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A Systematic Review of Methods to Measure Family Co-Participation in Physical Activity

Léonie Uijtdewilligen^{#1,*}, Helen Elizabeth Brown^{#2}, Falk Müller-Riemenschneider^{1,3}, Yee Wei Lim¹, Soren Brage², and Esther MF van Sluijs²

¹Saw Swee Hock School of Public Health, National University of Singapore, Singapore, Singapore

²UKCRC Centre for Diet and Activity Research (CEDAR) & MRC Epidemiology Unit, University of Cambridge, School of Clinical Medicine, Box 285 Institute of Metabolic Science, Cambridge Biomedical Campus, Cambridge CB2 0QQ, United Kingdom

³Institute for Social Medicine, Epidemiology and Health Economics, Charite University Medical Centre Berlin, Germany

These authors contributed equally to this work.

Abstract

The family environment is key in influencing children's health behaviours. Encouraging family co-participation in physical activity may therefore be an effective approach to increasing children's physical activity levels. Yet, little is known about how to best assess family co-participation in physical activity. This review summarizes methods to measure family co-participation in physical activity, which was defined as joint physical activities including at least 1 healthy child (0-18 years) and 1 other family member. Methods were identified through a systematic literature search, cross-referencing pre-selected reviews, and contacting research groups. Thirty-seven measurement methods were included. Questionnaires were the most common method used, with most assessing frequency of co-participation and few also assessing duration and type. Reliability and internal consistency of scales were often reported, but rarely specified for the item(s) relevant to co-participation. Other methods of measuring co-participation included diaries, event history calendars, direct observations, and accelerometry combined with diary, ecological momentary assessment, or Global Positioning Systems (GPS). Whilst a large number of measurement methods of family co-participation in physical activity exist, few are comprehensive and/or report acceptable psychometric properties. Future work should focus on reaching consensus in defining family co-participation in physical activity, and subsequently developing a reliable and valid measures.

*Corresponding author: Dr Léonie Uijtdewilligen, Saw Swee Hock School of Public Health, National University of Singapore, Tahir Foundation Building, 12 Science Drive 2, #10-01, Singapore 117549, Phone: +65 66015006, Fax: +65 6779 1489, leonie_uijtdewilligen@nuhs.edu.sg.

Conflict of interest

None to declare

Keywords

Behavioral Research; Exercise; Family Health; Public Health

Introduction

Despite the established health benefits of physical activity for children 1,2,3,4,5,6, data from several countries suggest that the majority of children are insufficiently active to enjoy these benefits 7,8. Further, levels of physical activity decline substantially throughout childhood and into adolescence 9,10. Understanding the determinants of physical activity in young people, and developing effective interventions to promote and maintain their activity levels, is therefore a public health priority 11.

The family is the primary unit of socialisation and organisation during childhood 12, and is therefore central in shaping engagement in health behaviours, including physical activity 12,13,14. There is also substantial evidence showing that parenting behaviours and family processes play a critical role in adolescent well-being 15. Family factors, such as logistical support (e.g., provision of transport or covering costs), co-participation, or encouragement, have been consistently and positively correlated with physical activity in children 11,16,17. Moreover, the addition of parent involvement (e.g. education sessions, co-participation) to school-based physical activity interventions has been found to be effective in promoting activity in children and adolescents 18.

The involvement of family members in physical activity-focused interventions may not *just* be advantageous for the targeted child. For example, recent qualitative research suggests that in addition to the potential health benefits of family physical activity, parents also valued the opportunity to enhance parent-child communication and social interactions among family members 19. Authors describing the intervention “*A Family Affair*” report that joint physical activities led to an improved daughter-mother relationship and as such, greater support for a healthier lifestyle 20. Co-participation is also a key feature of the *Healthy Dads Healthy Kids* intervention, which was shown to be effective in improving physical activity for fathers and their children 21. *Healthy Dads Healthy Kids* demonstrates that reciprocal reinforcement between parent (father) and child is particularly pertinent when adopting and refining health behaviours 22. Encouraging *co-participation* of family members (e.g., parents, siblings, other relatives) may therefore be an effective approach to increasing or maintaining children’s activity levels 11, and simultaneously improving engagement in physical activity in adults.

Given the growing interest in involving family members in the promotion of young people’s physical activity 11, an appraisal of methods to measure family co-participation in physical activity is timely and necessary. High quality exposure assessment is essential to identify causal associations with health and behavioural outcomes, to quantify the magnitude of any association, and to describe any dose-response relationships 23. Accurate measurement is also required to document patterns of, and changes in, family physical activity over time 24, and may be of particular importance for those assessing intervention effectiveness.

Therefore, the aim of this study is to provide an overview of current methods used to measure family co-participation in physical activity.

Methods

Search methods

This review was conducted and is reported according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (Supplementary File 1) 25. We identified measurement methods of family co-participation in physical activity through three different approaches: 1) a formal literature search in four electronic databases, 2) an informal, snowball search of cross-referencing pre-selected review articles 11,17,18,26,27,28,29,30,31,32,33 and 3) contacting research groups known to be conducting research into family-based physical activity. Research groups were identified by co-authors, who used their extensive networks and attendance at conferences and key meetings to select 18 groups conducting relevant research (e.g. examining correlates of child physical activity, developing/evaluating physical activity interventions in family settings etc.).

The formal literature search was performed using computerized searches in PubMed, Scopus, PsychInfo and ScienceDirect for articles published up to and including April 2017, with no limit on earliest year of release. The search strategy consisted of three elements 34: (a) construct (e.g. physical activity, exercise), (b) population (e.g. family, parent) and (c) instrument (e.g. questionnaire, observation). Terms referring to these three elements were combined with AND terms and used as title words, abstract words, and/or keywords depending on the respective electronic database. In addition, 'Motor activity', 'Sports', 'Exercise', 'Family', 'Data collection', 'Accelerometry, and 'Observation' were added as MESH headings in PubMed. As the term co-participation does not adequately fit in the search term blocks described above, a simple additional search across all databases was performed combining the terms co-participation/co-participation and physical activity (see Supplementary File 2 for the detailed search strategy). References of included papers were checked to identify further publications.

Other search methods took place between May 2015 to October 2016. References of pre-selected review articles were checked to identify further publications. Research groups were asked whether they were using one or more measurement methods of family co-participation in physical activity, and if yes, if they were able to share the following:

- A copy/description of original method(s) and scoring algorithm(s);
- Background information (how it was developed, what study it was used in, data on validity/reliability testing);
- Any publications that reported on the method.

Both published and unpublished measurement methods were eligible for inclusion. References obtained via research group contact are highlighted with an asterisk in the reference list of this paper.

Inclusion criteria

Measurement methods were included if they were described in English language references, were available in the English language (solely, or in addition to other languages) and assessed family co-participation in physical activity which was defined as ‘joint physical activities including at least 1 healthy child (aged 0-18 years) and 1 other ‘family member’ (we included all types of family, e.g. parent/guardians, siblings, cousins). Measurement methods were excluded if they referred to the assessment of family co-participation in physical activity only in very general terms but did not provide further details e.g. the methods section states that ‘frequency of family exercising with child’ was assessed, but no exact item description, and/or answer categories were provided. Qualitative methods such as interviews and focus group discussions were excluded due to their usual focus on psychological constructs such as behavioural attitudes and perceived control, rather than on the actual measurement of the behaviour at interest.

Selection process

Two independent reviewers (LU and HEB) performed title/abstract and full-text selection of articles generated from the electronic database searches (81% agreement for full-text inclusion). One reviewer (HEB) screened the references of relevant review articles, and obtained published and unpublished references from relevant research groups. These were checked for eligibility by the second reviewer (LU). Disagreements on in/exclusion of references from all sources (electronic searches, review articles, and author contact) were discussed and resolved between the two reviewers.

Data extraction

Two reviewers (LU and HB) performed data extraction for a respective half of the obtained references. For each reference, data were extracted on a) the measurement method used to assess family co-participation in physical activity (e.g., questionnaire, diary), b) a description of the item text (if relevant), or a more detailed description of the method, c) method names, response scale or outcome, and d) the study population in which the method was used. If reported, information on psychometric properties (e.g., test-retest reliability, construct validity) was also extracted. For presentation purposes, references were grouped based on the ‘dimension’ of co-participation they assessed, i.e., existence, frequency, type or duration. Methods assessing whether co-participation in physical activity generally occurred or had occurred in daily life were grouped under ‘existence’. Methods assessing how often in a given time frame (e.g., per week, per month) participant’s co-participated in physical activity, were grouped under ‘frequency’. Methods assessing co-participation in specific physical activities such as cycling or active play rather than in general physical activity, were grouped under ‘type’. Methods assessing time spent in co-participation in physical activity were grouped under ‘duration’. The primary dimension was determined depending on the available response options. If the method assessed other dimensions of co-participation, this was indicated in Table 1. Measurement methods were further grouped based on whether co-participation was assessed through the child or parent and similarity of methods (e.g., questionnaires versus accelerometry).

Results

Figure 1 provides an overview of the different search methods. In total, we identified 37 measurement methods assessing family co-participation in physical activity among 97 references. Of the 97 included references, two were considered unpublished: one conference abstract 35 and one PhD thesis 36. Both were obtained via research group contact.

Method characteristics

Measurement methods of family co-participation in physical activity are summarized and described in Table 1. Measurement methods included both subjective (N=33) and objective methods (N=4), and were primarily used in the USA and Europe (specifically in the UK). The majority of methods assessed co-participation of primary school aged children (approximate age between 5 and 11 years) and their respective family members. The most commonly used method of assessment was through questionnaire items (N=28), either child- (N=10) or parent-reported (N=18). Frequency of co-participation was assessed most often as primary dimension of co-participation in physical activity, followed by existence, type and duration. Duration of co-participation was also assessed using device-based methods including a combination of accelerometry with diary, ecological momentary assessment, and Global Positioning Systems (GPS). In addition, the type of co-participation was assessed using child- and parent-reported event history calendar, and child- and parent reported diaries and direct observation.

Psychometric properties

Methods assessing the ‘existence’ and/or ‘frequency’ of family co-participation in physical activity were mostly one- or two-item questionnaires which were part of a more comprehensive multiple-item scale, e.g. social influences scale 37, instrumental support scale 38, social support scale 39, parental social support scale 40. Reliability and internal consistency of these scales were often reported and deemed acceptable, but rarely split out for the item(s) specific to co-participation. One of the exceptions are the studies by Singh et al 41,42, which reported reliability and validity figures for both child- and parent-reported items on the frequency of co-participation. They presented an intraclass correlation coefficient (ICC) of 0.47 with 47% agreement, and an ICC of 0.80 with 73% agreement to demonstrate test-retest reliability of the child- and parent reported item, respectively. Validity against interviews for the child- and parent reported items were reported as an ICC of 0.24 with 51% agreement, and an ICC of 0.56 with 57% agreement, respectively. The factor analysis performed by Loucaides and colleagues 43 identified one specific factor for ‘parental physical activity with child’ (i.e., co-participation). They authors reported Cronbach’s alphas of .849 and .844 for weekdays and weekend days. Yet, no significant associations with pedometer-measured steps and diary-assessed time spent playing outside were found for this factor, which undermines the scale’s validity. Further, some of the ‘existence’ and ‘frequency’ measurement methods were modified from existing questionnaires, but provided references to reliability and validity information for the original format only.

Three of the seven measurement methods assessing the duration of family co-participation in physical activity used accelerometry; either in the form of identifying periods of simultaneous counts (using information provided in a complimentary activity diary), or in combination with ecological momentary assessment and GPS. To illustrate, in the case of combining accelerometry and GPS, parent-child pairs were asked to wear accelerometers for seven continuous days, and a portable GPS device was attached to the accelerometer belt with recording interval matching those of the accelerometer 44. Co-participation in physical activity among the parent-child pairs was defined as activities of the same intensity (assessed by accelerometer) that occurred at the same time and in the same location (assessed by GPS device). From this data, the average daily minutes spend in moderate-to-vigorous physical activity performed together by parent-child pairs could be calculated; i.e., reflecting the duration of co-participation. For these 'combination' methods, no explicit information on reliability or validity were reported. Regarding the four questionnaires assessing 'duration' of co-participation, only Rhodes and colleagues 45 provided test-retest ICCs from 0.25-0.59 to 0.41-0.86 at two different time points for several items, including the one assessing duration.

For three of the eight measurement methods assessing the type of family co-participation in physical activity (e.g. active travel, after school activities), information on reliability or validity was presented. Danford and Martyn 46 noted that the child- and parent-reported event history calendar they used, demonstrated good face validity and construct validity. In addition, they stated that the reliability of the event history calendar was investigated through assessing correlations between child and parent reported activities, but no further details on agreement were provided. An event history calendar is typically a tool that collects reflective data at one point in time, rather than involving daily entries. In this specific study, children and parents were asked to look back at the past 2 months and note down any physical activity they had engaged in together as a family and as such obtained information on the type of family co-participation in physical activity. Sääkslahti et al 47 assessed the inter-observer reliability of their parent-reported diary among families of 19 children and found a correlation of $r=.91$ for actively doing things together as parent and child. The authors also stated that this method was ecologically valid because 'children were able to live their normal life and seasonal variation was taken into account' [page 169]. Finally, Patterson et al 48 assessed the inter-observer reliability of direct observations of families at the zoo, which was maintained at >90% during data collection. In this particular case, direct observation of families spending time in the zoo was used as an indicator of the family's habitual physical activity whilst being together. For example, observers noted whether the family used the stairs or the elevator, and the duration of time they spent walking rather than seated.

Discussion

This review provides a comprehensive overview of methods used to measure family co-participation in physical activity, and demonstrates the heterogeneity in the constructs assessed and methodology employed. The information provided in this review may be used to inform researchers' selection of an appropriate methods to assess family co-participation in physical activity and to describe this important context-specific behaviour.

In navigating measurement methods of family co-participation in physical activity, researchers may choose to work from either a narrow definition or a slightly broader framework; each of which may have different correlates and determinants, and may be influenced via different mechanisms. We suggest a narrow definition to include engaging in physical activity directly with the child (e.g. playing together in the garden), usually as a parent-child pair. We defined co-participation as 'joint physical activities including at least 1 healthy child (aged 0-18 years) and 1 other 'family member'. This has been the target behaviour of family-based physical activity interventions such as *Healthy Dads Healthy Kids21*. A looser characterisation of co-participation may also encompass habitual family activity (e.g. active family gatherings), which may be more difficult to capture with self-reported methods, as parents and/or children may not think to include such events. Identifying the behaviour of interest, and then determining the most accurate methods of measurement, is an important challenge for researchers looking to assess family co-participation in physical activity.

As highlighted in Table 1, measurement methods are available for a variety of dimensions of family co-participation in physical activity. We included 37 different methods of four different dimensions; frequency, duration, existence, and type. Frequency of co-participatory activities was most commonly assessed exclusively via questionnaire. These measures presented acceptable levels of reliability and sometimes validity, and given how short the items are, may be appropriate for inclusion in longer questionnaires without adding to participant burden. In addition, a large number of international studies have previously used such an item, offering the possibility to compare findings between countries.

We also identified both child- and parent-reported questionnaires with *multiple* questionnaire/survey items (as compared to 1-item scales) that may offer a more precise assessment of family co-participation in physical activity. Specifically, one study exploring family-based joint activities more broadly asked children to report on a range of physical activities that they might have participated in with family members (e.g. indoor games, going for a walk, or playing sports) 49. Similarly, a few other studies asked parents to report on *how often* they/as a family engaged in any of a list of shared family activities 50,51,52,53. Such measures may help to offset some of the limitations of broad, less-precise, single-item measures. Items which provide more detailed responses may allow for a greater understanding of specific behaviours that families enjoy together.

Objective measurement of family co-participation in physical activity was relatively uncommon (less than 10% of references included for review). Increasing the use of device-based assessment may further improve the accuracy of reporting family co-participation in physical activity, and reduce the impact of social desirability bias 54. Another important advantage of device-based assessment, specifically accelerometry, is the ability to measure intensity of family co-participation in physical activity. Many of the questionnaire items we identified focused only on moderate-to-vigorous physical activity, and were not able to capture other activity intensities. This may be important, as family activities of light intensity, for example, may have alternative psychological or social health benefits. However, simply simultaneously wearing objective physical activity monitors may not be sufficient, as additional information on location and/or social context is required. One

example of this approach is identifying periods of simultaneous activity from accelerometer data using information from a supplementary diary, as was done in one study assessing family dog-walking behaviour 55. This approach also allowed the researchers to demonstrate that increases in family co-participation in physical activity led to physical activity compensation at other times, an important consideration when promoting specific types of activity.

Accelerometry has also been used alongside GPS devices to classify periods of family co-participation in physical activity, defined by a linear separation distance of less than 50m between parent and child 44,56. Issues of participant burden should be considered when combining methods of measurement; for example, researchers should look to use dual devices which track both activity and locations, or if asking participants to wear two devices, these should be placed upon the same waist-worn belt. Another recent example is a study which validated Bluetooth-enabled accelerometers against detailed time-use diaries, for the purpose of proximity tagging between parents and children and hence assessing co-participation 57,58. Other objective measurement methods used included ecological momentary assessment; electronic surveys assessed primary activity, social context, physical location, current mood, and enjoyment. This may be particularly useful for those researchers interested in understanding not only the duration or frequency of family co-participation in physical activity, but also the wider context within it occurs.

In general, we observed that most methods assessing family co-participation in physical activity do not include a definition of co-participation, or even use the word co-participation in their study. This construct seems generally overpowered by or clustered within more classical constructs such as modelling and encouragement. Subsequently, the methods used are not specifically designed to measure family co-participation in physical activity. They also often include different examples of ‘activities done together’ and hence obtain information that is difficult to compare across studies and settings, even if the same dimension, i.e., existence, frequency, duration or type is assessed. Further, there was limited information on the validity and/or reliability of measurement methods. This mirrors recent claims that there is a current lack of consensus about the best way to define, assess or apply concepts such as co-participation in physical activity and physical activity in general 59.

We therefore strongly encourage researchers to first work towards consensus in defining family co-participation in physical activity, before developing a reliable and valid measure that:

- distinguishes between existence, frequency, duration, type, and intensity of activity,
- allows respondents to report upon multiple activities,
- collects data from both the target child and relevant family members, including parents, siblings and other extended family;
- incorporates objective assessments, e.g., accelerometers in combination with an event history calendar or GPS.

For those researchers looking to use an established method of measuring family co-participation in physical activity, a combination of accelerometry and GPS devices as per the work of Dunton and colleagues may be a good option 44,45. This method allows for the recording of family members' simultaneous physical activity, and hence provides an objective measure of frequency, duration, and intensity of co-participation, in addition to information about the geographical and social context (i.e. where and with which family members). If such devices are not available to researchers or do not fit within study logistics, the inclusion of multiple-item questionnaires could be considered, capturing at least the frequency of co-participation and type of activities done. In this respect, the items used by Zaborskis et al 49 may serve as a model for other studies as they ask adolescents to list how often ('frequency') their families engage in a list of eight different activities ('type'). Researchers could refer to Corder et al 50, Ghekiere et al 51, McMinn et al 52 and O'Connor et al 53 for parent-reported equivalents. The inclusion of an additional option within such items to indicate the duration of co-participation through the e.g., reporting of minutes per week as free text, per the study of Hnatiuk et al 127, may allow researchers to even more comprehensively assess the behaviour of interest. Further, for any study using questionnaires, it would be recommended to collect data from both child and other (extended) family members similar to the ENERGY study design 77, so as to compare different perspectives of family co-participation in physical activity within family units.

In contrast, single-item methods, categorized as primarily assessing 'existence' of family co-participation in physical activity with a yes/no or disagree-agree answering format (see Table 1) may be of insufficient quality to adequately capture different dimensions of family co-participation in physical activity. Also, methods that do not distinguish between family members when asking about co-participation, e.g., items referring to 'you or another adult in your household', may not have enough distinctive value. Finally, direct observations of families may be useful when the interest is in specific activity types or locations, however they may not be regarded as representations of general family co-participation in physical activity.

Strengths and limitations

This is the first review to comprehensively summarize methods to measure family co-participation in physical activity. Its main strengths are the use of three different search strategies and the inclusion of unpublished measurement methods due to our contacts with relevant research groups. Although we employed an extensive search strategy, it is possible that relevant methods were missed in the selection process. The first in/exclusion of papers from the database searches was mostly based on the reviewers' knowledge of the literature and common sense, as the methods we were looking for are often not reported on in the title or abstract of an article. Including other, broader search terms e.g., 'instrument', 'assessment', 'method') may also have yielded additional relevant articles and thus methods, but would have likely seriously affected the specificity of the database searches, and with that the feasibility of the work. Finally, only methods that were available in the English language were included. Considering the above, we would like to invite researchers who have assessed or will be assessing family co-participation in physical activity *with different*

instruments/yielding different outcomes than those summarized in Table 1, to contact the corresponding author of this paper.

Conclusion

This review demonstrates that whilst a large number of studies use methods to measure family co-participation in physical activity, only few do so using comprehensive assessments. Most methods are not specifically designed to measure family co-participation in physical activity, and detailed information on their psychometric properties is largely lacking. Individual items in existing questionnaires, and objective assessment methods, do however measure the existence, frequency, duration, and/or type of family co-participation. Researchers can use the information provided in this review to help them to select the most appropriate measure for their study. Future work should focus on developing a comprehensive, consistent and validated overall measurement of family co-participation in physical activity, which will help improve our understanding of family-based physical activity, its contribution to all family members' activity levels, its determinants, and enable rigorous evaluation of family physical activity interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Not applicable

Abbreviations

PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
GPS	Global Positioning Systems
ICC	Intraclass Correlation Coefficient

References

1. Boreham CA, McKay HA. Physical activity in childhood and bone health. *Br J Sport Med.* 2011; 45:877–879.
2. Brown HE, Pearson N, Braithwaite RE, Brown WJ, Biddle SJ. Physical activity interventions and depression in children and adolescents: A systematic review and meta-analysis. *Sport Med.* 2013; 43:195–206.
3. Ekelund U, Luan J, Sherar LB, Esliger DW, Griew P, Cooper A. Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. *JAMA.* 2012; 307:704–712. [PubMed: 22337681]
4. Hills AP, Andersen LB, Byrne NM. Physical activity and obesity in children. *Br J Sport Med.* 2011; 45:866–870.
5. Singh AS, Uijtdewilligen L, Twisk JWR, van Mechelen W, Chinapaw MJM. Physical activity and performance at school: A systematic review of the literature including a methodological quality assessment. *Arch Pediatr Adolesc Med.* 2012; 166:49–55. [PubMed: 22213750]

6. Wilks DC, Sharp SJ, Ekelund U, et al. Objectively measured physical activity and fat mass in children: a bias-adjusted meta-analysis of prospective studies. *PLoS One*. 2011; 6:e17205. [PubMed: 21383837]
7. Andersen LB, Mota J, Die Pietro L. Update on the global pandemic of physical inactivity. *Lancet*. 2016; 388:1255–1256. [PubMed: 27475275]
8. Cooper AR, Goodman A, Page AS, et al. Objectively measured physical activity and sedentary time in youth: The International Children's Accelerometry Database (ICAD). *Int J Behav Nutr Phys Act*. 2015; 12:113. [PubMed: 26377803]
9. Dumith SC, Gigante DP, Domingues MR, Kohl HW. Physical activity change during adolescence: a systematic review and a pooled analysis. *Int J Epidemiol*. 2011; 40:685–698. [PubMed: 21245072]
10. Nader PR, Bradley RH, Houts RM, McRitchie SL, O'Brien M. Moderate-to-vigorous physical activity from ages 9 to 15 years. *JAMA*. 2008; 300:295–305. [PubMed: 18632544]
11. Brown HE, Atkin AJ, Panter J, Wong G, Chinapaw MJM, van Sluijs EMF. Family-based interventions to increase physical activity in children: A systematic review, meta-analysis and realist synthesis. *Obes Rev*. 2016; 17:345–360. [PubMed: 26756281]
12. Maccoby EE. The role of parents in the socialization of children: An historical overview. *Dev Psychol*. 1992; 28:1006–1017.
13. Kitzman-Ulrich H, Wilson DK, St George SM, Lawman H, Segal M, Fairchild A. The integration of a family systems approach for understanding youth obesity, physical activity, and dietary programs. *Clin Child Fam Psychol Rev*. 2010; 13:231–253. [PubMed: 20689989]
14. Yao CA, Rhodes RE. Parental correlates in child and adolescent physical activity: A meta-analysis. *Int J Behav Nutr Phys Act*. 2015; 12:10. [PubMed: 25890040]
15. Gavazzi SM. *Families with adolescents: Bridging the gaps between theory, research, and practice*. Springer-Verlag New York; New York: 2011. 91–109.
16. Kirby J, Levin KA, Inchley J. Parental and peer influences on physical activity among Scottish adolescents: A longitudinal study. *J Phys Act Health*. 2011; 8:785–793. [PubMed: 21832293]
17. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sport Exerc*. 2000; 32:963–975.
18. Van Sluijs EMF, McMinn AM, Griffin SJ. Effectiveness of interventions to promote physical activity in children and adolescents: Systematic review of controlled trials. *BMJ*. 2007; 335:703. [PubMed: 17884863]
19. Thompson JL, Jago R, Brockman R, Cartwright K, Page AS, Fox KR. Physically active families - de-bunking the myth? A qualitative study of family participation in physical activity. *Child Care Health Dev*. 2010; 36:265–274. [PubMed: 20047594]
20. Barr-Anderson DJ, Adams-Wynn AW, Alhassan S, Whitt-Glover MC. Culturally-appropriate, physical activity and healthy eating intervention for African American middle school-aged girls and their mothers: A feasibility pilot. *J Adolesc Fam Heal*. 2013; 6:1–25.
21. Morgan PJ, Collins CE, Plotnikoff RC, et al. The 'Healthy Dads, Healthy Kids' community randomized controlled trial: A community-based healthy lifestyle program for fathers and their children. *Prev Med (Baltim)*. 2014; 61:90–99.
22. Bandura A. The self system in reciprocal determinism. *Am Psychol*. 1978; 33:344–358.
23. Wareham NJ, Rennie KL. The assessment of physical activity in individuals and populations: Why try to be more precise about how physical activity is assessed? *Int J Obes Relat Metab Disord*. 1998; 22(Suppl 2):S30–S38.
24. Atkin A, Gorely T, Clemes SA, et al. Methods of measurement in epidemiology: Sedentary behaviour. *Int J Epidemiol*. 2012; 41:1460–1471. [PubMed: 23045206]
25. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ*. 2009; 339:b2535. [PubMed: 19622551]
26. Craggs C, Corder K, Van Sluijs EMF, Griffin SJ. Determinants of change in physical activity in children and adolescents: A systematic review. *Am J Prev Med*. 2011; 40:645–658. [PubMed: 21565658]
27. Hinkley T, Crawford D, Salmon J, Okely AD, Hesketh K. Preschool children and physical activity. A review of correlates. *Am J Prev Med*. 2008; 34:435–441. [PubMed: 18407012]

28. Van der horst K, Chinapaw MJM, Twisk JWR, van Mechelen W. A brief review on correlates of physical activity and sedentariness in youth. *Med Sci Sports Exerc.* 2007; 39:1241–1250. [PubMed: 17762356]
29. O'Connor TM, Jago R, Baranowski T. Engaging parents to increase youth physical activity. A systematic review. *Am J Prev Med.* 2009; 37:141–149. [PubMed: 19589450]
30. Salmon J, Booth ML, Phongsavan P, Murphy N, Timperio A. Promoting physical activity participation among children and adolescents. *Epidemiol Rev.* 2007; 29:144–159. [PubMed: 17556765]
31. Van Sluijs EMF, Kriemler S, McMinn AM. The effect of community and family interventions on young people's physical activity levels: A review of reviews and updated systematic review. *Br J Sport Med.* 2011; 45:914–922.
32. Sung-Chan P, Sung YW, Zhao X, Brownson RC. Family-based models for childhood-obesity intervention: A systematic review of randomized controlled trials. *Obes Rev.* 2013; 14:265–278. [PubMed: 23136914]
33. Uijtdewilligen L, Nauta J, Singh AS, Van Mechelen W, Twisk JW, van der Horst K, Chinapaw MJM. Determinants of physical activity and sedentary behaviour in young people: A review and quality synthesis of prospective studies. *Br J Sport Med.* 2011; 45:896–905.
34. Terwee CB, Jansma EP, Riphagen II, De Vet HC. Development of a methodological PubMed search filter for finding studies on measurement properties of measurement instruments. *Qual Life Res.* 2009; 18:1115–1123. [PubMed: 19711195]
35. Morgan PJ, Lubans DR, Young MD, Barnes AT, Eather N, Pollock ER. Engaging dads to increase physical activity and well-being in girls: The DADEE (Dads And Daughters Exercising and Empowered) RCT. Australian Conference of Science and Medicine in Sport/2015 ASICS Sports Medicine Australia Conference. *J Sci Med Sport.* 2015; 19:e11. *
36. Hnatiuk J. Understanding young children's physical activity [dissertation]. Melbourne (VIC): Deakin University Melbourne; 2015. *
37. Saunders RP, Pate RR, Felton G, et al. Development of questionnaires to measure psychosocial influences on children's physical activity. *Prev Med.* 1997; 26:241–247. [PubMed: 9085394]
38. Siceloff ER, Wilson DK, Van Horn L. A longitudinal study of the effects of instrumental and emotional social support on physical activity in underserved adolescents in the ACT trial. *Ann Behav Med.* 2014; 48:71–79. [PubMed: 24327135]
39. Reis RS, Sallis JF. Validade e reprodutibilidade da versão brasileira da escala se suporte social para o exercício em adolescentes [Reliability and validity of the Brazilian version of social support for exercise scale for adolescents]. *R brasCi e Mov.* 2005; 13:7–13.
40. Duncan SC, Duncan TE, Strycker LA, Chaumeton NR. A cohort-sequential latent growth model of physical activity from ages 12 to 17 years. *Ann Behav Med.* 2007; 33:80–89. [PubMed: 17291173]
41. Singh AS, Chinapaw MJM, Uijtdewilligen L, et al. Test-retest reliability and construct validity of the ENERGY-parent questionnaire on parenting practices, energy balance-related behaviours and their potential behavioural determinants: the ENERGY-project. *BMC Res Notes.* 2012; 5:434. [PubMed: 22888983]
42. Singh AS, Vik FN, Chinapaw MJM, et al. Test-retest reliability and construct validity of the ENERGY-child questionnaire on energy balance-related behaviours and their potential determinants: the ENERGY-project. *Int J Behav Nutr Phys Act.* 2011; 8:136. [PubMed: 22152048]
43. Loucaides CA, Tsangaridou N. Associations between parental and friend social support and children's physical activity and time spent outside playing. *Int J Pediatr.* 2017; 2017 7582398.
44. Dunton GF, Liao Y, Almanza E, et al. Joint physical activity and sedentary behavior in parent-child pairs. *Med Sci Sports Exerc.* 2012; 44:1473–1480. [PubMed: 22367744]
45. Rhodes RE, Naylor PJ, McKay HA. Pilot study of a family physical activity planning intervention among parents and their children. *J Behav Med.* 2010; 33:91–100. [PubMed: 19937106]
46. Danford CA, Martyn KK. Exploring eating and activity behaviors with parent-child dyads using Event History Calendars. *J Fam Nurs.* 2013; 19:375–398. [PubMed: 23783521]
47. Sääkslahti A, Numminen P, Salo P, Tuominen J, Helenius H, Välimäki I. Effects of a three-year intervention on children's physical activity from age 4 to 7. *Pediatr Exerc Sci.* 2004; 16:167–180.

48. Patterson TL, Sallis JF, Nader PR, et al. Direct observation of physical activity and dietary behaviors in a structured environment: Effects of a family-based health promotion program. *J Behav Med.* 1988; 11:447–458. [PubMed: 3070048]
49. Zaborskis A, Zemaitiene N, Borup I, Kuntsche E, Moreno C. Family joint activities in a cross-national perspective. *BMC Public Health.* 2007; 7:94. [PubMed: 17537247]
50. Corder K, Craggs C, Jones AP, Ekelund U, Griffin SJ, van Sluijs EMF. Predictors of change differ for moderate and vigorous intensity physical activity and for weekdays and weekends: a longitudinal analysis. *Int J Behav Nutr Phys Act.* 2013; 10:69. [PubMed: 23714688]
51. Ghekiere A, Carver A, Veitch J, Salmon J, Deforche B, Timperio A. Does parental accompaniment when walking or cycling moderate the association between physical neighbourhood environment and active transport among 10–12 year olds? *J Sci Med Sport.* 2015; 19:149–153. *. [PubMed: 25661722]
52. McMinn AM, Griffin SJ, Jones AP, Van Sluijs EMF. Family and home influences on children's after-school and weekend physical activity. *Eur J Public Health.* 2013; 23:805–810. *. [PubMed: 23172732]
53. O'Connor TM, Cerin E, Hughes SO, et al. Psychometrics of the preschooler physical activity parenting practices instrument among a Latino sample. *Int J Behav Nutr Phys Act.* 2014; 11:3. [PubMed: 24428935]
54. Reilly JJ, Penpraze V, Hislop J, Davies G, Grant S, Paton JY. Objective measurement of physical activity and sedentary behaviour: Review with new data. *Arch Dis Child.* 2008; 93:614–619. [PubMed: 18305072]
55. Morrison R, Reilly JJ, Penpraze V, et al. Children, parents, and pets exercising together (CPET) randomised controlled trial: Study rationale, design, and methods. *BMC Public Health.* 2012; 12:208. [PubMed: 22429665]
56. Dunton GF, Liao Y, Almanza E, Jerrett M, Spruijt-Metz D, Pentz MA. Locations of joint physical activity in parent-child pairs based on accelerometer and GPS monitoring. *Ann Behav Med.* 2013; 45(Suppl 1):S162–S172. [PubMed: 23011914]
57. Dunton GF, Liao Y, Intille S, Wolch J, Pentz MA. Physical and social contextual influences on children's leisure-time physical activity: an ecological momentary assessment study. *J Phys Act Health.* 2011; 8(Suppl 1):S103–S108. [PubMed: 21350250]
58. Dunton GF, Whalen CK, Jamner LD, Floro JN. Mapping the social and physical contexts of physical activity across adolescence using ecological momentary assessment. *Ann Behav Med.* 2007; 34:144–153. [PubMed: 17927553]
59. Kelly P. Reframing the measurement of physical activity. Proceedings of the 14th International Society of Behavioral Nutrition and Physical Activity meeting; Edinburgh (United Kingdom). 2015. 14
60. Fermino RC, Rech CR, Hino AA, Rodriguez Añez CR, Reis RS. Physical activity and associated factors in high-school adolescents in Southern Brazil. *Rev Saude Publica.* 2010; 44:986–995. [PubMed: 21107498]
61. Huang Y-J, Wong SH, Salmon J, Hui SS. Reliability and validity of psychosocial and environmental correlates measures of physical activity and screen-based behaviors among Chinese children in Hong Kong. *Int J Behav Nutr Phys Act.* 2011; 8:16. [PubMed: 21385418]
62. Pate RR, Trost SG, Felton GM, Ward DS, Dowda M, Saunders R. Correlates of physical activity behavior in rural youth. *Res Q Exerc Sport.* 1997; 68:241–248. [PubMed: 9294878]
63. Jacobson D, Melnyk BM. A primary care healthy choices intervention program for overweight and obese school-age children and their parents. *J Pediatr Heal Care.* 2012; 26:126–138.
64. Jago R, Fox KR, Page AS, Brockman R, Thompson JL. Development of scales to assess children's perceptions of friend and parental influences on physical activity. *Int J Behav Nutr Phys Act.* 2009; 6:67. [PubMed: 19821970]
65. Davison KK, Cutting TM, Birch LL. Parent's activity-related parenting practices predict girls' physical activity. *Med Sci Sports Exerc.* 2003; 35:1589–1595. [PubMed: 12972881]
66. Davison KK. Activity-related support from parents, peers and siblings and adolescents' physical activity: are there gender differences? *J Phys Act Health.* 2004; 1:363–376. *.

67. Lampard AM, Nishi A, Baskin ML, Carson TL, Davison KK. The Activity Support Scale for Multiple Groups (ACTS-MG): Child-reported physical activity parenting in African American and non-Hispanic white families. *Behav Med*. 2016; 42:112–119. [PubMed: 25350515]
68. Davison KK, Jago R. Change in parent and peer support across ages 9 to 15 yr and adolescent girls' physical activity. *Med Sci Sports Exerc*. 2009; 41:1816–1825. *. [PubMed: 19657287]
69. Barnes AT, Plotnikoff RC, C C, Morgan PJ. Maternal correlates of objectively measured physical activity in girls. *Matern Child Health J*. 2015; 19:2348–2357. [PubMed: 26092328]
70. Hinkley T, Salmon J, Okely AD, Crawford D, Hesketh K. The HAPPY Study: Development and reliability of a parent survey to assess correlates of preschool children's physical activity. *J Sci Med Sport*. 2012; 15:407–417. *. [PubMed: 22480665]
71. De La Haye K, De Heer HD, Wilkinson AV, Koehly LM. Predictors of parent-child relationships that support physical activity in Mexican-American families. *J Behav Med*. 2014; 37:234–244. [PubMed: 23203139]
72. Hume C, Ball K, Salmon J. Development and reliability of a self-report questionnaire to examine children's perceptions of the physical activity environment at home and in the neighbourhood. *Int J Behav Nutr Phys Act*. 2006; 3:16. [PubMed: 16846519]
73. Verloigne M, Cardon G, DC M, D'Haese S, De Bourdeaudhuij I. Mediating effects of self-efficacy, benefits and barriers on the association between peer and parental factors and physical activity among adolescent girls with a lower educational level. *PLoS One*. 2016; 11:e0157216. [PubMed: 27309847]
74. Garcia-Cervantes L, D'Haese S, Izquierdo-Gomes R, et al. Physical activity co-participation and independent mobility as correlates of objectively measured non-school physical activity in different school grades. The UP&DOWN Study. *J Phys Act Health*. 2016; 13:747–753. [PubMed: 26900750]
75. Brunet J, Sabiston CM, O'Loughlin J, et al. Perceived parental social support and moderate-to-vigorous physical activity in children at risk of obesity. *Res Q Exerc Sport*. 2014; 85:198–207. [PubMed: 25098015]
76. Rebholz CE, Chinapaw MJM, van Stralen MM, et al. Agreement between parent and child report on parental practices regarding dietary, physical activity and sedentary behaviours: The ENERGY cross-sectional survey. *BMC Public Health*. 2014; 14:918. [PubMed: 25190541]
77. Van Stralen MM, te Velde SJ, Singh AS, et al. European Energy balance Research to prevent excessive weight Gain among Youth (ENERGY) project: Design and methodology of the ENERGY cross-sectional survey. *BMC Public Health*. 2011; 11:65. [PubMed: 21281466]
78. Ommundsen Y, Page A, Ku PW, Cooper AR. Cross-cultural, age and gender validation of a computerised questionnaire measuring personal, social and environmental associations with children's physical activity: The European Youth Heart Study. *Int J Behav Nutr Phys Act*. 2008; 5:29. [PubMed: 18489736]
79. Pirasteh A, Hidarnia A, Asghari A, Faghihzadeh S, Ghofranipour F. Development and validation of psychosocial determinants measures of physical activity among Iranian adolescent girls. *BMC Public Health*. 2008; 8:150. [PubMed: 18462488]
80. Atkin A, Corder K, Ekelund U, Wijndaele K, Griffin SJ, van Sluijs EMF. Determinants of change in children's sedentary time. *PLoS One*. 2013; 8:e67627. [PubMed: 23840753]
81. Morrissey JL, Janz KF, Letuchy EM, Francis SL, Levy SM. The effect of family and friend support on physical activity through adolescence: A longitudinal study. *Int J Behav Nutr Phys Act*. 2015; 12:103. [PubMed: 26289232]
82. Dowda M, Dishman RK, Pfeiffer KA, Pate RR. Family support for physical activity in girls from 8th to 12th grade in South Carolina. *Prev Med*. 2007; 44:153–159. [PubMed: 17157371]
83. Duncan SC, Duncan TE, Strycker LA. Sources and types of social support in youth physical activity. *Heal Psychol*. 2005; 24:3–10.
84. Saunders RP, Moti RW, Dowda M, Dishman RK, Pate RR. Comparison of social variables for understanding physical activity in adolescent girls. *Am J Heal Behav*. 2004; 28:426–437.
85. Sallis JF, Grossman RM, Pinski RB, Patterson TL, Nader PR. The development of scales to measure social support for diet and exercise behaviors. *Prev Med (Baltim)*. 1987; 16:825–836.

86. Barr-Anderson DJ, Robinson-O'Brien R, Haines J, Hannan P, Neumark-Sztainer D. Parental report versus child perception of familial support: Which is more associated with child physical activity and television use? *J Phys Act Health*. 2011; 76:1358–1375.
87. Baskin ML, Thind H, Affuso O, Gary LC, LaGory M, Hwang SS. Predictors of moderate-to-vigorous physical activity (MVPA) in African American young adolescents. *Ann Behav Med*. 2013; 45(Suppl 1):S142–S150. [PubMed: 23334766]
88. Prochaska JJ, Rodgers MW, Sallis JF. Association of parent and peer support with adolescent physical activity. *Res Q Exerc Sport*. 2002; 73:206–210. [PubMed: 12092896]
89. Sallis JF, Alcaraz JE, McKenzie TL, Hovell MF. Predictors of change in children's physical activity over 20 months: Variations by gender and level of adiposity. *Am J Prev Med*. 1999; 16:222–229. [PubMed: 10198662]
90. Morrissey JL, Wenthe PJ, Letuchy EM, Levy SM, Janz KF. Specific types of family support and adolescent non-school physical activity levels. *Pediatr Exerc Sci*. 2012; 24:333–346. [PubMed: 22971551]
91. Määttä S, Ray C, Roos E. Associations of parental influence and 10-11-year-old children's physical activity: Are they mediated by children's perceived competence and attraction to physical activity? *Scand J Public Health*. 2013; 42:45–51. [PubMed: 24026356]
92. Anderssen N, Jacobs DR JR, Aas H, Jakobsen R. Do adolescents and parents report each other's physical activity accurately? *Scand J Med Sci Sport*. 1995; 5:302–307.
93. Cleland V, Timperio A, Salmon J, Hume C, Telford A, Crawford D. A longitudinal study of the family physical activity environment and physical activity among youth. *Am J Heal Promot*. 2011; 25:159–167.
94. Timperio A, Salmon J, Ball K, et al. Family physical activity and sedentary environments and weight change in children. *Int J Pediatr Obes*. 2008; 3:160–167. *. [PubMed: 19086186]
95. Crawford D, Cleland V, Timperio A, et al. The longitudinal influence of home and neighbourhood environments on children's body mass index and physical activity over 5 years: The CLAN study. *Int J Obes*. 2010; 34:1177–1187.
96. Dowda M, Pfeiffer KA, Brown WH, Hitchell JA, Byun W, Pate RR. Parental and environmental correlates of physical activity of children attending preschool. *Arch Pediatr Adolesc Med*. 2011; 165:939–944. [PubMed: 21646573]
97. McMinn AM, van Sluijs EMF, Harvey NC, et al. Validation of a maternal questionnaire on correlates of physical activity in preschool children. *Int J Behav Nutr Phys Act*. 2009; 6:81. [PubMed: 19954524]
98. Schoeppe S, Trost SG. Maternal and paternal support for physical activity and healthy eating in preschool children : a cross-sectional study. *BMC Public Health*. 2015; 15:971. [PubMed: 26415527]
99. Sallis JF, Alcaraz JE, McKenzie TL, Hovell MF, Kolody B, Nader PR. Parental behavior in relation to physical activity and fitness in 9- year-old children. *Am J Dis Child*. 1992; 146:1383–1388. [PubMed: 1415081]
100. Trost SG, Sallis JF, Pate RR, Freedson PS, Taylor WC, Dowda M. Evaluating a model of parental influence on youth physical activity. *Am J Prev Med*. 2003; 25:277–282. [PubMed: 14580627]
101. Trost SG, Tang R, Loprinzi PD. Feasibility and efficacy of a church-based intervention to promote physical activity in children. *J Phys Act Heal*. 2009; 6:741–749.
102. Tandon PS, Zhou C, Sallis JF, Cain KL, Frank LD, Saelens BE. Home environment relationships with children's physical activity, sedentary time, and screen time by socioeconomic status. *Int J Behav Nutr Phys Act*. 2012; 9:88. [PubMed: 22835155]
103. Hnatiuk JA, Hesketh KR, van Sluijs EMF. Correlates of home and neighbourhood-based physical activity in UK 3–4-year-old children. *Eur J Public Health*. 2016; 26:947–953. [PubMed: 27175002]
104. Barnett L, Hinkley T, Okely AD, Salmon J. Child, family and environmental correlates of children's motor skill proficiency. *J Sci Med Sport*. 2013; 16:332–336. [PubMed: 23020935]
105. VanderPloeg KA, Kuhle S, Maximova K, McGavock J, Wu B, Veugelers PJ. The importance of parental beliefs and support for pedometer-measured physical activity on school days an

106. VanderPloeg KA, Maximova K, Kuhle S, Simen-Kapeu A, Veugelers PJ. The importance of parental beliefs and support for physical activity and body weights of children: A population-based analysis. *Can J Public Heal.* 2012; 103:277–281.
107. Timperio AF, van Stralen MM, Brug J, et al. Direct and indirect associations between the family physical activity environment and sports participation among 10-12 year- old European children: Testing the EnRG framework in the ENERGY project. *Int J Behav Nutr Phys Act.* 2013; 10:15. [PubMed: 23374374]
108. Gattshall ML, Shoup JA, Marshall JA, Crane LA, Estabrooks PA. Validation of a survey instrument to assess home environments for physical activity and healthy eating in overweight children. *Int J Behav Nutr Phys Act.* 2008; 5:3. [PubMed: 18190709]
109. Ihmels MA, Welk GJ, Eisenmann JC, Nusser SM. Development and preliminary validation of a Family Nutrition and Physical Activity (FNPA) screening tool. *Int J Behav Nutr Phys Act.* 2009; 6:14. [PubMed: 19284631]
110. Ihmels MA, Welk GJ, Eisenmann JC, Nusser SM, Myers EF. Prediction of BMI change in young children with the family nutrition and physical activity (FNPA) screening tool. *Ann Behav Med.* 2009; 38:60–68. [PubMed: 19806417]
111. Fisher A, Saxton J, Hill C, Webber L, Purslow L, Wardle J. Psychosocial correlates of objectively measured physical activity in children. *Eur J Public Heal.* 2011; 21:145–150.
112. Barnes AT, Plotnikoff RC, Collins CE, Morgan PJ. Feasibility and preliminary efficacy of the MADE4Life program: A pilot randomized controlled trial. *J Phys Act Heal.* 2015; 12:1378–1393. *.
113. Lloyd AB, Lubans DR, Plotnikoff RC, Morgan PJ. Paternal lifestyle-related parenting practices mediate changes in children’s dietary and physical activity behaviours: Findings from the Healthy Dads Healthy Kids community randomized controlled trial. *J Phys Act Heal.* 2015; 12:1327–1335. *.
114. Bélanger-Gravel A, Gauvin L, Lagarde F, Laferté M. Correlates and moderators of physical activity in parent-tween dyads: A socio-ecological perspective. *Public Health.* 2015; 129:1218–1223. [PubMed: 26169685]
115. Alderman BL, Benham-Deal TB, Jenkins JM. Change in parental influence children’s physical activity over time. *J Phys Act Health.* 2010; 7:60–67. [PubMed: 20231756]
116. Heitzler CD, Martin SL, Duke J, Huhman M. Correlates of physical activity in a national sample of children aged 9-13 years. *Prev Med.* 2006; 42:254–260. [PubMed: 16490241]
117. Hennessy E, Hughes SO, Goldberg JP, Hyatt RR, Economos CD. Parent-child interactions and objectively measured child physical activity: a cross-sectional study. *Int J Behav Nutr Phys Act.* 2010; 7:71. [PubMed: 20929570]
118. O’Connor TM, Chen T-AA, Baranowski J, Thompson D, Baranowski T. Physical activity and screen-media-related parenting practices have different associations with children’s objectively measured physical activity. *Child Obes.* 2013; 9:446–453. [PubMed: 24028564]
119. Edwardson CL, Gorely T. Activity-related parenting practices and children’s objectively measured physical activity. *Pediatr Exerc Sci.* 2010; 22:105–113. [PubMed: 20332544]
120. Rutten C, Boen F, Seghers J. The relation between environmental factors and pedometer-determined physical activity in children: the mediating role of autonomous motivation. *Pediatr Exerc Sci.* 2013; 25:273–287. [PubMed: 23505004]
121. Hendrie GA, Coveney J, Cox DN. Factor analysis shows association between family activity environment and children’s health behaviour. *Aust N Z J Public Heal.* 2011; 35:524–529.
122. Hendrie GA, Coveney J, Cox DN. Defining the complexity of childhood obesity and related behaviours within the family environment using structural equation modelling. *Public Health Nutr.* 2012; 15:48–57. [PubMed: 21806870]
123. Moreno JP, Kelley ML, Landry DN, et al. Development and validation of the Family Health Behavior Scale. *Int J Pediatr Obes.* 2011; 6:e480–e486. [PubMed: 21615229]
124. Sosa ET, Parra-Medina D, He M, Trummer V, Yin Z. ¡Miranos! (Look at Us! We Are Healthy!): Home-Based and Parent Peer-Led Childhood Obesity Prevention. *Health Promot Pract.* 2016; 17:675–681. [PubMed: 26895848]

125. Larson NI, Wall MM, Story MT, Neumark-Sztainer DR. Home/family, peer, school, and neighborhood correlates of obesity in adolescents. *Obes (Silver Spring)*. 2013; 21:1858–1869.
126. Hnatiuk J, Salmon J, Campbell KJ, Ridgers ND, Hesketh KD. Early childhood predictors of toddlers' physical activity: longitudinal findings from the Melbourne InFANT Program. *Int J Behav Nutr Phys Act*. 2013; 10:123. *. [PubMed: 24188589]
127. Hnatiuk JA, Ridgers ND, Salmon J, Hesketh KD. Maternal correlates of young children's physical activity across periods of the day. *J Sci Med Sport*. 2015; 20:178–183.
128. Carver A, Panter JR, Jones AP, van Sluijs EMF. Independent mobility on the journey to school: A joint cross-sectional and prospective exploration of social and physical environmental influences. *J Transp Heal*. 2014; 1:25–32.
129. Sherwood NE, Levy RL, Langer SL, et al. Healthy Homes/Healthy Kids: A randomized trial of a pediatric primary care-based obesity prevention intervention for at-risk 5-10 year olds. *Contemp Clin Trials*. 2013; 36:228–243. [PubMed: 23816490]
130. Pearce M, Page AS, Griffin TP, Cooper AR. Who children spend time with after school: Associations with objectively recorded indoor and outdoor physical activity. *Int J Behav Nutr Phys Act*. 2014; 11:45. [PubMed: 24679149]
131. Noonan RJ, Fairclough SJ, Knowles ZR, Boddy LM. Context matters! Sources of variability in weekend physical activity among families: A repeated measures study. *BMC Public Health*. 2017; 17:330. *. [PubMed: 28420363]
132. Nader PR, Sallis JF, Abramson IS, et al. Family-based cardiovascular risk reduction education among Mexican and Anglo-Americans. *Fam Community Heal J Heal Promot Maint*. 1992; 15:57–58.
133. Nader PR, Sallis JF, Patterson TL, et al. A family approach to cardiovascular risk reduction: Results from the San Diego Family Health Project. *Heal Educ Q*. 1989; 16:229–244.

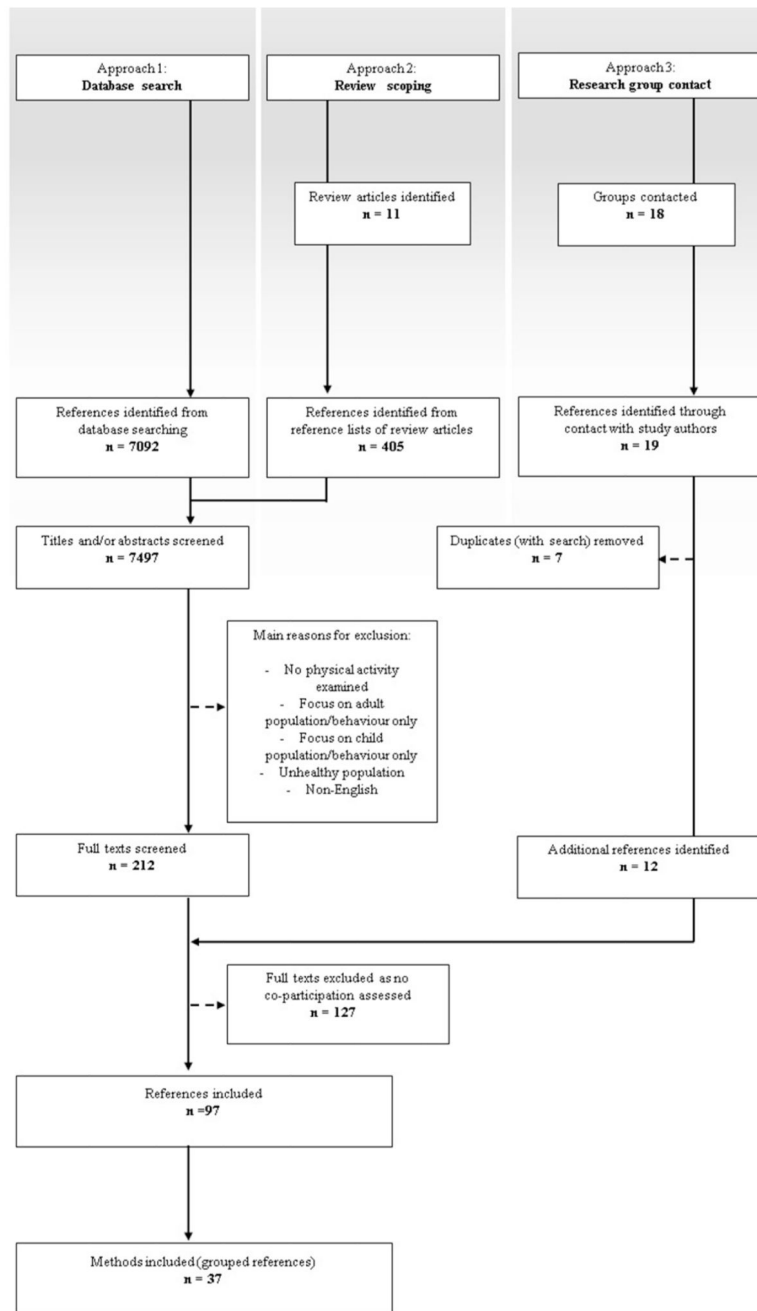


Figure 1. Flow chart for selection of references 190x338mm (96 x 96 DPI)

Table 1
Description of included measures of family co-participation in physical activity.

Primary dimension of co-participation	Method	Example of item text or description* Method name (available language, other than English)	Response scale	Study population in which method is used. Number of studies, location, age (of child)
Existence	Child-reported; single-item in questionnaire	<ul style="list-style-type: none"> • "In the last [period of time], did anyone in your family practice physical activities with you?" • Social Support for Exercise Scale (Brazilian-Portuguese) 60 • Unnamed; scale assesses family support for physical activity (Chinese) 61 • Social Influences Scale 37,62 	Dichotomous; yes/no	4 studies; Brazil 60, Hong Kong 61 and USA 37,62 Age range: 9-18 years - Pre-school ✓ Primary school ✓ Secondary school
Existence	Child-reported; single-item in questionnaire	<ul style="list-style-type: none"> • "I exercise with my parent" • Healthy Lifestyle Behaviors Scale 63 	5-point response scale; ranging from strongly disagree to strongly agree	1 study; USA 63 Age range: 9-12 years - Pre-school ✓ Primary school - Secondary school
Existence	Child-reported; two items in questionnaire	<ul style="list-style-type: none"> • "The adult(s) I live with on a week day / weekend day take part in physical activity with me" • Parental Influence on Physical Activity Scale 64 	4-point response scale; ranging from disagree a lot to agree a lot	1 study; UK 64 Age range: 10-12 years - Pre-school ✓ Primary school - Secondary school
Existence	Child-reported; two items in questionnaire	<ul style="list-style-type: none"> • "My parents or other adults who live with me, take part in physical activity with me during weekdays / weekend days" • Adopted Parental Influence on Physical Activity Scale (Turkish and/or Greek) 43 	4-point response scale; ranging from strongly disagree to strongly agree	1 study; Cyprus 43 Age range: 11-12 years - Pre-school ✓ Primary school - Secondary school
Existence	Child-reported; multiple items in questionnaire	<ul style="list-style-type: none"> • "My [mother/father] and I do active things together (like walking, bike riding, playing sports) and "When my [mother/father] does something active [she/he] lets me do it with [her/him]". Also assesses frequency of co-participation with siblings and general familial support including the family using sport/physical activity as family recreation and the extent to which the family is active. • Activity-Related Parenting Practices Scale 65 	Children were asked if the statement was "true" or "false" for them. Based on their initial response they were asked if the statement was "really" or "sort of" true/false	3 studies; USA 63,64,65 ^a , Age range: 5-13 years - Pre-school ✓ Primary school - Secondary school

Primary dimension of co-participation	Method	Example of item text or description* Method name (available language, other than English)	Response scale	Study population in which method is used. Number of studies, location, age (of child)
		<ul style="list-style-type: none"> The Activity Support Scale (ACTS) 66 The Activity Support Scale for Multiple Groups (ACTS-MG) 67 		
Existence	Parent reported; single-item in questionnaire	<ul style="list-style-type: none"> "I exercise/am physically active with my child[ren]/family [on a regular basis]" Healthy Lifestyle Behaviors Scale 63 Activity Support Scale 68,69 	4 to 5-point response scale; ranging from strongly disagree to strongly agree	3 studies; Australia 69, USA 63,68 Age range: 5-15 years - Pre-school ✓ Primary school ✓ Secondary school
Existence	Parent reported; single-item in questionnaire	<ul style="list-style-type: none"> "My preschool child is active with his/her siblings (e.g. outdoor play, rough-and tumble)" Unnamed; scale assesses physical activity social interaction and support 70 	5-point response scale; ranging from strongly disagree to strongly agree	1 study; Australia 70 Age range: 3-5 years ✓ Pre-school - Primary school - Secondary school
Existence	Parent-reported; two items in questionnaire	<ul style="list-style-type: none"> "I take part in physical activity with my child during weekdays / weekend days (e.g. walking, cycling)" Adopted Parental Influence on Physical Activity Scale (Turkish and/or Greek) 43 	4-point response scale; ranging from strongly disagree to strongly agree	1 study; Cyprus 43 Age range: 11-12 years - Pre-school ✓ Primary school - Secondary school
Existence	Parent reported; multiple item in questionnaire	<ul style="list-style-type: none"> Respondents identified with whom they often exercise from a list of enumerated family members. Unnamed; no specific construct reported (Spanish) 71 	Depending on enumerated family members (tick yes/no)	1 study; USA 71 Age range: 5-18 years - Pre-school ✓ Primary school ✓ Secondary school
Frequency	Child-reported; single-item in questionnaire	<ul style="list-style-type: none"> "In [period of time], how often does/did [your mum or dad parents/a member of your household] exercise, a physical activity or played sports together with you?" Unnamed; scale assesses the social environment at home 72 Unnamed; scale assesses parent co-participation in physical activity 73,74 (Dutch 73) (Spanish 74) 	4 to 6-point response scale; ranging from none or never to every day, very often, daily or always	23 studies; Australia 72, Belgium 73, Brazil 39, Canada 75, Europe (multiple countries) 42,76,77,78 Iran 79, Spain 74, UK 52,80, and USA 81 ^{40,82,83,84,85,86,87,88,89,90} Age range: 8-17 years - Pre-school ✓ Primary school

Primary dimension of co-participation	Method	Example of item text or description* Method name (available language, other than English)	Response scale	Study population in which method is used. Number of studies, location, age (of child)
		<ul style="list-style-type: none"> The Social Support for Exercise Scale for Adolescents (Brazilian-Portuguese) 39 Modified Parent Support Scale (French) 75 ENERGY-Child Questionnaire (Dutch, Greek, Hungarian, Norwegian, Spanish, Slovenian) 42,76,77 Perceived Social Support Scale (Danish, Estonian, Norwegian Portuguese) 78 		<ul style="list-style-type: none"> ✓ Secondary school
Frequency	Child-reported; single-item in questionnaire	<ul style="list-style-type: none"> "Do you participate in physical activity together with <i>[your mother/father?]</i>" Unnamed; scale assesses parent involvement in physical activity (Swedish) 91 Unnamed; no specific construct reported (Norwegian) 92 	5-point response scale; ranging from not at all or never to very much or 4 times a week	<ul style="list-style-type: none"> 2 studies; Finland 91 and Norway 92 Age range; 11-13 years - Pre-school ✓ Primary school - Secondary school
Frequency	Child reported; two items in questionnaire	<ul style="list-style-type: none"> "In the past month how often did your family members help you do a physical activity?" and "In the past month how often did your family members show you how to do a physical activity?"" Unnamed; scale assesses perceived instrumental social support for physical activity from family 38 	5-point response scale; ranging from not at all to about every day	<ul style="list-style-type: none"> 1 study; USA 38 Age range; 11-12 years - Pre-school ✓ Primary school - Secondary school
Frequency	Child-reported; multiple items in questionnaire	<ul style="list-style-type: none"> Children reported how often they engaged in shared family activities including playing indoor games, going for a walk, playing sports, sitting and talking about things.** The Health Behaviour in School-Aged Children Study Questionnaire (available in 36 languages) 49 	5-point response scale; ranging from never to every day	<ul style="list-style-type: none"> 1 study; Europe (multiple countries) 49 Age range; 13-15 years - Pre-school - Primary school ✓ Secondary school
Frequency	Parent-reported; single-items in questionnaire	<ul style="list-style-type: none"> "In <i>[period of time]</i>, how often are you <i>[and/or your partner/another parent/guardian/another member of your household/your child's siblings]</i> physically active/playing sports with your child?" Unnamed; scale assessed physical activity social interaction and support 70 Unnamed; scale assesses family co-participation in physical activity 93,94 Unnamed; scale assesses social/family/parent support for physical activity 95,96,97,98,99,100,101,102 Unnamed; scale assesses parent encouragement for physical activity 103 	4 to 6-point response scale; ranging from never, none, not at all to daily, often or very often	<ul style="list-style-type: none"> 23 studies; Australia 68,93,92,95,103,104, Canada 105,106, Europe (multiple countries) 41,76,77,107, USA 96,98^c, 99-100,101-102^d,108,109,110, and UK 97,111 Age range; 2-18 years ✓ Pre-school ✓ Primary school ✓ Secondary school

Primary dimension of co-participation	Method	Example of item text or description* Method name (available language, other than English)	Response scale	Study population in which method is used. Number of studies, location, age (of child)
		<ul style="list-style-type: none"> • Unnamed; scale assesses parental interaction in physical activity 104 • Adapted Activity-Related Parenting Practices Scale 105,106 • ENERGY-Child Questionnaire 		
Frequency	Parent-reported; single-item in questionnaire	<ul style="list-style-type: none"> • "In <i>(period of time)</i>, how many days did you or another adult in your household do any physical activities with child including things like active games, sports, or other physical activities, and so forth?" **** • Maternal Parenting for Physical Activity Scale 112 • Unnamed; scale assesses co-physical activity/social support for physical activity 113,35,114,114 (French 114) • Unnamed; no specific construct reported 115 	7-point response scale to indicate number of days per week or free text option	6 studies; Australia 112,113,35, Canada 114, USA 115,116 Age range: 4-15 years - Pre-school ✓ Primary school ✓ Secondary school
Frequency	Parent-reported; single item in questionnaire	<ul style="list-style-type: none"> • "How often does your family use sport/physical activity as a form of family recreation (e.g., going on bike rides together, hiking, ice skating)?" • Activity-Related Parenting Practices Scale 65,117,118,119,120 (Dutch 120) 	4-point response scale; ranging from rarely to frequently	5 studies; USA 65,117,118, UK 119, and Belgium 120 Age range: 6-12 years - Pre-school ✓ Primary school - Secondary school
Frequency	Parent-reported; single item in questionnaire	<ul style="list-style-type: none"> • "Do you ever do sports or exercise together with your child in 7th grade?" • Unnamed; no specific construct reported (Norwegian) 92 	5-point response scale; ranging from never to 4 times a week or more often	1 study; Norway 92 Age range: 13 years - Pre-school ✓ Primary school - Secondary school
Frequency	Parent-reported; single item in questionnaire	<ul style="list-style-type: none"> • "When we are at social gatherings (friends, family) children and adults are usually active together" • Unnamed; scale assesses physical activity social interaction and support 70 	5-point response scale; ranging from never to always	1 study; Australia 70 Age range: 3-5 years ✓ Pre-school - Primary school - Secondary school
Frequency	Parent-reported; two item in questionnaire	<ul style="list-style-type: none"> • "How often does your family do something active together?" and "How often would you do 30min or more of moderate to vigorous activity with your child?" **** 	5-point response scale; ranging from never to more than 4 times per week	2 studies; Australia 121,122 Age range: 5-11 years - Pre-school

Primary dimension of co-participation	Method	Example of item text or description* Method name (available language, other than English)	Response scale	Study population in which method is used. Number of studies, location, age (of child)
		<ul style="list-style-type: none"> Adapted Family Food Environment Scale and Food Involvement Scale 121,122 		<ul style="list-style-type: none"> ✓ Primary school - Secondary school
Frequency	Parent-reported; two items in questionnaire	<ul style="list-style-type: none"> "My child participates in physical activities with parents/caregivers", and "I participate in physical activity with my child" Family Health Behavior Scale 123 	5-point response scale; ranging from almost never to nearly always	<ul style="list-style-type: none"> 1 study; USA 123 Age range; 5-12 years - Pre-school ✓ Primary school - Secondary school
Frequency	Parent-reported; multiple items in questionnaire	<ul style="list-style-type: none"> Parents reported how often they/as a family engaged in shared family activities including going for bike rides, walk the dog, dance and/or play sports. Note ** Unnamed; no specific construct reported 51 Unnamed; scale assesses family social support for physical activity 50,52 Preschooler Physical Activity Parenting Practices Scale 53 	4 to 6-point response scale; ranging from never or don't know/doesn't apply to more than 4 times a week, always, daily	<ul style="list-style-type: none"> 4 studies; Australia 51, UK 50,52 and USA 53 Age range; 3-12 years ✓ Pre-school ✓ Primary school - Secondary school
Frequency	Parent-reported; multiple items in questionnaire	<ul style="list-style-type: none"> Family-supported behaviors included the frequency of parents going to the park with the child, parents walking with the child, parents going to the playground with the child, and other family members taking the child to the park or playground or for a walk. ** Unnamed scale (Spanish) 124 	No complete response scale given, but described as 'never, once a week, etc.'	<ul style="list-style-type: none"> 1 study; USA 124 Age range; 3-5 years ✓ Pre-school - Primary school - Secondary school
Duration	Parent-reported; single-item in questionnaire	<ul style="list-style-type: none"> "In a typical week, how many hours do you spend being physically active with your child (e.g., throwing a ball around, taking a walk or bike ride together)?" Unnamed; 'parental time spent being active with adolescent' included in Families and Eating and Activity among Teens (F-EAT) survey 125 	Hours per week; entered as free text	<ul style="list-style-type: none"> 1 study; USA 125 Age range; 11-14 years - Pre-school - Primary school ✓ Secondary school
Duration	Parent-reported; single-item in questionnaire	<ul style="list-style-type: none"> Mothers indicated the amount of time in the last week their infant spent in various physical activity behaviours, including being physically active with mum. ** Unnamed; no specific construct reported 126 	Minutes per week; entered as free text	<ul style="list-style-type: none"> 1 study; Australia 126 Age range; 4-19 months ✓ Pre-school - Primary school

Primary dimension of co-participation	Method	Example of item text or description* Method name (available language, other than English)	Response scale	Study population in which method is used. Number of studies, location, age (of child)
Duration	Child and parent; global positioning systems (GPS) and accelerometry	Parent-child pairs wore an ActiGraph accelerometers and GPS devices over the same 7-day period. Joint behaviour was defined by a linear separation distance of less than 50m between parent and child.	Accelerometer counts, conditioned on GPS-based proximity	2 studies; USA 44,56 Age range; 8-14 years - Pre-school ✓ Primary school ✓ Secondary school
Type	Child-reported; single-item in questionnaire	Children indicated how they usually travelled to school and with whom. <ul style="list-style-type: none"> • Unnamed; no specific construct reported 128 	Possible responses; by car; bus/train; bicycle; or on foot; alone; with a brother/sister; a parent/other adult; a friend; another person	1 study; UK 128 Age range; 9-11 years - Pre-school ✓ Primary school - Secondary school
Type	Parent-reported; two items in questionnaire	Parents report the number of times they were physically active with their child over the past week and then selected the type of physical activity they participated in with their child from a list of 22 types of activities. <ul style="list-style-type: none"> • Unnamed; scale assesses parent physical activity with child 129 	Not reported	1 study; USA 129 Age range; 5-10 years - Pre-school ✓ Primary school - Secondary school
Type	Child-reported; diary	Children completed a one day recall diary for three school days. In addition to the start and end time of after school activities, they selected who they were with for each activity. <ul style="list-style-type: none"> • Unnamed; scale assesses parent physical activity with child 129 	Possible responses; on my own, with friend, with brother/sister, with mum or dad, with another grown up	1 study; UK 130 Age range; 10-11 years - Pre-school ✓ Primary school - Secondary school
Type	Child-reported; diary	Children filled in a diary relating to the time that they spent outside the house playing. They also noted with whom they spent each day outside playing. <ul style="list-style-type: none"> • Adopted Parental Influence on Physical Activity Scale (Turkish and/or Greek) 43 	Possible responses; alone, brothers or sisters, friend(s), parents, or other adult.	1 study; Cyprus 43 Age range; 11-12 years - Pre-school ✓ Primary school - Secondary school
Type	Child and parent-reported diary	Each participant was provided with a calendar format paper-based diary on which they manually record their own physical activity at the end of each day. They could indicate the type and duration of physical activity, and with whom the activity was undertaken.	Free text	1 study; UK 131 Age range; 9-11 - Pre-school ✓ Primary school

Primary dimension of co-participation	Method	Example of item text or description* Method name (available language, other than English)	Response scale	Study population in which method is used. Number of studies, location, age (of child)
Type	Child and parent-reported; event history calendar (EHC)	Both parents and children were asked to report on the type of activities they had engaged in as a family over the past two months (may include non-active time). Also answered, "what does your family do to play or be active?" as free text question.	Not applicable	1 study; USA 46 Age range: 7-14 years - Pre-school ✓ Primary school ✓ Secondary school
Type	Parent-reported; diary	Parents observed their children in their home environment and filled in a diary using five-min time units and nine activity categories; of which one was parent-child interaction (i.e. doing active things together). Diaries filled for one weekend in April and one weekend in September during the years 1995, 1996, and 1997. *****	Not applicable	1 study; Finland 47 Age range: 4-7.5 years - Pre-school ✓ Primary school - Secondary school
Type	Direct observations by graduate students	Families were observed for 1 hour during a visit at the zoo through momentary time sampling (every 30 seconds). Total distance travelled, percentage of intervals being physically active, and use of escalators was assessed for all family members. *****	Not applicable	3 studies; USA 48, 132, 133 Age range: 10-12 years - Pre-school ✓ Primary school - Secondary school

GPS, Global Positioning System; EMA, Ecological Momentary Assessment, EHC, Event History Calendar

* Note: similar items have been grouped.

** Also assesses type as sub-dimension of co-participation in physical activity

*** Also assesses frequency as sub-dimension of co-participation in physical activity

**** Also assesses duration as sub-dimension of co-participation in physical activity

^a General familial support was not assessed in Lampard et al (2014)

^b Morrissey et al (2015) reported that all questionnaire items were answered on a 5-point scale ranging from 1 (disagree a lot) to 5 (agree a lot)

^c The item used by Schoeppe et al (2015) also included 'play outside with child' as an example of co-participation in physical activity

^d For the measure used by Tandon et al (2012) no response scale was reported. Outcomes in mean/days week.