and 7.	Age.	MANCOVA, correlations.	234 children. 109 (85%) girls and 199 white.	Tri-axial accelerometer, RT3.	Three days the monitor was worn, 2 weekdays and 1 weekend day.	Not reported.	**Age 3:** TPA per day(CPM):443,000±114,000 MVPA per day: 85±38 LPA per day:380±45 **Age 4:** TPA per day(CPM):461,000±114,000 MVPA per day:90±37 LPA per day:382±42 **Age 5:** TPA per day(CPM):473,000 MVPA per day:94±37 LPA per day:381±42.	
Grzywacz et al. (2014)[109]	Cross-sectional	U.S.	Describe time spent being sedentary and MVPA by children in Latino farmworker families; and delineate sources of variation in sedentary MVPA.	Sex, mother employment status, farmworker status, attends government program, season, BMI, street traffic make it difficult to walk, dogs allowed to run loose, play equipment/toys, house has an enclosed play space, parental limits on screen time, child taken to play spaces and concern about child's level of activity.	Regression.	248 children from Latino farmworker households. 131 children are 2 year olds, 117 children are 3 year olds. 119 boys, 129 girls.	Uniaxial Accelerometer, Actical.	Eight hours of activity on 5 days with at least 1 on a weekend day.	Not reported.	Median average of 6 minutes of MVPA per day.	
Hesketh et al. (2014)[110]	Cross-sectional	England-	(1) Investigate the association between	Mothers PA.	Regression.	554 children and mothers (284 girls (51.3%), mean age	Actiheart, only acclererometry was used.	Actiheart was worn for 7 days, including sleep and	Not reported.	Average daily CPM=130 (SD 45.8). Average daily LPA=496.1	Results include LPA and MVPA

		UK	objectively measured maternal and preschool children's PA. (2) Determine how the association of mothers PA and preschooler's differ by demographic and temporal factors.			4.1 years (SD 0.1). Mean age of mothers 35.2 (SD 3.6).		bathing.		(SD 88.1). Average MVPA=68.8 (SD 41.0).	separately. Due to LPA and MVPA both showing the correlate direction, results were added together to create TPA. Southampton Women's Survey.
Hesketh et al. (2014)[111]	Cross-sectional	England-UK	Determine how children's differing intensities of activity change throughout the day and how temporal and demographic factors influence this activity.	Sex, BMI, fulltime child care, age when mother left education, time of the week (weekend vs. weekday), and season.	Regression.	593 children. 300 girls (51%), mean age 4.1 years (SD 0.1), 17% non-white.	Actiheart, only acclerometry was used.	Actiheart was worn for 7 days, including sleep and bathing.	Not reported.	TPA daily=568.5(SD 72.2). LPA daily=498.9 (SD 65.8) MVPA daily=69.6 (30.7).	Southampton Women's Survey. Correlates are explored further by time of the day. Results are included for full totals. The difference of correlates by the segmented day is discussed in the discussion.
Hnatiuk et al. (2013)[112]	Prospective	Australia	Examine early childhood predictors of toddler's physical activity across domains of maternal beliefs and behaviors and the home environment.	**Correlates at 4months predicting 19 month TPA(Light-to-moderate-vigorous PA).** Maternal PA knowledge, maternal PA views, Maternal PA optimism, PA self-efficacy, maternal future expectations, maternal floor concerns, maternal TV knowledge, maternal TV use, maternal TV self-efficacy, maternal PA, maternal screen	Regression.	206 children, 53.4% male; time one mean age, 3.5 months; time two mean age 8.8 months; time three mean age 18.7 months.	Uniaxial accelerometer, GT1M Actigraph.	Accelerometer was worn for 7 days at the third time point (19 months). Monitor was taken off for bathing and sleeping.	Not reported.	TPA(LVPA)=233.5 (SD 41.0).	Melbourne InFANT program.

	time, time spent playing games with adults, time spent being active with mum, time spent having tummy time, time spent on the floor, time spent with other babies of similar age, time spent with older toddlers or children, time spent outside, PA equipment in the home, and TVs in home. **Correlates at 9months predicting 19 month TPA(Light-to-moderate-vigorous PA).** Maternal PA optimism, PA self-efficacy, maternal future expectations, maternal TV use, maternal TV self-efficacy, maternal PA, maternal screen time, time spent playing games with adults, time spent being active with mum, time spent having tummy time, time spent on the floor, time spent with other babies of similar age, time spent with older toddlers or children, time spent outside, PA equipment in the home, and TVs in home.		

Iivonen et al. (2013)[113]	Cross-sectional	Finland	Examine the relationship between objectively measured PA and outcomes of balance, locomotor and manipulative skills in 4 year old preschool children.	Sex, BMI, motor skills total score, static balance, dynamic balance, standing broad jump, sliding and galloping, kicking ball at target, throwing and catching combination, and throwing at target.	Regressions and Mann-Whitney tests.	37 children, 17 boys, mean age 4.2 years (SD 0.3) and 20 girls, mean age 4.0 years (SD 0.3).	Tri-axial accelerometer, only the vertical plan was used, so uni-axial accelerometer, GT3X Actigraph.	Five consecutive days.	Not reported.	TPA(CPM) 680.20(SD 173.78), LPA 38.82(7.21) mins per day, MVPA 60.64(SD 19.09), TPA(LVPA) 99.46(SD 25.14).	
Laukkanen et al. (2014)[114]	Cross-sectional	Finland	Examine the relationship between habitual PA and gross motor skills in primary and preschool children.	Sex and gross motor skills.	T-tests and Correlations.	Preschool children only for this review. 53 preschool children, 28 preschool girls (mean age 5.95 years, SD 0.47), 25 preschool boys (mean age 5.92 years, SD 0.45).	Tri-axial accelerometer, X6-1a.	No protocol was stated for the length of time participants were asked to wear the accelerometer. 5.47 days was the average length children wore monitors and only a minimum of 500 minutes on at least 3 days with two weekdays and 1 weekend days.	Not reported.	Girls LPA=4.65 (SD 1.05) minutes per day. MPA=2.74 (SD 0.82) minutes per day. VPA=2.44 (SD 1.18) minutes per day. Boys LPA=5.73 (SD 1.33) minutes per day. MPA=3.41 (SD 1.33) minutes per day. VPA=3.05 (SD 1.93) minutes per day.	More specific motor skills were tested, however an overall gross motor skill score was examined with PA variables, so only overall gross motor skills were included in results.
O'Connor et al. (2014)[115]	Cross-sectional	U.S.	(1) Develop a multi-dimensional self-report measure of pre-schoolers PA parenting practices (2) Examine the psychometric properties of the report among a Latino sample.	Parental Practices; encouragement of PA, lack of money to participate in sports clubs, outdoor toys available, safety concerns, promote inactivity, promote screen time, and psychological control.	Correlations.	94 children for accelerometer sub sample. Mean age 4.4 years (SD 0.8), 47 boys (56%) and 47 girls (44%).	Tri-axial accelerometer, only the vertical plan was used, so uni-axial accelerometer. GT3X Actigraph.	The accelerometer was worn for 7 days.	Not reported.	LPA 247 (SD 36.6) minutes per day. MVPA 83.4 (SD 38.3) minutes per day, CPM (TPA) 611.8(SD230.5).	
O'Dwyer et al. (2013)[116]	Intervention	England-UK	To investigate the effect of curricular active play intervention on PA levels.	Sex, hours in school, BMI, wear time, parents education, and ethnicity.	T-tests and multi-level models.	Total of 156 children in the Intervention group, age 4.7 (SD 0.5) years. Control group mean age 4.5 years (SD 0.6).	Uniaxial accelerometer, GT1M Actigraph.	Worn for 7 consecutive days.	Not reported.	Refer to study for full levels of PA. Levels are segregated by time points of the intervention and gender.	This study although an intervention was included due to the non-effect of the intervention, and the multi-level model analysis which

											explored correlates of the group as a whole and not segregated by intervention group.
Olesen et al. (2013)[117]	Cross-sectional	Denmark	Investigate multiple potential correlates expected to be associated with preschool children's MVPA during preschool attendance.	Sex, age, BMI, motor coordination, ethnicity, born preterm, supervised trips, pre-schooler educational leader PA enjoyment, pre-schooler educational leader PA education, pre-schooler educational leader meets PA guidelines(>30 minutes MVPA daily), staff PA enjoyment, staff PA education, staff MVPA levels, staff sex, staff young assistants, staff initiate activities, location of preschool building (N sides around the building is accessible to playground), open space, natural environment, portable toys, fixed toys, PA rooms, and access to computer.	ICC, Multi level mixed modelling.	Data for 426 children (49.5% boys) mean age 5.8 years (SD 0.3) from 42 pre-schools had eligible data for final analysis.	Uni-axial and tri-axial accelerometers were used. Only the vertical plane function was applied, GT1M and GT3X Actigraph.	Four weeks in order to capture a minimum of 3 hours of wear time during 3 days of attending preschool. Only time during preschool was taken into account.	Not reported.	15% (SD 5.0) of preschool time was spent in MVPA for boys and 12.2% (SD 3.9) for girls.	The sum scores of natural environment, fixed toys and portable toys were only included in univariate results. For multi-level model results the specific variables are stated.
Ostbye et al. (2013)[118]	Intervention RCT, supplement cross-sectional study.	U.S.	Examine the role of the home physical activity and food environment on corresponding outcomes in young children and assess maternal	Age, sex, ethnicity, BMI, mother education, accessible to PA equipment, role modelling of PA, and parental policy promoting PA.	Bivariate correlations and Linear regression models.	208 children, 56% male, 55% under the age of 5, 85% white ethnicity.	Uniaxial Accelerometer, Actical.	Worn for 7 days and only taken off for bathing and sleeping. 6 hours on 3 days, 1 weekend day and 2 weekdays.	Not reported.	17 minutes of MVPA per day.	Cross sectional sub study of a RCT.

			education/work status as a moderator.							
Rice et al. (2014)[119]	Cross-sectional	U.S.	(1) Objectively measure PA characteristics of a large and age diverse sample of children attending family day care. (2) Examine the influence of age, sex, and weight status on PA participation.	Age, BMI, and sex.	ANOVA's.	47 family day care homes. Final sample of 114 children, 52.6% boys. Mean age 3.7 years (SD 1.1).	Uniaxial Accelerometer, GT1M Actigraph.	Worn during day care. Inclusion criteria of 2 days with >75% of attendance time.	Accelerometer intraclass reliability was 0.73-0.84.	MVPA=5.8(SD 3.2) minutes/hour. TPA (LVPA)=10.4(SD 4.4) minutes/hour.
Tanaka et al. (2013)[120]	Cross-sectional	Japan	Examine the relationship between weight status and habitual physical activity in pre-school children.	Sex and weight status.	ANCOVA.	Final sample was 425 children (202 girls, 223 boys). Mean age 5.8 years (SD 0.6).	Triaxial Accelerometer, all three planes of movement were applied, Activ Tarcer.	Worn for 6 days, 4 weekdays and 2 weekend days.	Not reported.	For all groups; LPA=157 minutes per day (SD 0.6). MVPA=101 min (SD 30). Physical activity level (PAL) energy expenditure minus base metabolic rate, PAL=1.54(SD 0.08).
Taylor et al. (2013)[121]	Prospective	New Zealand	Examine the changes in PA both overall and by categories of intensity of activity that occur in boys and girls from preschool (age 3 years) to two years after school.	Sex, age, weekday vs. weekend, rainfall, and cold weather.	Regression.	242 children (105 girls, 137 boys) had accelerometer data available for 3 years to 7 years. Only 3 to 5.5 years were inputted in the review.	Uniaxial accelerometer, Actical.	Worn for 24 hours and sleep time was subtracted by researcher. 3 hours on 5 days was the wear time criteria.	Not reported.	Girls Counts per minute (TPA) 3y:773 (SD 264) 4y: 522 (SD 220) 5y: 506 (SD 212) 5.5y: 382 (SD 128). Boys Counts per minute (TPA) 3y:813 (SD 249) 4y: 532 (SD 200) 5y: 542 (SD 244) 5.5y: 444 (SD 165).
Vale et al. (2014)[122]	Cross-sectional	Portugal	(1) Objectively assess preschool children's PA patterns and compliance with guidelines of TPA and MVPA (2) Examine differences to parent's education.	Sex, weekday vs. weekend, and parental education.	T-test, ANCOVA, regression	509 healthy preschool children, 48.5% girls, mean age 5.2 years (SD 0.8).	Uniaxial accelerometer, GT1M Actigraph.	The monitor was worn for 7 days with 10 hours on each day included for analysis.	Not reported.	TPA=141 (SD 36.3) minutes per day, weekday. 124.3 (SD 40.3) minutes per day, weekend. MVPA=101.6 (SD 27.9) minutes per day, weekday. 88.1 (SD 31.0) minutes per day, weekend.

Vale et al. (2013)[123]	Cross-sectional	Portugal	(1) Determine compliance with current PA guidelines in Portuguese preschool children (2) Examine the association between meeting daily PA recommendations and weight status.	Sex and weight status.	T-test, chi square tests, regression.	607 children, 170 girls, 172 boys. Mean age 5.1 years (SD 0.8).	Uniaxial accelerometer, GT1M Actigraph.	The monitor was worn for 7 days with 10 hours on each day included for analysis.	Not reported.	TPA=295 (SD 51) minutes per week. MVPA 96 (SD26) minutes per week.	
van Sluijs et al. (2013)[124]	Cross sectional	UK – England	Investigate associations between a range of personal, social and environmental factors and objectively measured LPA and MVPA in four year old children.	**Personal Level:** Sex, BMI z scores, enjoyment of PA, restless, and well-behaved **Social/cultural level:** Maternal age, maternal BMI z score, age of mother, finished education, home ownership, young siblings, older siblings, maternal PA, maternal screen use, short transportation mode, parental support (rules and restrictions) TV at meal times, bedtime, snack at TV, PA-related indoor rules, play in garden, restrict computer use, restrict TV watching, restrict playing outside, and general barriers **Environmental level:** Environmental barriers, concern about road safety, park availability, other children to play with in the	Regression models.	487 were included in the final sample. Mean age 4.1 years (SD 0.1), 47% male.	Actiheart, only acclerometry was used.	Actiheart was worn for 7 days, including sleep and bathing. Data measured during 6AM to 10PM were included for analysis.	Not reported.	LPA=502.6 (SD 63.8) minutes per day. MVPA=70.3 (SD 30.9) minutes per day.	Southampton Women's Survey.

				neighborhood, and season.							
Vanderloo et al. (2013)[125]	Cross-sectional	Canada	Examine the differences in peschoolers objectively measured PA levels accumulated indoors and outdoors during childcare hours.	Outdoor vs. indoor play.	Wilcoxon signed-ranked tests.	31 preschoolers (17 boys, 14 girls) mean age 4.10 years (0.85).	Uniaxial Accelerometer, Actical.	One full day during childcare.	Not reported.	Mean wear time was 451.77 (SD 81.12). Average indoor MVPA was 0.54 (SD 0.59) min per hours, and TPA was 14.42 (SD 6.78). Average outdoor MVPA was 5.03 (SD 4.92) min per hours, and TPA was 31.68 (SD 10.83).	
Wijtzes et al. (2013)[126]	Cross-sectional	Netherlands	Describe and identify correlates of objectively measured physical activity and sedentary behavior in 2 year old toddlers.	Sex, age, preterm birth, birth weight, infant temperament, gross motor development delay, BMI z score, TV time weekdays, TV weekend days, age of mother, BMI of mother, breastfeeding, marital status, number of siblings, smoking in households, day care attendance, educational level of mother, and weekend vs. weekdays.	Linear regression models.	347 children, 182 boys (52.4%), 165 girls (47.6%), mean age 2.09 years.	Uniaxial Accelerometer, Actigraph AM-7164.	Worn for at least 1 weekday and 1 weekend day. 400 minutes minimum wear time.	Not reported.	CPM=41.8 (11.4) MVPA% =0.5% (0.2).	Generation R study.
Jimenez-Pavon et al. (2013)[127]	Cross-sectional	Multi-European countries (Italy, Estonia, Cyprus, Belgium, Sweden, Germany, Hungary, Spain)	Evaluate the associations between objectively-measured PA intensities and clustered CVD risk factors in a large sample of European children aged 2 to 9 years, and to provide evidence for the development of gender-specific recommendations of PA for this young population.	Sex.	T-test.	994 (2 to 6 year old children). 524 boys, 470 girls. Mean age 4.4 (SD 0.08) years.	Uniaxial Accelerometer, GT1M Actigraph.	Monitor was worn during waking hours for 4-5days. 6 hours on 3 days (2 weekdays and 1 weekend day) was the minimum wear time to be included in analysis.	Wear time reliability was cited as 80%.	CPM=598 (174) LPA=395 (SD 65) MVPA=36 (SD 20).	Health outcome paper (CVD risk) but sex differences were assessed.

Tandon et al. (2012)[128]	Cross-sectional	U.S.	To compare the PA and beverage characteristics of a group of licensed center- and home-based child care programs with each other and with NAP SACC guidelines.	Type of child care, presence of indoor play area, hours of daily TV exposure, educational attainment of care provider.	Chi-Square, multivariate linear regression.	168 child care providers (owners, directors) provided information upon the toddlers and preschoolers enrolled in their program. 94 were home based, 74 center based.	Telephone survey, questionnaire.	Length of interview.	A source was cited but no mention of validity or reliability statistics.	Toddlers: 1.6 (SD 0.8) hours a day playing outside. Preschoolers: 1.7(SD 1.2) hours per day playing outside.	
Tandon et al. (2012)[129]	Cross-sectional	U.S.	(1) To characterize the daily outdoor play frequency of preschoolers cared for at home-based child care settings. (2) To examine the factors associated with outdoor play for these children.	Age, sex, no. regular playmates, screen time, highest education level in the house, mothers ethnicity, employment, exercise frequency of parent, hours in child care, care providers educational attainment, perceptions of neighborhood safety, type of care, care provider is relative, care provider is a non-relative, 3 regular playmates.	Chi-square, Ordinal logistics regression.	1,900 children, mean age 4.4 (SD 0.01) years, 48% girls.	Survey, questionnaire.	Length of questionnaire.	A source was cited, which stated "significant" correlation with accelerometry, however, no mention of statistics.	Play outside once or more a week=50% (n=950) children. Play outside few times a week=35% (n=665) children. Go outside to play a few times a month or rarely at all=15% (n=285).	Sample part of a the ECLS-B longitudinal study.
Vanderloo et al. (2014)[130]	Cross-sectional	Canada	To measure the objective PA levels of preschoolers in childcare was well as assessing which attributes within the center-based child care environment influenced PA.	Variables derived from the environment and policy assessment observation (EPAO) Active opportunities, Sedentary environment, Portable play equipment, Fixed play equipment, Staff behaviors, PA training and education.	Multiple regression analysis.	31 preschoolers (mean n=4.10, SD=0.85), 17 were boys.	Actical Accelerometer	Accelerometer was worn for 1 day during child care.	A source cited "accepted" validity and reliability.	TPA=132.60 minutes during child care. MVPA=11.45 minutes during a child care.	

Appendix 2. Included Study Quality Check List and Level of Quality and Study Design

Study [No]	Question 1 *Eligibility*	Question 2 *Random selection*	Question 3 *PA reliability*	Question 4 *Correlate reliability*	Question 5 *Power*	Question 6 *No. participants*	Total (0-6)	Level of quality[a]	Study design[b]
Adams et al. (2010)[2]	1	1	0	0	0	0	2	Low	Cross
Anderson et al. (2008)[3]	1	1	0	0	0	0	2	Low	Cross
Baranowski et al. (1993)[32]	1	1	1	1	0	0	4	Moderate	**Pro**
Barkley et al. (2014)[103]	1	1	0	0	0	1	3	Moderate	Cross
Becker et al. (2014)[104]	1	0	0	1	0	0	2	Low	Cross
Beets et al. (2008)[33]	**1**	**1**	**1**	**1**	**0**	**1**	**5**	**High**	Cross
Bellows et al. (2013)[34]	1	1	0	0	0	0	2	Low	Inter-B
Benham-Deal (2005)[28]	1	1	0	0	0	1	3	Moderate	Cross
Blaes et al. (2011)[21]	1	1	0	0	0	1	3	Moderate	Cross
Boldemann et al. (2006)[35]	1	1	0	1	0	0	3	Moderate	Cross
Bower et al. (2008)[36]	1	1	0	1	0	1	4	Moderate	Cross
Brasholt et al. (2013)[105]	0	0	0	0	0	1	1	Low	Cross
Brown et al. (2009)[23]	1	1	1	0	0	0	3	Moderate	Cross
Brown et al. (2010)[37]	1	1	0	0	0	0	2	Low	**Pro**
Burdette et al. (2004)[39]	1	1	0	0	0	0	2	Low	Cross
Burdette et al. (2005)[38]	1	1	0	1	0	0	3	Moderate	Cross
Burgi et al. (2010)[41]	**1**	**1**	**1**	**1**	**0**	**1**	**5**	**High**	**Pro**
Burgi et al. (2011)[40]	**1**	**1**	**1**	**1**	**0**	**1**	**5**	**High**	Cross
Buss et al. (1980)[42]	1	0	0	0	0	0	1	Low	Cross
Cardon et al. (2008)[22]	1	1	0	0	0	1	3	Moderate	Cross
Cardon et al. (2008)[43]	1	1	0	0	0	1	3	Moderate	Cross
Caroli et al. (2011)[44]	1	1	0	0	0	0	2	Low	Cross
Cespedes et al. (2013)[106]	1	1	0	0	0	1	3	Moderate	Inter-B
Chuang et al. (2013)[45]	1	1	0	0	0	0	2	Low	Cross
Cliff et al. (2009)[48]	1	1	0	1	0	1	4	Moderate	Cross
Collings et al. (2013)[24]	1	0	0	1	0	1	3	Moderate	Cross
Cox et al. (2012)[49]	1	1	0	1	0	1	4	Moderate	Cross
Davies et al. (1995)[47]	**1**	**1**	**1**	**1**	**0**	**1**	**5**	**High**	Cross
Dowda et al. (2004)[50]	1	1	1	1	0	0	4	Moderate	Cross
Dowda et al. (2009)[25]	1	1	0	1	0	0	3	Moderate	Cross
Driessen et al. (2013)[107]	1	1	0	0	0	1	3	Moderate	Cross
Dwyer et al. (2011)[26]	1	1	1	0	0	1	4	Moderate	Cross
Edwards et al. (2013)[108]	0	0	0	0	0	1	1	Low	Cross
Eriksson et al. (2012)[51]	1	0	0	0	0	1	2	Low	Cross
Espana-Romero et al. (2013)[52]	1	0	0	0	0	1	2	Low	Cross
Fernald et al. (2008)[31]	1	1	0	0	0	0	2	Low	**Pro**
Finn et al. (2002)[53]	**1**	**1**	**1**	**1**	**0**	**1**	**5**	**High**	Cross
Firrincieli et al. (2005)[54]	1	1	0	0	0	0	2	Low	Cross
Fisher et al. (2005)[55]	1	1	0	1	0	0	3	Moderate	Cross
Gagne et al. (2013)[56]	**1**	**1**	**1**	**1**	**0**	**1**	**5**	**High**	Cross
Grigsby-Toussaint et	1	1	0	0	0	0	2	Low	Cross

al. (2011)[30]									
Grontved et al. (2009)[57]	1	1	0	0	0	0	2	Low	Cross
Grzywacz et al. (2014)[109]	0	0	0	0	0	0	0	Low	Cross
Gubbels et al. (2011)[58]	1	1	0	0	0	1	3	Moderate	Cross
Gubbels et al. (2012)[29]	1	1	1	0	0	1	4	Moderate	Cross
Gunter et al. (2012)[20]	1	1	0	0	0	0	2	Low	Cross
Heelan et al. (2006)[59]	1	1	0	0	0	1	3	Moderate	Cross
Hesketh et al. (2014)[110]	1	0	0	0	0	1	2	Low	Cross
Hesketh et al. (2014)[111]	1	0	0	0	0	1	2	Low	Cross
Hinkley et al. (2012)[13]	1	1	1	1	0	0	4	Moderate	Cross
Hinkley et al. (2012)[19]	**1**	**1**	**1**	**1**	**0**	**1**	**5**	**High**	Cross
Hnatiuk et al. (2012)[14]	1	1	1	0	0	1	4	Moderate	**Pro**
Hnatiuk et al. (2013)[112]	1	0	0	1	0	1	3	Moderate	Cross
Iannotti et al. (2005)[60]	1	1	1	0	0	1	4	Moderate	**Pro**
Iivonen et al. (2013)[113]	1	1	0	1	0	1	4	Moderate	Cross
Jackson et al. (2003)[15]	1	1	0	0	0	1	3	Moderate	**Pro**
Jago et al. (2005)[61]	1	1	0	0	0	1	3	Moderate	**Pro**
Janz et al. (2004)[63]	1	1	1	0	0	1	4	Moderate	**Pro**
Janz et al. (2005)[62]	1	1	0	0	0	1	3	Moderate	Cross
Jimenez-Pavon et al. (2013)[127]	1	1	1	0	0	1	4	Moderate	Cross
Kambas et al. (2012)[64]	1	1	0	1	0	1	4	Moderate	Cross
Kelly et al. (2006)[65]	1	1	0	0	0	1	3	Moderate	Cross
Kimbro et al. (2011)[16]	1	1	0	0	0	1	3	Moderate	Cross
Klesges et al. (1990)[66]	1	1	1	0	0	1	4	Moderate	Cross
Kuepper-Nybelen et al. (2005)[67]	1	1	0	0	0	1	3	Moderate	Cross
LaRowe et al. (2010)[68]	1	1	0	0	0	0	2	Low	Cross
Laukkanen et al. (2014)[114]	1	1	0	1	0	1	4	Moderate	Cross
Lawrence et al. (1991)[46]	1	1	0	0	0	1	3	Moderate	Cross
Loprinzi et al. (2010)[71]	1	1	0	0	0	1	3	Moderate	Cross
Loprinzi et al. (2013)[69]	1	1	0	1	0	0	3	Moderate	Cross
Loprinzi et al. (2013)[70]	1	1	0	1	0	0	3	Moderate	Cross
Louie et al. (2003)[72]	1	0	0	0	0	1	2	Low	Cross
Marino et al. (2012)[73]	1	1	0	0	0	1	4	Moderate	**Pro**
McKee et al. (2005)[74]	1	0	1	0	0	1	3	Moderate	Cross
McKee et al. (2012)[75]	1	0	0	0	0	1	2	Low	Cross
Metallinos-Katsaras et al. (2007)[76]	1	1	0	0	0	0	2	Low	Cross
Mickle et al. (2011)[77]	1	1	0	0	0	0	2	Low	Cross
Montgomery et al. (2004)[78]	1	1	0	0	0	1	3	Moderate	Cross
Moore et al. (1991)[79]	1	1	0	0	0	1	3	Moderate	Cross
Niederer et al. (2012)[80]	**1**	**1**	**1**	**1**	**0**	**1**	**5**	**High**	Cross
O'Connor et al. (2014)[115]	1	1	0	1	0	1	4	Moderate	Cross
O'Dwyer et al.	1	1	0	0	0	1	3	Moderate	Inter-B

(2013)[116]									
O'Dwyer et al. (2011)[82]	1	1	0	0	0	0	2	Low	Cross
O'Dwyer et al. (2012)[81]	1	1	0	0	0	1	3	Moderate	**Inter-Pro**
Olesen et al. (2013)[117]	1	1	0	1	0	1	4	Moderate	Cross
Oliver et al. (2010)[83]	1	1	0	0	0	1	3	Moderate	Cross
Ostbye et al. (2013)[118]	1	0	0	0	0	1	2	Low	Cross
Pate et al. (2008)[85]	1	1	0	0	0	1	3	Moderate	Cross
Pate et al. (2013)[84]	1	1	0	1	0	1	4	Moderate	Cross
Pate RR (2004)[86]	1	1	0	0	0	1	3	Moderate	Cross
Penpraze et al. (2006)[87]	1	0	0	0	0	1	2	Low	Cross
Pfeiffer et al. (2009)[88]	1	1	0	1	0	1	4	Moderate	Cross
Poest et al. (1989)[89]	1	1	0	0	0	1	3	Moderate	Cross
Raustorp et al. (2012)[90]	1	0	0	0	0	1	2	Low	Cross
Rice et al. (2014)[119]	1	0	1	1	0	1	4	Moderate	Cross
Saakslahti et al. (1999)[91]	1	1	0	0	0	1	3	Moderate	Cross
Sallis et al. (1988)[27]	1	1	0	0	0	0	2	Low	Cross
Sallis et al. (1993)[1]	1	1	0	0	0	1	3	Moderate	Cross
Schary et al. (2012)[92]	1	1	0	1	0	0	3	Moderate	Cross
Shen et al. (2012)[93]	1	0	1	0	0	1	3	Moderate	Cross
Sigmund et al. (2007)[17]	1	1	0	0	0	1	3	Moderate	Cross
Smith et al. (2010)[18]	1	1	0	0	0	1	3	Moderate	Cross
Spurrier et al. (2008)[11]	1	1	0	0	0	0	2	Low	Cross
Sugiyama et al. (2010)[94])	1	1	0	0	0	1	3	Moderate	Cross
Sundberg et al. (2012)[95]	1	0	0	0	0	1	2	Low	Cross
Tanaka et al. (2009)[6]	1	1	0	0	0	1	3	Moderate	Cross
Tanaka et al. (2012)[96]	1	1	0	0	0	1	3	Moderate	Cross
Tanaka et al. (2013)[120]	0	0	0	1	0	1	2	Low	Cross
Tandon et al. (2012)[128]	1	1	0	0	0	1	3	Moderate	Cross
Tandon et al. (2012)[129]	1	1	0	0	0	1	3	Moderate	Cross
Taylor et al. (2009)[97]	**1**	**1**	**1**	**1**	**0**	**1**	**5**	**High**	**Pro**
Taylor et al. (2013)[121]	0	0	1	1	0	1	3	Moderate	**Pro**
Temple et al. (2009)[98]	1	1	0	0	0	0	2	Low	Cross
Trost et al. (2003)[12]	1	1	0	0	0	1	3	Moderate	Cross
Vale et al. (2010)[10]	1	1	0	0	0	0	2	Low	Cross
Vale et al. (2011)[9]	1	1	0	0	0	0	2	Low	Cross
Vale et al. (2013)[123]	1	1	0	0	0	1	3	Moderate	Cross
Vale et al. (2014)[122]	1	1	0	0	0	1	3	Moderate	Cross
van Rossem et al. (2012)[99]	1	1	0	0	0	1	3	Moderate	Cross
van Sluijs et al. (2013)[124]	0	0	0	0	0	1	1	Low	Cross
Vanderloo et al. (2013)[125]	0	0	0	0	0	0	0	Low	Cross
Vanderloo et al. (2014)[130]	1	1	0	0	0	1	3	Moderate	Cross
Vasquez et al. (2006)[8]	1	0	0	0	0	0	1	Low	Cross

Verbestel et al. (2011)[100]	1	1	0	1	0	1	4	Moderate	Cross
Vorwerg et al. (2013)[7]	1	1	0	0	0	1	3	Moderate	Cross
Wijtzes et al. (2013)[126]	0	0	1	0	0	1	2	Low	Cross
Williams et al. (2008)[5]	1	1	0	1	0	0	3	Moderate	Cross
Worobey et al. (2005)[101]	1	0	0	0	0	0	1	Low	Cross
Yamamoto et al. (2011)[4]	1	1	0	0	0	0	2	Low	Cross
Zecevic et al. (2010)[102]	1	1	0	1	0	1	4	Moderate	Cross
Total	122(93%)	103(79%)	25(19%)	38(29%)	0(0%)	90(69%)		Low - 43(33%) Mod - 78(60%) High = 9(7%)	

(Q1) Did the study describe the participant eligibility criteria?
(Q2) Were the participants randomly selected?
(Q3) Did the study report the sources and details of physical activity assessment clearly and did the instruments have acceptable reliability for the specific age group (an intra-class correlation coefficient .70 or Pearson correlation .80 was considered acceptable)?
(Q4) Did the study report the sources and details of assessment of biological, demographic, psychological and environmental correlates and did all of the methods have acceptable reliability (e.g. parents physical activity, green space)?
(Q5) Did the study report a power calculation and was the study adequately powered to detect hypothesized relationships?
(Q6) Did the study report the numbers of participants who completed each of the different measures?
[a]Level of Quality: 5–6=High, 4–3=Moderate, 2–0=Low.
[b]Cross=Cross-sectional, Inter-B=Intervention Baseline results, Pro=prospective study.

Appendix 3. Full Summary of Potential Correlates for Total Physical Activity

	Related to physical activity		Unrelated to physical activity	Summary code[a]		Additional coding for high quality studies [e]
	Positive association	Negative association	No association			
Variables	**Reference no.**	**Reference no.**	**Reference no.**	**n/N[b] for row (%)[c]**	**Association [d]**	
Demographic and biological variables						
Age	18f(meeting guidelines), 46, 54, **56**f, 57f, 58f(outdoor), 72(PA class), 83g, 93, 95, **97**, 100, 108, 119(childcare-normal weight)	**13**f, 15h, 19, 102f, 121	15i, 16f(model1), 26, 32, 43, 46, 47, 48, 65, 69f, 71f, 73(outside PA @ home), 78f, 85f, 88, 105, 113g(LVPA), 119(childcare-ow/ob), 126f, 129f(frequency play outside)	14/39(36%)	**?**	
Sex (male)	1, 6, 9, 10, 13, 15, 17(activity EE), 18f(meeting PA guidelines), **19**, 21, 22 (recess), 30(outdoor PA), 32, **33**f, 35g, 39, 42, 53g, 54, **56**f, 57f, 62, 65, 72(PA class), 74, 78f, **80**, 84(outdoor PA), 87, 88f, 89, 91, 93, 95, **97**f, 102g, 103,105, 109, 119(child care), 122, 123, 127		2, 3(no. times playing outside), 7, 8(obese children), 14, 16f(model1) 26, 31g, 42(3years), 48, 58f, 61, 64, 66f, 69f, 70(active play), 71f(home PA), 73(outside PA @ home), 73(outside PA @ preschool), 75, 76, 77,81(LPA+MVPA), 83, 85f, 92, 96, 98, 100, 114, 116g(LPA+MVPA), 121, 124f(LPA+MVPA), 126f, 129f(frequency play outside)	42/77(55%)	?	6/6(100%) ++
Ethnicity (white)	1g, 67(playing sport/outside), 73(outside PA @ home), 85f, 99(model1-playing outside), 99(model2-playing outside)	16f(model1)	3hi(no. times playing outside), 30(outdoor PA), 32, **33**f, 45f(African-American vs. Hispanic), 61, 65, 73(outside PA @ preschool), 116g(LPA+MVPA), 129g(frequency play outside -mothers ethnicity)	6/17(335%)	**?**	
SES			1f, 15, 16f(model2), 31g, **33**f, 48, 65	0/7(0%)	**0**	
Parents education		18fk(meeting PA guidelines), **33**f, 73k(outside PA @ home), 122(weekday)	14, 16fk(model1), 30(outdoor PA), **41**, 70(active play), 86(LPA+MVPA), 99k(playing outside), 102f, 111fk(LPA+MVPA), 116f(LPA+MVPA), 122(weekend days), 124(LPA+MVPA), 126k, 129g(frequency play outside)	4/18(22%)	**0**	
Household income		18f(meeting PA guidelines)	16f(model1), 102	1/3(33%)		
Fat free-mass			59	0/2(0%)		
Preterm birth		53g, 53g(childcare PA)	126	2/2(100%)		
Birth weight	88		126f	1/1(100%)		
Adiposity		47, 51h, 83	1f, **40**, 51i, 59	3/8(38%)	**0**	
BMI	12h, **33**f, 66f, 85, 88f	**33**f(underweight), **33**f(overweight), 46(low weight-6months), 83, 119(childcare-4-5years), 120(thinness)	3hi(no. times playing outside), 12i, 31g, 46(low weight-12months), 46(low weight-18months), 48, 49, 53, 59, 65, 68, 73(outside PA @ home), 73(outside PA @ preschool), 76, **80**, 82i(LPA+MVPA), 84(outdoor PA), 95, **97**f, 105, 111f(LPA+MVPA), 114f(LVPA), 116f(LPA+MVPA), 119(childcare), 123, 124f(LPA+MVPA), 126	6/37(14%)	0	2/5(40%) **?**
Breastfed			99(playing outside), 126f	0/1(0%)		
Smoking during pregnancy			99(playing outside)	0/1(0%)		
Mother's pre-pregnancy BMI			99(playing outside)	0/1(0%)		
Nationality	44(playing outside), 46, 90			3/3(100%)		
Aerobic fitness	40			1/1(100%)		

Gross motor skill performance	**33**f, **40**, 48h(object control scores), 54, 55, 64, 113f(total score), 113f(throwing & catching), 114h	9	48h (locomotor score), 48h (gross motor quotient), 48i (gross motor quotient), 48i (object control), 48i (locomotor score), 113f (LVPA [static balance]), 113f (LVPA [dynamic balance]), 113f (LVPA [sliding & galloping]), 113f (LVPA [standing broad jump]), 113f (LVPA [kick ball at target]), 113f (LVPA [throwing at target]), 114i, 126f	9/23(37%)	**0**
Linguistic/language group			102f	0/1(0%)	
Physical health		77h (Plantar pressures), 95 (Type1 Diabetes), 107g (4y; functional constipation)	16f (model1; general health), 31g (stunting status), 46 (ill), 54 (history of wheezing), 77i (Plantar pressures), 91 (history of wheezing), 107g (3y; functional constipation)	3/7(42%)	**?**
Physical disorder scale	16fk (model4)			1/1(100%)	
Parents psychological wellbeing			16fk (model1)	0/1(0%)	
High maternal depressive symptoms		31g (@ age 15months)	31g (@ age4-6years)	1/2(50%)	
Education mothers partner			126	0/1(0%)	
Immigrant background (native born parent)		106g (active play)	41 (TPA), 41 (time play outdoors)	1/3(33%)	
Family structure			16f (model2-no of residents in home), 16fk (model1-parents living together), 126, 16fk (model1-single parent family), 73 (outside PA @ home-single parent family), 99k (playing outside-single parent family), 13fi (parents marital status), 126f (parents marital status)	0/8(0%)	**0**
Siblings (no. and order)	13fi (no.), 126g (no.)		4fhi (model4;no), **33**f, **97(no.),** 124f (LPA+MVPA; younger), 16f (model1; older), **97**(older)	2/8(25%)	**0**
Parents age			16fk (model1), 31gk, **33**fj, 88, 102, 124f (LPA+MVPA), 126, 16fk (model1-single parent family), 73 (outside PA @ home-single parent family), 99k (playing outside-single parent family), 13fi (parents marital status), 126f (parents marital status)	0/7(0%)	**0**
Family financial difficulties			99 (playing outside)	0/1(0%)	
Parents BMI		16fk (model1) (overweight), 53j, 66f	16fk (model1) (obese), 30f (outdoor PA), 31gk, 53k (TPA), 53 (childcare PA), 83, 88, 124fk (LPA+MVPA), 126f	3/12(25%)	**0**
Parents waist circumference			83j, 83k	0/2(0%)	
Psychological, cognitive and emotional variables					
Active by themselves	**13**fh (weekend days)		13fh (weekdays)	1/2(50%)	
Personality			42	0/1(0%)	
IQ			42	0/1(0%)	
Child is more likely to play inside/draw/do crafts than be active?		13fi		1/1(100%)	
Child constraints		13fi (weekend days)	13fi (weekdays)	1/2(50%)	
Enjoyment of PA			124f (LPA+MVPA)	0/1(0%)	
Restless			124f (LPA+MVPA)	0/1(0%)	
Well behaved			124f (LPA+MVPA)	0/1(0%)	

Infant temperament			126	0/1(0%)		
Internalizing behaviors (withdrawal behaviors)			31g	0/1(0%)		
Externalizing behaviors			31g	0/1(0%)		
Behavioral variables						
Prompts/request from child	1f, 58f (indoor), 58f (outdoor)			3/3(100%)		
Participation in organized sports/activities			1f, 11, 53 (childcare PA)	0/3(0%)		
TV viewing		13fh (weekdays), 31f, **33**f, 39, 61, 102f	1f, 7, 13fh (weekend days), 37, 49, 61, 70 (active play), 126, 128f (outdoor play, childcare), 129g (frequency play outside)	7/17(41%)	**?**	
Objective sedentary behavior		78f				
Quiet activities (in preschool)			7	0/1(0%)		
Bedtime			124fk (LPA+MVPA)	0/1(0%)		
Daily sleep	**13**fh (weekdays)		13fh (weekend days)	1/2(50%)		
Social and cultural variables						
Parental PA/familial interaction	1, 11,11k 13fhk, **33**fj, 58f, 66f, 69f, 75, 79, 83g,88i, 89, **97**, 102f, 110fk 9 (LPA+MVPA)	31gk	1f, 13fij, 60k, 66f, 71f (home PA), 83, 88h	10/17(58%)	?	3/4(75%) ++
Parental practices	1f, 13fh (no rough games), 30f (outdoor PA), 69f (monitoring of PA)	83(take to playground)	61, 66, 69f, 83, 69f (style of parenting), 92f (model3), 69f (pattern of parenting), 124fk (Snack@TV), 124fk (PA indoor games), 124fk (play in garden), 124fk (restrict computer), 124fk (restrict TV), 124fk (restrict outside play), 126 (smoking in home)	4/19(21%)	0	
Parents perceptions and beliefs	18f (meeting PA guidelines-self efficacy), 33f , 71f(home PA; PA competence perception), 88(competence perception), 102f(father PA enjoyment)		16f (model2; fear play outside), 18 (organized PA-self efficacy), 18f (non-organized PA-self efficacy), 102f (PA importance)	5/9(21%)	0	
Parent(s) work status	33fk (full-time), 41k (part-time)	13fik (part-time-weekday), 13fik (fulltime-weekend), 16fk (model1) (part-time), 16fk (model1) (fulltime)	13fik (part-time-weekend), 13fik (fulltime-weekday), 33fj (full-time), **33**fj (part-time), **33**fk (part-time), 99k (playing outside), 126k, 126 (partner), 129g (frequency play outside)	4/15(27%)	?	
Parental barriers		13fh (weekdays),18f (meeting PA guidelines), 18 (organized PA), 115	13fh (weekends),18f (non-organized PA), 124fk (LPA+MVPA)	4/7(57%)	**?**	
Parental support	13fi (weekend days), 30 (outdoor PA), 69f, 71f (home PA), 88, 92f (model1), 102		1f, 13**fi** (weekdays), 61, 66f, 83, 115(LPA+MVPA) 124fk (LPA+MVPA)	7/14(50%)	**?**	
Collective efficacy	16fk (model3)			1/1(100%)		
Frequency child sees parent being active			13fi	0/1(0%)		
Frequency child sees other adults being active			13fi	0/1(0%)		
Peers to be active with	13fh		129f (frequency of play outside)	1/1(100%)		
Same activities as siblings		13fh (weekdays)	13fh (weekend days)	1/2(50%)		
Attendance to social gatherings			13f	0/1(0%)		

Social gatherings that are not active in nature			13fh	0/1(0%)	
Number of cars in the home			13fh, 102f	0/2(0%)	
Parental work-load (high)			**41**	0/1(0%)	
Dog ownership			11	0/1(0%)	
Teacher's/day care worker education/training	88, 36g		**56**f, 129 (frequency playing outside)	2/3(66%)	
Teacher/day care worker age		**56**f		1/1(100%)	
Teacher/day care worker INTENTION of engaging to get children to be active	**56**f			1/1(100%)	
No. days child is in the care of others			99(playing outside)	0/1(0%)	
Democratic interventions of teachers/day care workers	**56**f			1/0(100%)	
Teachers/day care workers DECRIPTIVE NORM (perceived fewer educators engage children in physical activity)		**56**f		1/1(100%)	
Teachers/day care worker PAST BEHAVIOR - (engaging children to be active).			**56**f	0/1(0%)	
Highest education of child care provider			128f (outdoor play)	0/1(0%)	
Playing with friends vs. alone	103, 129 (frequency play outside-parental childcare, n=≥3 friends), 129 (frequency play outside-parental childcare, n=≥3 friends)			3/3(100%)	
House ownership			124f (LPA+MVPA)	0/1(0%)	
Family exercise frequency			129f (frequency play outside)	0/1(0%)	
Physical environmental variables					
Time outdoors/in play spaces	1f, 7, 35i, 66, 72 (PA class), 90, 125		73f (outside PA @ preschool)	7/8(89%)	+
Attend nursery/kindergarten/children's center/preschool	21	43	16fk (model1), 17, 126g	1/4(20%)	0
Nursery/kindergarten/children's centers have PA promoting policies and practices	20 (childcare)			1/1(100%)	
Convenient play spaces	1f		11 (presence of playground near to home), 73f (outside PA @ home-presence of playground near home)	1/3(33%)	
Family lives in public/social housing		16f (model2)		1/1(100%)	
Frequency in play spaces	1f			1/1(100%)	
Play equipment at home	88f			1/2(5%)	
Presence of playground at preschool	73f (outside PA @ preschool)			1/1(100%)	
Weather conditions	89			1/1(100%)	

Availability of toys			1f, 115 (LPA+MVPA)	0/2(0%)	
Distance to park (miles)			88f	0/1(0%)	
Attend/go to a park			88	0/1(0%)	
Park safety			88	0/1(0%)	
Safe place to play	75			1/1(100%)	
Have desktop computer in home		13fh (weekend days)	13fh (weekdays)	1/2(50%)	
Season (summer)	39, 75, 95, 105, 126g	16fk (model1), 53 (childcare PA)	53, 97, 124fk (LPA+MVPA)	5/10(50%)	**?**
Region of house (urban)	18f (meeting PA guidelines)	72 (PA class)		1/2(50%)	
Region of preschool/child care center	73 (outside PA @ preschool)		57	1/2(50%)	
Region of country	**41** (TPA), **41** (time play outdoor)		73 (outside PA @ home)	4/8(50%)	**?**
No. hours of childcare/preschool	116f		**97**	0/1(0%)	
Housing type (apartment [A], row house [RH], other housing)		16f (model2)	16f (model2)	1/2(50%)	
Weekday versus weekend (weekday)	7, 10, 34, 122	13, 38 (outdoor PA), 87, 105, 121, 126	17 (activity EE), 75, 97, 100, 111f (LPA+MVPA)	6/15(33%)	**?**
Days of week			**97**	0/1(0%)	
Preschool-PE classes	9			1/1(100%)	
Time at preschool (full day)			73 (outside PA @ home)	0/1(0%)	
Time at preschool (half day)			73 (outside PA @ home)	0/1(0%)	
Time of day (afternoon)	28, 100		32, 93	2/4(50%)	**?**
Month of PA data collected	13fi (Aug-weekend days)		13fi (Aug-weekdays), 13fi (Sep), 13fi (Oct), 13fi (Nov), 13fi (Dec)	1/6(17%)	**0***
No footpaths in neighborhood		**13**fi		1/1(100%)	
Size of backyard/garden	11			1/1(100%)	
Yard near home	73f (outside PA @ home)			1/1(100%)	
No. items of outdoor play equipment	11			1/1(100%)	
Time outdoors on weekends	13fh (weekdays)		13fi	1/2(50%)	
No. visits to shopping centers per week			13fh	0/1(0%)	
Use of balls and objects (preschool outside)	23f			1/1(100%)	
Childcare physical activity promoting polices			57	0/1(0%)	
Open space outside at preschool	23f			1/1(100%)	
Childcare fixed play equipment		130	23f	1/2(50%)	
Wheel toys outside at preschool	23f			1/1(100%)	
Playing one-to-one with peers	23f			1/1(100%)	
Playing in a group without an adult	23f			1/1(100%)	
Playing solitary at preschool	23f			1/1(100%)	
Children initiator of activities	23f			1/1(100%)	
Neighborhood vegetation	30f (outdoor PA)			1/1(100%)	
Neighborhood quality			**33**f	0/1(0%)	
Neighborhood safety (perceived)	**33**f		38, 128f (frequency of play)	1/3(33%)	

Frequency of visits to active play spaces (per week)	**13**fh (weekdays)	**13**fi (weekend days)	**13**fh (weekend days), **13**fi (weekdays)	1/4(25%)	**0**
Recess (take part)	100			1/1(100%)	
Recess - no. children per m^2		22 (steps [p/m])		1/1(100%)	
Recess - no. supervising teachers		22i (steps [p/m])	22h (steps [p/m])	1/2(50%)	
Recess - aiming equipment			22h (steps [p/m]), 22i (steps [p/m])	0/2(0%)	
Recess - playing equipment			22h (steps [p/m]), 22i (steps [p/m])	0/2(0%)	
Recess - recess duration		22h (steps [p/m]), 22i (steps [p/m])		2/2(100%)	
Recess - ground surface type		22h (steps [p/m])	22I (steps [p/m])	1/2(50%)	
Recess - playground markings			22h (steps [p/m]), 22i (steps [p/m])	0/2(100%)	
Recess - vegetation			22h (steps [p/m]), 22i (steps [p/m])	0/2(100%)	
Recess- height differences			22h (steps [p/m]), 22i (steps [p/m])	0/2(100%)	
Recess - outdoor play time		84 (20 min<)		1/1(100%)	
Recess - availability of toys			22h (steps [p/m]), 22i (steps [p/m])	0/2(0%)	
Childcare-type (Center vs home)	129 (outdoor play-non-relation care provider in child home)		128 (outdoor play), 129 (frequency play outside-non relation care in another home), 129 (outdoor play-family relation care provider)	1/4(25%)*	
Childcare-indoor play			128f (outdoor play)	0/1(0%)	
Childcare - leisure time activities	35i			1/1(100%)	
Childcare - outdoor environment quality	35i			1/1(100%)	
Childcare - portable play environment	36g, 130			2/2(100%)	
Childcare - sedentary environment		36g (mean PA)		1/1(100%)	
Childcare – active opportunities	36g, 58f (indoors), 58f (outdoors)			3/3(100%)	
Childcare - sedentary opportunities			130	0/0(0%)	
Group size in child care - peers (large)		58g (indoors), 58 (outdoors)		2/2(100%)	
Group size in child care - staff (large)		58g (indoors), 58 (outdoors)		2/2(100%)	
Childcare staff behaviors			130	0/0(0%)	
Childcare indoor PA promoting space layout			56f	0/1(0%)	
Childcare PA promoting materials available	56f			1/1(100%)	
Individual preschool/childcare	53, 53 (childcare PA), 57f, 89, 93, 101			6/6(100%)	+
Rain		121		1/1(100%)	
Weather (temperature)		121		1/1(100%)	
Environmental barriers			124fk (LPA+MVPA)	0/1(100%)	
Concern about safety			124fk (LPA+MVPA)	0/1(100%)	
Park availability			124fk (LPA+MVPA)	0/1(100%)	
Environment and Policy Assessment and Observation (EPAO) Total score			130	0/0(0%)	

a = summary code is an overall summary of finding for each variable

b N = number of studies that have investigated and reported on possible associations between the variable and physical activity; n = number of studies that report support for the direction of the hypothesized association.

c N = association shows the direction of the individual/summary association (+/-/?/0) – codes in **bold** are the final result for each correlate

d = additional coding for studies that scored a moderate to high quality rating (++/--/oo/?) – codes in **bold** are the final result for each correlate

e = additional coding for studies that scored a high quality rating (++/--/oo/?) – codes in **bold** are the final result for each correlate

f = reported in a multivariate analysis

g = reported in a multivariate and univariate analysis

h = association for boys only

i = association for girls only

j = paternal behaviour

k = maternal behaviour.
l = correlate at 4 months of age predicting physical activity at 19 months of age.
m = correlate at 9 months of age predicting physical activity at 19 months of age.
MPA = moderate physical activity.
VPA = vigorous physical activity.
MVPA = moderate to vigorous physical activity.
LVPA = light to vigorous physical activity.
* one study testing different months so no additional coding is awarded.
N in **Bold** = High quality studies.

[a]Summary code is an overall summary of finding for each variable.
[b]N=number of studies that have investigated and reported on possible associations between the variable and physical activity; n=number of studies that report support for the direction of the hypothesized association.
[c]N=association shows the direction of the individual/summary association (+/-/?/0) – codes in bold are the final result for each correlate.
[d]Additional coding for studies that scored a moderate to high quality rating (++/--/oo/?) – codes in bold are the final result for each correlate.
[e]Additional coding for studies that scored a high quality rating (++/--/oo/?) – codes in bold are the final result for each correlate
[f]Reported in a multivariate analysis
[g]Reported in a multivariate and univariate analysis
[h]Association for boys only
[i]Association for girls only
[j]Paternal behavior
[k]Maternal behavior
[l]Correlate at 4 months of age predicting physical activity at 19 months of age.
[m]Correlate at 9 months of age predicting physical activity at 19 months of age.
MPA, moderate physical activity; VPA, vigorous physical activity; MVPA, moderate to vigorous physical activity; LVPA, light to vigorous physical activity.
* one study testing different months so no additional coding is awarded.
N in Bold = High quality studies.

Appendix 4. Full Summary of Potential Determinants for Total Physical Activity

	Related to physical activity		Unrelated to physical activity	Summary Code[a]	
	Positive association	Negative association	No association	n/N for row	
Determinant	Reference no.	Reference no.	Reference no.	(%)[b]	Association [c]
Demographic and biological variables					
Age	15	**97**, 121	32	2/4(50%)	**?**
Sex (male)	32, 121		**97**f	2/3(66%)	+
Ethnicity (white)			32, 116g (LPA+MVPA)	0/2(0%)	**0**
Parents education			116f (LPA+MVPA)	0/1(18%)	**0**
Adiposity			**40**	0/1(0%)	**0**
BMI			**97**f, 116f (LPA+MVPA)	0/2(0%)	**0**
Aerobic fitness			**40**	0/1(0%)	**0**
Gross motor skill performance			**40**	0/1(0%)	**0**
High maternal depressive symptoms		31g		1/1(100%)	-
Social and cultural variables					
Parental PA	**97j**		60k, **97**k, 112fkl (modelA), 112fkm (modelA)	1/6(20%)	**0**
Parental PA knowledge			112fkl (modelA)	0/1(0%)	**0**
Parental PA views			112fkl (modelA)	0/1(0%)	**0**
Parental PA optimism	112fkm (modelA)		112fkl (modelA), 112fkm (modelB)	1/3(33%)	**0**
Parental PA self-efficacy			112fkl (modelA), 112fkm (modelA)	0/2(0%)	**0**
Parental PA future expectations			112fkl (modelA), 112fkm (modelA)	0/2(0%)	**0**
Parental floor concerns			112fkl (modelA)	0/1(0%)	**0**
Parental TV knowledge			112fkl (modelA)	0/1(0%)	**0**
Parental TV use			112fkl (modelA), 112fkm (modelA)	0/2(0%)	**0**
Parental TV self-efficacy			112fkl (modelA), 112fkm (modelA)	0/2(0%)	**0**
Parental screen time			112fkl (modelA), 112fkm (modelA)	0/2(0%)	**0**
Time spent playing outside with adults			112fl (modelA), 112fm (modelA)	0/2(0%)	**0**
Time spent playing with parent	112fkm (modelA), 112fkm (modelB), 112fkm (modelC)		112fkl (modelA)	3/4(75%)	+
Tummy time			112fl (modelA), 112fm (modelA)	0/2(0%)	**0**
Time spent on the floor			112fl (modelA)	0/1(0%)	**0**
Time spent with peers of the similar age		112fm (modelA)	112fl (modelA), 112fl (modelB), 112fl (modelC), 112fm (modelB)	1/5(20%)	**0**
Time spent with older toddlers or children			112fl (modelA), 112fm (modelA)	0/2(0%)	**0**
Physical environmental variables					
Time outdoors/in play spaces			112fl (modelA), 112fm (modelA)	0/2(0%)	**0**
Play equipment at home			112fl (modelA), 112fm (modelA)	0/2(0%)	**0**

Time of day (afternoon)	32	0/1(0%)	**0**
TV in home	112fl (modelA), 112fm (modelA)	0/2(0%)	**0**

a = summary code is an overall summary of finding for each variable

b N = number of studies that have investigated and reported on possible associations between the variable and physical activity; n = number of studies that report support for the direction of the hypothesized association.

c N = association shows the direction of the individual/summary association (+/-/?/0) – codes in **bold** are the final result for each correlate

d = additional coding for studies that scored a moderate to high quality rating (++/--/oo/?) – codes in **bold** are the final result for each correlate

e = additional coding for studies that scored a high quality rating (++/--/oo/?) – codes in **bold** are the final result for each correlate

f = reported in a multivariate analysis

g = reported in a multivariate and univariate analysis

h = association for boys only

i = association for girls only

j = paternal behaviour

k = maternal behaviour.
l = correlate at 4 months of age predicting physical activity at 19 months of age.
m = correlate at 9 months of age predicting physical activity at 19 months of age.
MPA = moderate physical activity.
VPA = vigorous physical activity.
MVPA = moderate to vigorous physical activity.
LVPA = light to vigorous physical activity.
* one study testing different months so no additional coding is awarded.
N in **Bold** = High quality studies.

[a]Summary code is an overall summary of finding for each variable.
[b]N=number of studies that have investigated and reported on possible associations between the variable and physical activity; n=number of studies that report support for the direction of the hypothesized association.
[c]N=association shows the direction of the individual/summary association (+/-/?/0) – codes in bold are the final result for each correlate.
[d]Additional coding for studies that scored a moderate to high quality rating (++/--/oo/?) – codes in bold are the final result for each correlate.
[e]Additional coding for studies that scored a high quality rating (++/--/oo/?) – codes in bold are the final result for each correlate.
[f]Reported in a multivariate analysis.
[g]Reported in a multivariate and univariate analysis.
[h]Association for boys only.
[i]Association for girls only.
[j]Paternal behavior.
[k]Maternal behavior.
[l]Correlate at 4 months of age predicting physical activity at 19 months of age.
[m]Correlate at 9 months of age predicting physical activity at 19 months of age.
MPA, moderate physical activity; VPA, vigorous physical activity; MVPA, moderate to vigorous physical activity; LVPA, light to vigorous physical activity
* one study testing different months so no additional coding is awarded.
N in Bold = High quality studies.

Appendix 5. Full Summary of Potential Correlates for Moderate to Vigorous Physical Activity

	Related to physical activity		Unrelated to physical activity	Summary code[a]		Additional coding for high quality studies [e]
	Positive association	Negative association	No association	n/N [b] for row (%)[c]	Association [d]	
Determinant variables	**Reference no.**	**Reference no.**	**Reference no.**			
Demographic and biological variables						
Age	57f, **80** (VPA), 88, 95, 108, 118g, 119 (childcare-normal weight), 126g	4fl (model4), 48h	4fh (model4), 26 (MPA+VPA), 48h (%VPA), 71, **80**, 85f, 86g, 93, 104 (active play), 117 (preschool), 119 (childcare-ow/ob)	8/21(30%)	**?**	
Sex (male)	6, 7 (VPA), 9, 10, **19** (%MPA), 21, 24 (MPA), **40**, 43 (MPA), 52, 53g (%VPA), 54, 57f, 62 (VPA), 63 (VPA), 76 (VPA), 78, **80**, 86g, 88f, 95, 96, 105, 111f, 115, 117 (preschool), 118g, 119 (childcare), 120, 122, 123, 126g, 127	85f	14, **19** (%VPA), 24 (VPA), 26 (MPA+VPA) 43, 48, 62 (MPA), 63 (MPA), 71, 76, 77, 81, 93, 98, 104 (active play), 109g, 113g, 114 (VPA), 116f, 124f	33/54(61%)	+	3/4(75%) ++
Ethnicity (white)	85f (African-American)	86f (African-American, model2, VPA), 88g (African-American)	86f (African-American, model1, MPA), 117 (preschool, west country), 117 (preschool, others), 118g	2/7(28%)	**0**	
SES			48, 126f, 65	0/3(0%)		
Parents education (degree)	117g (preschool)	122 weekdays	4fhi (model4), 14, **41**, 86f, 111fk, 116fk, 118gk, 122 (weekend), 124fk, 126k,126 (partner)	1/13(8%)	**0**	
Parents age			88, 124fk, 126k	0/3(0%)		
Fat free-mass		59i	59h	1/2(50%)		
Immigrant background			4fhi (model4), **41**	0/2(0%)		
Preterm birth		53g (%VPA), 117g (preschool), 126		3/3(100%)		
Birth weight	88		126g	1/2(100%)		
Adiposity		24f (% body fat, VPA), 24f (fat free mass, VPA), 24f (trunk fatness index, VPA)	40, 24f (% body fat, MPA), 24f (fat free mass, MPA), 24f (trunk fatness index, MPA), 59h	3/8(37.5%)	**?**	
BMI	82h (MPA-weekday), 85, 88g	76 (VPA), **80** (VPA), 119 (childcare-4-5years), 123i	27f (MPA),48, 49, 53 (%VPA), 59, 68, 76, **80**, 82h (MPA, weekend), 82h (VPA), 82i, 95, 109k, 111f, 113f, 116f, 117 (preschool), 118g, 119 (childcare-2-3years), 120, 123h, 124f, 126g	4/30(13%)	**0**	
Parents BMI		27fj (MPA)	4fhi (model4), 27fk (MPA), 53k (%VPA), 88, 124fk, 126gk	1/6(17%)	**?**	
Aerobic fitness	40			1/1(100%)		
Breastfeeding			126g	1/1(100%)		
Physical health	4fi (model4-health status)	54 (VPA-history of wheezing), 77h	4fh (model4-health status), 77i (plantar	4/9(44%)	**?**	

		(plantar pressures), 95 (Type I diabetes), 107g (4 years-functional constipation)	pressures), 46 (VPA-illness), 107g (3 years-functional constipation)		
Gross motor-skill performance	5 (4 years), **40**, 48hg (object control scores), 54, 55, 96 (related to fitness), 113g (total score), 113g (sliding & galloping), 113g (throwing & catching), 114h (MPA), 117g(preschool)	48ij (locomotor skills), 48i (gross motor quotient)	5 (3years), 48h (locomotor score), 48h (gross motor quotient), 48i (object control), 48i (locomotor score), 113g (static balance), 113g (dynamic balance), 113g (standing broad jump), 113g (kicking ball at target), 113g (throwing at target), 114h (VPA), 114i, 126g	10/25(40%)	**?**
Skills related to physical fitness	96			1/1(100%)	
Family CVD risk		27f (MPA)		1/1(100%)	
Siblings (no. and order)	124f (older sibling), 126g		124f (younger sibling)	2/3(66%)	
Psychological, cognitive and emotional variables					
Desire to be active	4fh (model4)		4fi (model4)	1/2(50%)	
Infant temperament			126	1/1(100%)	
Self-regulation	5 (active play)			1/1(100%)	
Literacy			5 (active play)	0/1(0%)	
Math achievement			5 (active play)	0/1(0%)	
Enjoyment of PA			124f	0/1(0%)	
Restless			124f	0/1(0%)	
Well behaved			124f	0/1(0%)	
Type A behavior			27f (MPA)	1/1(100%)	
Behavioral variables					
Energy intake whilst watching TV		49 (weekend days)	124f (meals), 124f (snacks)	1/1(100%)	
Surveys of obsegenic foods		49		1/1(100%)	
Surveys of fruits/veg			49	0/1(0%)	
Participation in organized sports/activities	4fh (model3)		4fi (model4), 53 (%VPA)	1/3(33%)	
Sedentary behaviors: electronic, media/screen viewing (TV, computer, games)	4fh (model4)	25	49, 126	1/4(25%)	**0**
TV commercial viewing			49	0/1(0%)	
Non TV commercial viewing			49	0/1(0%)	
Bedtime			124k	0/1(0%)	
Social and cultural variables					

Parental PA/familial interaction	4fi (model4), **13**fij (MPA), 27f (MPA), 110fk		4fh (model4), **13**fik (VPA), 88, 124fk	4/8(50%)	**?**
Parents screen time			124fk	0/1(0%)	
Short transportation mode (inactive)	124fk			1/1(100%)	
Family support			88	0/1(0%)	
Parental support			71, 124fk	0/1(0%)	
Parent's perception of their child's competence to be active	71, 88f			2/2(100%)	
Parents concern about child's level of activity			109g	0/1(0%)	
Parent(s) work status	**41**k (fulltime), **41**k (part-time), 109kf		109k, 126k, 126 (partner)	3/6(50%)	**?**
Farmworker status			109k	0/1(0%)	
Parental work-load (high)			**41**	0/1(0%)	
Teacher's/day care worker education	50 (outside)		25	1/2(50%)	
Teachers PA/day care worker training	94f		25	1/2(50%)	
Teacher/day care worker PA			25	0/1(0%)	
Limits on screen time			109g	0/1(0%)	
Promote inactivity			115	0/1(0%)	
Psychological concern			115	0/1(0%)	
Home ownership (renting)			124f	0/1(0%)	
PA related indoor rules			124f	0/1(0%)	
Play in garden			124f	0/1(0%)	
Restrict computer use			124f	0/1(0%)	
Restrict TV watching			124f	0/1(0%)	
Restrict playing outside			124f	0/1(0%)	
Barriers to PA			124f	0/1(0%)	
Smoking in house hold			126	0/1(0%)	
Rain days			117g (preschool)	0/1(0%)	
Free time (childcare)		50 (child care)		1/1(100%)	
Role modelling of PA			118g	0/1(0%)	
Physical environmental variables					
Attend nursery/kindergarten/ children's center/preschool	21 (MPA), 111f		21 (VPA), 109k, 126g	2/5(40%)	**?**

Time outdoors/in play spaces	90, 109g	50 (child care)	4fhi (model4), 25, 109g	2/6(33%)	**0**
Play equipment at home	88		109g, 118g	1/3(33%)	
Distance to park (miles)		88f		1/1(100%)	
Attend/go to a park			88	0/1(0%)	
Use of space in child care for motor activities	94f			1/1(100%)	
Supervised school trips			117(preschool)	0/1(0%)	
Time using playground			117(preschool)	0/1(0%)	
Natural outdoor surface		94f		1/1(100%)	
Season	95 (summer), 111f, 124f (spring)	126f (winter)	53 (%VPA), 109k, 124f (autumn), 124f (summer)	3/8(38%)	**?**
Region of country	**41**		117g (preschool)	1/1(100%)	
Size of playground	25		94f, 117 (preschool)	1/3(33%)	
Access from playground to preschool building (no. of accessible building sides to playground)	117f (preschool)			1/1(100%)	
Childcare outside vegetation			94f	0/1(0%)	
Gradient of outdoor space			94f	0/1(0%)	
Home has enclosed play space			109g	0/1(0%)	
Childcare SHADE in outdoor space			94f	0/1(0%)	
Size of childcare center			94f	0/1(0%)	
Perceived environment and neighborhood opportunities to play			4fhi (model4)	0/1(0%)	
Preschool			117g	0/1(0%)	
Weekday versus weekend (weekday)	10, 122		28, 43, 111f, 126	2/6(33%)	**?**
Time of day (afternoon)	117g (preschool)		28, 93	1/3(33%)	
Use of balls and objects (preschool outside)	23f			1/1(100%)	
Preschool-PE classes	9			1/1(100%)	
Area indoor per child	117f (preschool)			1/1(100%)	
Childcare physical activity promoting polices	25f			1/1(100%)	
Open space outside at	23f			1/1(100%)	

preschool				
Fixed equipment outside at preschool	23f, 94f	25		2/3(67%)
Wheel toys outside at preschool			23f	0/1(0%)
Playing one-to-one with peers	23f			1/1(100%)
No. field trips in childcare	50		25	1/2(50%)
No. community organized visits			25	0/1(0%)
No. children per classroom			25, 50	0/2(0%)
Playing in a group without an adult	23f			1/1(100%)
Playing solitary at preschool	23f			1/1(100%)
Children initiator of activities	23f			1/1(100%)
No. portable playground equipment	25			1/1(100%)
Childcare: portable play environment			130	0/0(0%)
Childcare ITEMS - portable jumping equipment	29 (indoor)			1/1(100%)
Childcare ITEMS - push-pull toys	29 (indoor)		29 (outdoor)	1/2(50%)
Childcare ITEMS - slides (portable)	29 (indoor)			1/1(100%)
Childcare ITEMS - slides (Fixed)	29 (indoor), 29 (outdoor)			2/2(100%)
Childcare ITEMS - fixed balancing surfaces	29 (indoor)		29 (outdoor)	1/2(50%)
Childcare ITEMS - riding toys (portable)		29 (indoor)	29 (outdoor)	1/2(50%)
Childcare ITEMS - sand/water toys (portable)		29 (indoor)		1/1(100%)
Childcare ITEMS - balls			29 (indoor), 29 (outdoor)	0/2(0%)
Childcare ITEMS - portable climbing structures			29 (indoor), 29 (outdoor)	0/2(0%)
Childcare ITEMS - floor play equipment			29 (indoor), 29 (outdoor)	0/2(0%)
Childcare ITEMS – twirling equipment			29 (indoor), 29 (outdoor)	0/2(0%)

Childcare ITEMS - fixed structured track	29 (outdoor)		29 (indoor)	1/2(50%)	
Childcare ITEMS - merry-go-around			29 (indoor), 29 (outdoor)	0/2(0%)	
Childcare ITEMS - fixed climbing structures	29 (outdoor)		29 (indoor)	1/2(50%)	
Childcare ITEMS - see saw			29 (indoor), 29 (outdoor)	0/2(0%)	
Childcare ITEMS - fixed tunnels	29 (outdoor)		29 (indoor)	1/2(50%)	
Childcare ITEMS - sand box	29 (outdoor)		29 (indoor), 29 (outdoor)	1/3(33%)	
Childcare ITEMS - jumping equipment	29 (outdoor)			1/1(100%)	
Childcare ITEMS - swinging equipment			29 (indoor), 29 (outdoor)	0/2(0%)	
Childcare - portable play environment	36g		117g (preschool)	1/1(100%)	
Childcare - fixed play environment		36g	117g (preschool), 117f (preschool sport equipment)	1/3(33%)	
Childcare - active opportunities	36g			1/1(100%)	
Childcare: sedentary opportunities			130	0/0(0%)	
Staff - child ratio (low level)	94f			1/1(100%)	
Preschool: PA rooms			117(preschool)	0/1(0%)	
Preschool open space			117(preschool)	0/1(0%)	
Vegetation on preschool grounds		118g (preschool)		1/1(100%)	
Preschool hilly landscape			117 (preschool)	0/1(0%)	
Childcare - support from community organizations			50	0/1(0%)	
Childcare/preschool overall quality			5	0/1(0%)	
Childcare - computer use			50, 117 (preschool)	0/1(0%)	
Individual preschool/childcare	53 (%VPA), 57f, 86f		50	3/4(75%)	+
Street traffic makes it difficult to walk			109g	0/1(0%)	
Dogs allowed to run loose			109g	0/1(0%)	
Parental safety concerns			115	0/1(0%)	

Preschool educational leader enjoyment of PA			117 (preschool)	0/1(0%)
Preschool educational leader PA education level			117g (preschool)	0/1(0%)
Preschool educational leader meet PA guidelines (>30MVPA min per day)			117 (preschool)	0/1(0%)
Preschool staff enjoyment of PA			117 (preschool)	0/1(0%)
Preschool staff education level			117 (preschool)	0/1(0%)
Preschool staff meet PA guidelines (>30MVPA min per day)			117 (preschool)	0/1(0%)
Preschool staff sex (male)			117 (preschool)	0/1(0%)
Preschool staff young assistants			117 (preschool)	0/1(0%)
Preschool staff initiate PA			117 (preschool)	0/1(0%)
Staff behaviors			130	0/0(0%)
Environmental barriers			124f	0/1(0%)
Road safety concern			124f	0/1(0%)
Park availability			124f	0/1(0%)
Neighborhood children to play with		124fh	124fi	1/2(50%)
Playing outside versus inside	125h		125i	1/2(50%)
Environment and Policy Assessment and Observation (EPAO) Total score			130	0/0(0%)

[a]Summary code is an overall summary of finding for each variable.
[b]N=number of times reported associations between the variable and physical activity; n=number of times supporting the direction of the hypothesized association. N=total number of times variables has been investigated
[c]Percentage % of studies finding an association.
[d]Association shows the direction of the individual/summary association (+/-/?/0) – codes in bold are the final result for each correlate.
[e]Additional coding for studies that scored a high quality rating (++/--/oo/?) – codes in bold are the final result for each correlate.
[f]Reported in a multivariate analysis.
[g]Reported in a multivariate and univariate analysis.
[h]Association for boys only.
[i]Association for girls only.
[j]Paternal behavior.
[k]Maternal behavior.
MPA, moderate physical activity; VPA, vigorous physical activity; N in Bold = High quality studies

Appendix 6. Full Summary of Potential Determinants for Moderate- to Vigorous-Intensity Physical Activity

	Related to physical activity		Unrelated to physical activity	Summary code[a]	
	Positive association	Negative association	No association		
Determinant variables	**Reference no.**	**Reference no.**	**Reference no.**	**n/N[b] for row (%)[c]**	**Association [d]**
Demographic and biological variables					
Sex (male)	**40**	116f		1/2(50%)	**?**
Ethnicity (white)			116f	0/1(0%)	**0**
Parents education (degree)			116fk	0/0(0%)	**0**
Adiposity			**40**	0/1(0%)	**0**
BMI			116f	0/1(0%)	**0**
Aerobic fitness			**40**	0/1(0%)	**0**
Gross motor-skill performance			**40**	0/1(0%)	**0**
Physical environmental variables					
Hours spent at preschool			116f	0/1(0%)	**0**

[a]Summary Code is an overall summary of finding for each variable
[b]N=number of times reported associations between the variable and physical activity; n=number of times supporting the direction of the hypothesized association. N=total number of times variables has been investigated
[c]Percentage % of studies finding an association
[d]Association shows the direction of the individual/summary association (+/-/?/0) – codes in bold are the final result for each correlate
[f]Reported in a multivariate analysis
[g]Reported in a multivariate and univariate analysis
[h]Association for boys only
[i]Association for girls only
[j]Paternal behavior
[k]Maternal behavior
MPA, moderate physical activity; VPA, vigorous physical activity; N in Bold, High quality studies

Appendix 7. Full Summary of Potential Correlates for Light Intensity Physical Activity

	Related to physical activity		Unrelated to physical activity	Summary code[a]		Additional coding for high quality studies [e]
	Positive association	Negative association	No association			
Determinant variables	**Reference no.**	**Reference no.**	**Reference no.**	**n/N[b] for row (%)[c]**	**Association [d]**	
Demographic and biological variables						
Age	108	86		1/2(50%)		
Sex (male)	21, 24, 78, 114, 127		14, 26, 81, 86, 96, 111f, 113, 120, 124f	5/14(35%)	**?**	
Ethnicity (white)			86	0/1(0%)		
Adiposity			24f (% body fat), 24f (fat-free mass), 24f (trunk fat mass index)	0/3(0%)		
BMI (normal weight)			68, 76, 82, 111f, 120, 124f	0/6(0%)	**0**	
Plantar pressures			77	0/1(0%)		
Gross motor-skill performance	55, 114h	9	114i	2/3(67%)		
Skills related to fitness			96	0/1(0%)		
Functional constipation		107g (4years)	107g (3years)	1/2(50%)		
Parents education			14, 86, 111fk, 124fk	0/4(0%)	**0**	
Parents age			124fk	0/1(0%)		
Parents BMI			124fk	0/1(0%)		
Younger siblings			124f	0/1(0%)		
Older siblings			124f	0/1(0%)		
Psychological, cognitive and emotional variables						
Enjoyment of PA			124f	0/1(0%)		
Restless			124f	0/1(0%)		
Well behaved			124f	0/1(0%)		
Behavioral variables						
TV viewing			49	0/1(0%)		
Bedtime			124f	0/1(0%)		
Social and cultural variables						
Parental PA/familial interaction	109fk, 124fk			2/2(100%)		
Cost of sports clubs as a barrier			115	1/1(100%)		
Parental safety concerns			115	0/1(0%)		
Parents promote inactivity			115	0/1(0%)		
Parents promote screen time		115		1/1(100%)		
Parental psychological control			115	0/1(0%)		
Home ownership			124f	0/1(0%)		
Parents screen use			124f	0/1(0%)		

Parental support		115, 124fk	0/2(0%)
Short transportation mode		124f	0/1(0%)
TV at mealtimes		124f	0/1(0%)
Snack at TV		124f	0/1(0%)
PA-related indoor rules		124f	0/1(0%)
Play in garden		124f	0/1(0%)
Restrict computer use		124f	0/1(0%)
Restrict TV watching		124f	0/1(0%)
Restrict playing outside		124f	0/1(0%)
General PA barriers		124f	0/1(0%)
Physical environmental variables			
Time outdoors/ in play spaces		115	0/1(0%)
Attend nursery/kindergarten/ children's center/preschool	21	111f	1/2(50%)
Season (summer)		111f, 124f	0/2(0%)
Weekday versus weekend (weekday)		111f	0/1(0%)
Availability of toys		115 (outdoor toys)	0/1(0%)
Hours spent in preschool		116f	0/1(0%)
Environment mental barriers		124f	0/1(0%)
Concern about road safety		124f	0/1(0%)
Park play availability		124f	0/1(0%)
Other children to play with in the neighborhood		124f	0/1(0%)

[a]Summary code is an overall summary of finding for each variable.
[b]N=number of studies that have investigated and reported on possible associations between the variable and physical activity; n=number of studies that report support for the direction of the hypothesized association.
[c]Percentage % of studies finding an association.
[d]Association shows the direction of the individual/summary association (+/-/?/0) – codes in bold are the final result for each correlate.
[f]Reported in a multivariate analysis.
[g]Reported in a multivariate and univariate analysis.
[h]Association for boys only.
[i]Association for girls only.
[j]Paternal behavior.
[k]Maternal behavior.
* Less than 4 studies so ? is graded.

Appendix 8. Full Summary of Potential Determinants for Light Intensity Physical Activity

	Related to physical activity		Unrelated to physical activity	Summary code[a]	
	Positive association	Negative association	No association		
Determinant Variables	**Reference no.**	**Reference no.**	**Reference no.**	**n/N[b] for row (%)[c]**	**Association [d]**
Demographic and biological variables					
Sex (male)	116f			1/1(100%)	+
Ethnicity (white)			116f	0/1(0%)	**0**
Parents education (degree)			116fk	0/1(0%)	**0**
BMI			116f	0/1(0%)	**0**
Physical environmental variables					
Hours spent at preschool			116f	0/1(0%)	**0**

[a]Summary code is an overall summary of finding for each variable.
[b]N=number of times reported associations between the variable and physical activity; n=number of times supporting the direction of the hypothesized association. N=total number of times variables has been investigated.
[c]Percentage % of studies finding an association.
[d]Association shows the direction of the individual/summary association (+/-/?/0) – codes in bold are the final result for each correlate.
[f]Reported in a multivariate analysis.
[g]Reported in a multivariate and univariate analysis.
[h]Association for boys only.
[i]Association for girls only.
[j]Paternal behavior.
[k]Maternal behavior.
MPA, moderate physical activity; VPA, vigorous physical activity; N in Bold, High quality studies

Appendix 9. PUB MED- Search Strategy – Bingham et al. early years correlates review

#1 "physical activity"[All Fields]
#2 "exercise"[MeSH Terms] #3/OR "exercise"[All Fields])
#4 "play"[All Fields]
#5 "physical fitness"[All Fields]
#6 "physical inactivity" [All Fields]
#7 "sedentary"[All Fields]
#8 "sports"[MeSH Terms] #9/OR "sports"[All Fields] #10/OR "sport"[All Fields]
#11 "health behaviour"[All Fields] #12/OR "health behavior"[MeSH Terms]
#13 "motor movement"[All Fields]
#14 "child"[MeSH Terms] #15/OR "child"[All Fields]
#16 "children"[All Fields]
#17 kindergarten[All Fields]
#18 preschool[All Fields]
#19 "early years"[All Fields]
#20 "humans"[MeSH Terms]
#21 English[lang]
#22 "child, preschool"[MeSH Terms]
#23 "infant"[MeSH Terms:noexp]

Appendix 10

Author & year Today's date:
Reviewer:

Question	Yes	Not Clear	No	Further information:
Is the study published in a peer-review journal?				State Journal:
Is the study written in English?				
Is the study an **observational (cross or pro) study / baseline intervention study ?**				State the type of study:
Is the age group studied **preschool mean age<6?**				Mean age of the sample:
Do the participants **attend formal/statuary schooling** ?				
Is **physical activity** measured using quantitative methods? I.e. electronic and/or direct observation				State the primary measure applied (e.g Actigraph):
Is physical activity the main **outcome/dependant** variable?(Total PA; VPA; MVPA)				State Outcome/Dependant variable:
Are associations investigated between **physical activity** and correlates/determinants/factors?				State correlates/determinants/factors:
Are participants unable to be physically active (i.e. disabled or ill)				
Does the sample have a special need or health condition? (asthma, learning difficulties, autism etc).				If yes please state:

IF THE ANSWER TO ANY OF THE ABOVE IS SHADED BOX, EXCLUDE THE STUDY OR DISCUSS WITHIN THE REVIEW MEETING.
IF ANY ANSWERS ARE "NOT CLEAR" PLEASE DISCUSS WITHIN THE REVIEWING MEETING

This study is:	**Included**	☐	**Excluded**	☐	**Not sure**	☐
	Details:					
Other information						

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