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3 1 **A Systematic Review of Methods to Measure Family Co-Participation in Physical**  
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5 2 **Activity**

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54 24 **Key words**

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56 25 Behavioral Research; Exercise; Family Health; Public Health

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26 **Running title**

27 Family Co-Participation in Physical Activity

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29 **Acknowledgements**

30 Not applicable

31

32 **Conflict of interest**

33 None to declare

34

35 **Abbreviations**

36 PRISMA, Preferred Reporting Items for Systematic reviews and Meta-Analyses; GPS,

37 Global Positioning Systems; ICC, Intraclass Correlation Coefficient

For Peer Review

## 38 ABSTRACT

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

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3 57 INTRODUCTION  
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5 58 Despite the established health benefits of physical activity for children <sup>1,2,3,4,5,6</sup>, data from  
6  
7 59 several countries suggest that the majority of children are insufficiently active to enjoy these  
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9 60 benefits <sup>7,8</sup>. Further, levels of physical activity decline substantially throughout childhood and  
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11 61 into adolescence <sup>9,10</sup>. Understanding the determinants of physical activity in young people,  
12  
13 62 and developing effective interventions to promote and maintain their activity levels, is  
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15 63 therefore a public health priority <sup>11</sup>.  
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21 65 The family is the primary unit of socialisation and organisation during childhood <sup>12</sup>, and is  
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23 66 therefore central in shaping engagement in health behaviours, including physical activity  
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25 67 <sup>12,13,14</sup>. There is also substantial evidence showing that parenting behaviours and family  
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27 68 processes play a critical role in adolescent well-being <sup>15</sup>. Family factors, such as logistical  
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29 69 support (e.g., provision of transport or covering costs), co-participation, or encouragement,  
30  
31 70 have been consistently and positively correlated with physical activity in children <sup>11,16,17</sup>.  
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33 71 Moreover, the addition of parent involvement (e.g. education sessions, co-participation) to  
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35 72 school-based physical activity interventions has been found to be effective in promoting  
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37 73 activity in children and adolescents <sup>18</sup>.  
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43 75 The involvement of family members in physical activity-focused interventions may not just  
44  
45 76 be advantageous for the targeted child. For example, recent qualitative research suggests that  
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47 77 in addition to the potential health benefits of family physical activity, parents also valued the  
48  
49 78 opportunity to enhance parent-child communication and social interactions among family  
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51 79 members <sup>19</sup>. Authors describing the intervention “*A Family Affair*” report that joint physical  
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53 80 activities led to an improved daughter-mother relationship and as such, greater support for a  
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55 81 healthier lifestyle <sup>20</sup>. Co-participation is also a key feature of the *Healthy Dads Healthy Kids*

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3 82 intervention, which was shown to be effective in improving physical activity for fathers and  
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5 83 their children <sup>21</sup>. *Healthy Dads Healthy Kids* demonstrates that reciprocal reinforcement  
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7 84 between parent (father) and child is particularly pertinent when adopting and refining health  
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9 85 behaviours <sup>22</sup>. Encouraging *co-participation* of family members (e.g., parents, siblings, other  
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11 86 relatives) may therefore be an effective approach to increasing or maintaining children's  
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14 87 activity levels <sup>11</sup>, and simultaneously improving engagement in physical activity in adults.  
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20 89 Given the growing interest in involving family members in the promotion of young people's  
21 90 physical activity <sup>11</sup>, an appraisal of methods to measure family co-participation in physical  
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23 91 activity is timely and necessary. High quality exposure assessment is essential to identify  
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25 92 causal associations with health and behavioural outcomes, to quantify the magnitude of any  
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27 93 association, and to describe any dose-response relationships <sup>23</sup>. Accurate measurement is also  
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29 94 required to document patterns of, and changes in, family physical activity over time <sup>24</sup>, and  
30  
31 95 may be of particular importance for those assessing intervention effectiveness. Therefore, the  
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33 96 aim of this study is to provide an overview of current methods used to measure family co-  
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35 97 participation in physical activity.  
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## 41 99 METHODS

### 42 100 *Search methods*

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45 101 This review was conducted and is reported according to the Preferred Reporting Items for  
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47 102 Systematic reviews and Meta-Analyses (PRISMA) guidelines (Supplementary File 1) <sup>25</sup>. We  
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49 103 identified measurement methods of family co-participation in physical activity through three  
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51 104 different approaches: 1) a formal literature search in four electronic databases, 2) an informal,  
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53 105 snowball search of cross-referencing pre-selected review articles <sup>11,17,18,26,27,28,29,30,31,32,33</sup> and  
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56 106 3) contacting research groups known to be conducting research into family-based physical  
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3 107 activity. Research groups were identified by co-authors, who used their extensive networks  
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5 108 and attendance at conferences and key meetings to select 18 groups conducting relevant  
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7 109 research (e.g. examining correlates of child physical activity, developing/evaluating physical  
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9 110 activity interventions in family settings etc.).  
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14 112 The formal literature search was performed using computerized searches in PubMed, Scopus,  
15  
16 113 PsychInfo and ScienceDirect for articles published up to and including April 2017, with no  
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18 114 limit on earliest year of release. The search strategy consisted of three elements <sup>34</sup>:  
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21 115 (a) construct (e.g. physical activity, exercise), (b) population (e.g. family, parent) and (c)  
22  
23 116 instrument (e.g. questionnaire, observation). Terms referring to these three elements were  
24  
25 117 combined with AND terms and used as title words, abstract words, and/or keywords  
26  
27 118 depending on the respective electronic database. In addition, 'Motor activity', 'Sports',  
28  
29 119 'Exercise', 'Family', 'Data collection', 'Accelerometry, and 'Observation' were added as  
30  
31 120 MESH headings in PubMed. As the term co-participation does not adequately fit in the  
32  
33 121 search term blocks described above, a simple additional search across all databases was  
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35 122 performed combining the terms co-participation/co-participation and physical activity (see  
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37 123 Supplementary File 2 for the detailed search strategy). References of included papers were  
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39 124 checked to identify further publications.  
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45 126 Other search methods took place between May 2015 to October 2016. References of pre-  
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47 127 selected review articles were checked to identify further publications. Research groups were  
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49 128 asked whether they were using one or more measurement methods of family co-participation  
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51 129 in physical activity, and if yes, if they were able to share the following:  
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54 130 - A copy/description of original method(s) and scoring algorithm(s);  
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3 131 - Background information (how it was developed, what study it was used in, data on  
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5 132 validity/reliability testing);  
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7 133 - Any publications that reported on the method.  
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10 134 Both published and unpublished measurement methods were eligible for inclusion.

11 135 References obtained via research group contact are highlighted with an asterisk in the  
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13 136 reference list of this paper.  
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18 138 *Inclusion criteria*

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20 139 Measurement methods were included if they were described in English language references,  
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22 140 were available in the English language (solely, or in addition to other languages) and assessed  
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24 141 family co-participation in physical activity which was defined as ‘joint physical activities  
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26 142 including at least 1 healthy child (aged 0-18 years) and 1 other ‘family member’ (we included  
27  
28 143 all types of family, e.g. parent/guardians, siblings, cousins). Measurement methods were  
29  
30 144 excluded if they referred to the assessment of family co-participation in physical activity only  
31  
32 145 in very general terms but did not provide further details e.g. the methods section states that  
33  
34 146 ‘frequency of family exercising with child’ was assessed, but no exact item description,  
35  
36 147 and/or answer categories were provided. Qualitative methods such as interviews and focus  
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38 148 group discussions were excluded due to their usual focus on psychological constructs such as  
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40 149 behavioural attitudes and perceived control, rather than on the actual measurement of the  
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42 150 behaviour at interest.  
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49 152 *Selection process*

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52 153 Two independent reviewers (LU and HEB) performed title/abstract and full-text selection of  
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54 154 articles generated from the electronic database searches (81% agreement for full-text  
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56 155 inclusion). One reviewer (HEB) screened the references of relevant review articles, and  
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3 156 obtained published and unpublished references from relevant research groups. These were  
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5 157 checked for eligibility by the second reviewer (LU). Disagreements on in/exclusion of  
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7 158 references from all sources (electronic searches, review articles, and author contact) were  
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9 159 discussed and resolved between the two reviewers.  
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14 161 *Data extraction*

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16 162 Two reviewers (LU and HB) performed data extraction for a respective half of the obtained  
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18 163 references. For each reference, data were extracted on a) the measurement method used to  
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20 164 assess family co-participation in physical activity (e.g., questionnaire, diary), b) a description  
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22 165 of the item text (if relevant), or a more detailed description of the method, c) method names,  
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24 166 response scale or outcome, and d) the study population in which the method was used. If  
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26 167 reported, information on psychometric properties (e.g., test-retest reliability, construct  
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28 168 validity) was also extracted. For presentation purposes, references were grouped based on the  
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30 169 ‘dimension’ of co-participation they assessed, i.e., existence, frequency, type or duration.  
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32 170 Methods assessing whether co-participation in physical activity generally occurred or had  
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34 171 occurred in daily life were grouped under ‘existence’. Methods assessing how often in a  
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36 172 given time frame (e.g., per week, per month) participant’s co-participated in physical activity,  
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38 173 were grouped under ‘frequency’. Methods assessing co-participation in specific physical  
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40 174 activities such as cycling or active play rather than in general physical activity, were grouped  
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42 175 under ‘type’. Methods assessing time spent in co-participation in physical activity were  
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44 176 grouped under ‘duration’. The primary dimension was determined depending on the available  
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46 177 response options. If the method assessed other dimensions of co-participation, this was  
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48 178 indicated in Table 1. Measurement methods were further grouped based on whether co-  
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50 179 participation was assessed through the child or parent and similarity of methods (e.g.,  
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52 180 questionnaires versus accelerometry).  
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## 181 RESULTS

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

186

187 --- INSERT FIGURE 1 HERE ---

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189 *Method characteristics*

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

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206 *Psychometric properties*

207 Methods assessing the ‘existence’ and/or ‘frequency’ of family co-participation in physical  
208 activity were mostly one- or two-item questionnaires which were part of a more  
209 comprehensive multiple-item scale, e.g. social influences scale<sup>37</sup>, instrumental support scale  
210<sup>38</sup>, social support scale<sup>39</sup>, parental social support scale<sup>40</sup>. Reliability and internal consistency  
211 of these scales were often reported and deemed acceptable, but rarely split out for the item(s)  
212 specific to co-participation. One of the exceptions are the studies by Singh et al<sup>41,42</sup>, which  
213 reported reliability and validity figures for both child- and parent-reported items on the  
214 frequency of co-participation. They presented an intraclass correlation coefficient (ICC) of  
215 0.47 with 47% agreement, and an ICC of 0.80 with 73% agreement to demonstrate test-retest  
216 reliability of the child- and parent reported item, respectively. Validity against interviews for  
217 the child- and parent reported items were reported as an ICC of 0.24 with 51% agreement,  
218 and an ICC of 0.56 with 57% agreement, respectively. The factor analysis performed by  
219 Loucaides and colleagues<sup>43</sup> identified one specific factor for ‘parental physical activity with  
220 child’ (i.e., co-participation). They authors reported Cronbach’s alphas of .849 and .844 for  
221 weekdays and weekend days. Yet, no significant associations with pedometer-measured steps  
222 and diary-assessed time spent playing outside were found for this factor, which undermines  
223 the scale’s validity. Further, some of the ‘existence’ and ‘frequency’ measurement methods  
224 were modified from existing questionnaires, but provided references to reliability and validity  
225 information for the original format only.

226

227 Three of the seven measurement methods assessing the duration of family co-participation in  
228 physical activity used accelerometry; either in the form of identifying periods of simultaneous  
229 counts (using information provided in a complimentary activity diary), or in combination  
230 with ecological momentary assessment and GPS. To illustrate, in the case of combining

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3 231 accelerometry and GPS, parent-child pairs were asked to wear accelerometers for seven  
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5 232 continuous days, and a portable GPS device was attached to the accelerometer belt with  
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7 233 recording interval matching those of the accelerometer<sup>44</sup>. Co-participation in physical  
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10 234 activity among the parent-child pairs was defined as activities of the same intensity (assessed  
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12 235 by accelerometer) that occurred at the same time and in the same location (assessed by GPS  
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14 236 device). From this data, the average daily minutes spend in moderate-to-vigorous physical  
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16 237 activity performed together by parent-child pairs could be calculated; i.e., reflecting the  
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18 238 duration of co-participation. For these 'combination' methods, no explicit information on  
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20 239 reliability or validity were reported. Regarding the four questionnaires assessing 'duration' of  
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22 240 co-participation, only Rhodes and colleagues<sup>45</sup> provided test-retest ICCs from 0.25-0.59 to  
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24 241 0.41-0.86 at two different time points for several items, including the one assessing duration.  
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29 243 For three of the eight measurement methods assessing the type of family co-participation in  
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31 244 physical activity (e.g. active travel, after school activities), information on reliability or  
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33 245 validity was presented. Danford and Martyn<sup>46</sup> noted that the child- and parent-reported event  
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35 246 history calendar they used, demonstrated good face validity and construct validity. In  
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37 247 addition, they stated that the reliability of the event history calendar was investigated through  
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39 248 assessing correlations between child and parent reported activities, but no further details on  
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41 249 agreement were provided. An event history calendar is typically a tool that collects reflective  
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43 250 data at one point in time, rather than involving daily entries. In this specific study, children  
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45 251 and parents were asked to look back at the past 2 months and note down any physical activity  
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47 252 they had engaged in together as a family and as such obtained information on the type of  
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49 253 family co-participation in physical activity. Sääkslahti et al<sup>47</sup> assessed the inter-observer  
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51 254 reliability of their parent-reported diary among families of 19 children and found a  
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53 255 correlation of  $r=.91$  for actively doing things together as parent and child. The authors also  
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3 256 stated that this method was ecologically valid because ‘children were able to live their normal  
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5 257 life and seasonal variation was taken into account’ [page 169]. Finally, Patterson et al <sup>48</sup>  
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7 258 assessed the inter-observer reliability of direct observations of families at the zoo, which was  
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9 259 maintained at >90% during data collection. In this particular case, direct observation of  
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11 260 families spending time in the zoo was used as an indicator of the family’s habitual physical  
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13 261 activity whilst being together. For example, observers noted whether the family used the  
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15 262 stairs or the elevator, and the duration of time they spent walking rather than seated.  
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21 264 --- INSERT TABLE 1 HERE ---  
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## 24 266 DISCUSSION

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27 267 This review provides a comprehensive overview of methods used to measure family co-  
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29 268 participation in physical activity, and demonstrates the heterogeneity in the constructs  
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31 269 assessed and methodology employed. The information provided in this review may be used to  
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33 270 inform researchers’ selection of an appropriate methods to assess family co-participation in  
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35 271 physical activity and to describe this important context-specific behaviour.  
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41 274 In navigating measurement methods of family co-participation in physical activity,  
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43 275 researchers may choose to work from either a narrow definition or a slightly broader  
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45 276 framework; each of which may have different correlates and determinants, and may be  
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47 277 influenced via different mechanisms. We suggest a narrow definition to include engaging in  
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49 278 physical activity directly with the child (e.g. playing together in the garden), usually as a  
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51 279 parent-child pair. We defined co-participation as ‘joint physical activities including at least 1  
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53 280 healthy child (aged 0-18 years) and 1 other ‘family member’. This has been the target  
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3 281 <sup>21</sup>. A looser characterisation of co-participation may also encompass habitual family activity  
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5 282 (e.g. active family gatherings), which may be more difficult to capture with self-reported  
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7 283 methods, as parents and/or children may not think to include such events. Identifying the  
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10 284 behaviour of interest, and then determining the most accurate methods of measurement, is an  
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12 285 important challenge for researchers looking to assess family co-participation in physical  
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14 286 activity.

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18 288 As highlighted in Table 1, measurement methods are available for a variety of dimensions of  
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20 289 family co-participation in physical activity. We included 37 different methods of four  
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22 290 different dimensions; frequency, duration, existence, and type. Frequency of co-participatory  
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24 291 activities was most commonly assessed exclusively via questionnaire. These measures  
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26 292 presented acceptable levels of reliability and sometimes validity, and given how short the  
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28 293 items are, may be appropriate for inclusion in longer questionnaires without adding to  
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30 294 participant burden. In addition, a large number of international studies have previously used  
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32 295 such an item, offering the possibility to compare findings between countries.  
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38 298 We also identified both child- and parent-reported questionnaires with *multiple*  
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40 299 questionnaire/survey items (as compared to 1-item scales) that may offer a more precise  
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42 300 assessment of family co-participation in physical activity. Specifically, one study exploring  
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44 301 family-based joint activities more broadly asked children to report on a range of physical  
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46 302 activities that they might have participated in with family members (e.g. indoor games, going  
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48 303 for a walk, or playing sports) <sup>49</sup>. Similarly, a few other studies asked parents to report on *how*  
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50 304 *often* they/as a family engaged in any of a list of shared family activities <sup>50,51,52,53</sup>. Such  
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3 305 measures. Items which provide more detailed responses may allow for a greater  
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5 306 understanding of specific behaviours that families enjoy together.  
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9 308 Objective measurement of family co-participation in physical activity was relatively  
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11 309 uncommon (less than 10% of references included for review). Increasing the use of device-  
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13 310 based assessment may further improve the accuracy of reporting family co-participation in  
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15 311 physical activity, and reduce the impact of social desirability bias <sup>54</sup>. Another important  
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17 312 advantage of device-based assessment, specifically accelerometry, is the ability to measure  
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19 313 intensity of family co-participation in physical activity. Many of the questionnaire items we  
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21 314 identified focused only on moderate-to-vigorous physical activity, and were not able to  
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23 315 capture other activity intensities. This may be important, as family activities of light intensity,  
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25 316 for example, may have alternative psychological or social health benefits. However, simply  
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27 317 simultaneously wearing objective physical activity monitors may not be sufficient, as  
28  
29 318 additional information on location and/or social context is required. One example of this  
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31 319 approach is identifying periods of simultaneous activity from accelerometer data using  
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33 320 information from a supplementary diary, as was done in one study assessing family dog-  
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35 321 walking behaviour <sup>55</sup>. This approach also allowed the researchers to demonstrate that  
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37 322 increases in family co-participation in physical activity led to physical activity compensation  
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39 323 at other times, an important consideration when promoting specific types of activity.  
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43 325 Accelerometry has also been used alongside GPS devices to classify periods of family co-  
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45 326 participation in physical activity, defined by a linear separation distance of less than 50m  
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47 327 between parent and child <sup>44,56</sup>. Issues of participant burden should be considered when  
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49 328 combining methods of measurement; for example, researchers should look to use dual  
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51 329 devices which track both activity and locations, or if asking participants to wear two devices,  
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3 330 these should be placed upon the same waist-worn belt. Another recent example is a study  
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5 331 which validated Bluetooth-enabled accelerometers against detailed time-use diaries, for the  
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7 332 purpose of proximity tagging between parents and children and hence assessing co-  
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9 333 participation<sup>57,58</sup>. Other objective measurement methods used included ecological  
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11 334 momentary assessment; electronic surveys assessed primary activity, social context, physical  
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13 335 location, current mood, and enjoyment. This may be particularly useful for those researchers  
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15 336 interested in understanding not only the duration or frequency of family co-participation in  
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17 337 physical activity, but also the wider context within it occurs.  
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23 339 In general, we observed that most methods assessing family co-participation in physical  
24  
25 340 activity do not include a definition of co-participation, or even use the word co-participation  
26  
27 341 in their study. This construct seems generally overpowered by or clustered within more  
28  
29 342 classical constructs such as modelling and encouragement. Subsequently, the methods used  
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31 343 are not specifically designed to measure family co-participation in physical activity. They  
32  
33 344 also often include different examples of ‘activities done together’ and hence obtain  
34  
35 345 information that is difficult to compare across studies and settings, even if the same  
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37 346 dimension, i.e., existence, frequency, duration or type is assessed. Further, there was limited  
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39 347 information on the validity and/or reliability of measurement methods. This mirrors recent  
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41 348 claims that there is a current lack of consensus about the best way to define, assess or apply  
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43 349 concepts such as co-participation in physical activity and physical activity in general<sup>59</sup>.  
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49 351 We therefore strongly encourage researchers to first work towards consensus in defining  
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51 352 family co-participation in physical activity, before developing a reliable and valid measure  
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53 353 that:

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56 354 • distinguishes between existence, frequency, duration, type, and intensity of activity,  
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3 355 • allows respondents to report upon multiple activities,  
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5 356 • collects data from both the target child and relevant family members, including  
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7 357 parents, siblings and other extended family;  
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9  
10 358 • incorporates objective assessments, e.g., accelerometers in combination with an event  
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12 359 history calendar or GPS.  
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361 For those researchers looking to use an established method of measuring family co-  
362 participation in physical activity, a combination of accelerometry and GPS devices as per the  
363 work of Dunton and colleagues may be a good option <sup>44,56</sup>. This method allows for the  
364 recording of family members' simultaneous physical activity, and hence provides an  
365 objective measure of frequency, duration, and intensity of co-participation, in addition to  
366 information about the geographical and social context (i.e. where and with which family  
367 members). If such devices are not available to researchers or do not fit within study logistics,  
368 the inclusion of multiple-item questionnaires could be considered, capturing at least the  
369 frequency of co-participation and type of activities done. In this respect, the items used by  
370 Zaborskis et al <sup>49</sup> may serve as a model for other studies as they ask adolescents to list how  
371 often ('frequency') their families engage in a list of eight different activities ('type').  
372 Researchers could refer to Corder et al <sup>50</sup>, Ghekiere et al <sup>51</sup>, McMinn et al <sup>52</sup> and O'Connor et  
373 al <sup>53</sup> for parent-reported equivalents. The inclusion of an additional option within such items  
374 to indicate the duration of co-participation through the e.g., reporting of minutes per week as  
375 free text, per the study of Hnatiuk et al <sup>127</sup>, may allow researchers to even more  
376 comprehensively assess the behaviour of interest. Further, for any study using questionnaires,  
377 it would be recommended to collect data from both child and other (extended) family  
378 members similar to the ENERGY study design <sup>77</sup>, so as to compare different perspectives of  
379 family co-participation in physical activity within family units.



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3 380 In contrast, single-item methods, categorized as primarily assessing ‘existence’ of family co-  
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5 381 participation in physical activity with a yes/no or disagree-agree answering format (see Table  
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7 382 1) may be of insufficient quality to adequately capture different dimensions of family co-  
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10 383 participation in physical activity. Also, methods that do not distinguish between family  
11  
12 384 members when asking about co-participation, e.g., items referring to ‘you or another adult in  
13  
14 385 your household’, may not have enough distinctive value. Finally, direct observations of  
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16 386 families may be useful when the interest is in specific activity types or locations, however  
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18 387 they may not be regarded as representations of general family co-participation in physical  
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21 388 activity.

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25 390 *Strengths and limitations*

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27 391 This is the first review to comprehensively summarize methods to measure family co-  
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29 392 participation in physical activity. Its main strengths are the use of three different search  
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31 393 strategies and the inclusion of unpublished measurement methods due to our contacts with  
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33 394 relevant research groups. Although we employed an extensive search strategy, it is possible  
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35 395 that relevant methods were missed in the selection process. The first in/exclusion of papers  
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37 396 from the database searches was mostly based on the reviewers’ knowledge of the literature  
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39 397 and common sense, as the methods we were looking for are often not reported on in the title  
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41 398 or abstract of an article. Including other, broader search terms e.g., ‘instrument’,  
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43 399 ‘assessment’, ‘method’) may also have yielded additional relevant articles and thus methods,  
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45 400 but would have likely seriously affected the specificity of the database searches, and with that  
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47 401 the feasibility of the work. Finally, only methods that were available in the English language  
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49 402 were included. Considering the above, we would like to invite researchers who have assessed  
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51 403 or will be assessing family co-participation in physical activity *with different*

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3 404 *instruments/yielding different outcomes than those summarized in Table 1*, to contact the  
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5 405 corresponding author of this paper.  
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8  
9 407 CONCLUSION

10 408 This review demonstrates that whilst a large number of studies use methods to measure  
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12 409 family co-participation in physical activity, only few do so using comprehensive assessments.  
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14 410 Most methods are not specifically designed to measures family co-participation in physical  
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16 411 activity, and detailed information on their psychometric properties is largely lacking.  
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18 412 Individual items in existing questionnaires, and objective assessment methods, do however  
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20 413 measure the existence, frequency, duration, and/or type of family co-participation.  
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22 414 Researchers can use the information provided in this review to help them to select the most  
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24 415 appropriate measure for their study. Future work should focus on developing a  
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26 416 comprehensive, consistent and validated overall measurement of family co-participation in  
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28 417 physical activity, which will help improve our understanding of family-based physical  
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30 418 activity, its contribution to all family members' activity levels, its determinants, and enable  
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32 419 rigorous evaluation of family physical activity interventions.  
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For Peer Review

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*	Response scale	Study population in which method is used.
		Method name (available language, other than English)		Number of studies, location, age (of child)
Existence	Child-reported; single-item in questionnaire	“In the last [ <i>period of time</i> ], did anyone in your family practice physical activities with you?”	Dichotomous; yes/no	4 studies; Brazil <sup>60</sup> , Hong Kong <sup>61</sup> and USA <sup>37,62</sup> Age range; 9-18 years
		<ul style="list-style-type: none"> <li>• Social Support for Exercise Scale (Brazilian-Portuguese) <sup>60</sup></li> </ul>		- Pre-school ✓ Primary school
		<ul style="list-style-type: none"> <li>• Unnamed; scale assesses family support for physical activity (Chinese) <sup>61</sup></li> </ul>		✓ Secondary school
		<ul style="list-style-type: none"> <li>• Social Influences Scale <sup>37,62</sup></li> </ul>		
Existence	Child-reported; single-item in	“I exercise with my parent”	5-point response scale; ranging from strongly	1 study; USA <sup>63</sup> Age range; 9-12 years
		<ul style="list-style-type: none"> <li>• Healthy Lifestyle Behaviors Scale <sup>63</sup></li> </ul>		

1 2 3 4 5 6 7 8 9 10	(cont. from previous page)	questionnaire	disagree to strongly agree	- Pre-school ✓ Primary school - Secondary school
11 12 13 14 15 16 17 18 19 20 21 22	Existence	Child-reported; two items in questionnaire	“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 <sup>64</sup>	4-point response scale; ranging from disagree a lot to agree a lot  ✓ Primary school - Secondary school
23 24 25 26 27 28 29 30 31 32 33 34 35	Existence	Child-reported; two items in questionnaire	“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) <sup>43</sup>	4-point response scale; ranging from strongly disagree to strongly agree  ✓ Primary school - Secondary school
36 37 38 39 40 41 42 43 44 45 46 47 48 49	Existence	Child-reported; multiple items	“My [ <i>mother/father</i> ] and I do active things together (like walking, bike riding,	Children were asked if the statement was “true” or 3 studies; USA <sup>63,64,65a</sup> Age range; 5-13 years

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in questionnaire	playing sports) and "When my [ <i>mother/father</i> ] does something active [ <i>she/he</i> ] lets me do it with [ <i>her/him</i> ]".	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.	"false" for them. Based on their initial response they were asked if the statement was "really" or "sort of" true/false	- Pre-school ✓ Primary school - Secondary school
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- Activity-Related Parenting Practices Scale <sup>65</sup>
- The Activity Support Scale (ACTS) <sup>66</sup>
- The Activity Support Scale for Multiple Groups (ACTS-MG) <sup>67</sup>

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Existence	Parent reported; single-item in questionnaire	“I exercise/am physically active with my child[ren]/family [ <i>on a regular basis</i> ]” • Healthy Lifestyle Behaviors Scale <sup>63</sup> • Activity Support Scale <sup>68,69</sup>	4 to 5-point response scale; ranging from strongly disagree to strongly agree	3 studies; Australia <sup>69</sup> , USA <sup>63,68</sup> Age range; 5-15 years - Pre-school ✓ Primary school ✓ Secondary school
16 17 18 19 20 21 22 23 24 25 26 27 28 29	Existence	Parent reported; single-item in questionnaire	“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 <sup>70</sup>	5-point response scale; ranging from strongly disagree to strongly agree	1 study; Australia <sup>70</sup> Age range; 3-5 years ✓ Pre-school - Primary school - Secondary school
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49	Existence	Parent-reported; two items in questionnaire	“I take part in physical activity with my child during weekdays / weekend days (e.g. walking, cycling)” • Adopted Parental Influence on	4-point response scale; ranging from strongly disagree to strongly agree	1 study; Cyprus <sup>45</sup> Age range; 11-12 years - Pre-school ✓ Primary school - Secondary school

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<i>(cont. from previous page)</i>	Physical Activity Scale (Turkish and/or Greek) <sup>43</sup>	
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Existence	Parent reported; multiple items in questionnaire	Respondents identified with whom They often exercise from a list of enumerated family members. <ul style="list-style-type: none"> <li>• Unnamed; no specific construct reported (Spanish)<sup>71</sup></li> </ul>	Depending on enumerated family members (tick yes/no)	1 study; USA <sup>71</sup> Age range; 5-18 years - Pre-school ✓ Primary school ✓ Secondary school
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Frequency	Child-reported; single-item in questionnaire	“In [ <i>period of time</i> ], how often does/did [ <i>your mum or dad parents/a member of your household</i> ] exercise, a physical activity or played sports together with you?”	4 to 6-point response scale; ranging from none or never to every day, very often, daily or always	23 studies; Australia <sup>72</sup> , Belgium <sup>73</sup> , Brazil <sup>39</sup> , Canada <sup>75</sup> , Europe (multiple countries) <sup>42,76,77,78</sup> Iran <sup>79</sup> , Spain <sup>74</sup> , UK <sup>52,80</sup> , and USA <sup>81b,40,82,83,84,85,86,87,88,89,90</sup>
				Age range; 8-17 years
		<ul style="list-style-type: none"> <li>• Unnamed; scale assesses the social environment at home<sup>72</sup></li> </ul>		- Pre-school
		<ul style="list-style-type: none"> <li>• Unnamed; scale assesses parent co-participation in physical activity<sup>73,74</sup> (Dutch<sup>73</sup>) (Spanish<sup>74</sup>)</li> </ul>		✓ Primary school
		<ul style="list-style-type: none"> <li>• The Social Support for Exercise Scale for Adolescents (Brazilian-Portuguese)<sup>39</sup></li> </ul>		✓ Secondary school
		<ul style="list-style-type: none"> <li>• Modified Parent Support Scale (French)<sup>75</sup></li> </ul>		
		<ul style="list-style-type: none"> <li>• ENERGY-Child Questionnaire (Dutch, Greek, Hungarian, Norwegian, Spanish, Slovenian)<sup>42,76,77</sup></li> </ul>		
		<ul style="list-style-type: none"> <li>• Perceived Social Support Scale (Danish, Estonian, Norwegian Portuguese)<sup>78</sup></li> </ul>		

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Frequency	Child-reported; single-item in questionnaire	“Do you participate in physical activity together with <i>[your mother, father]?</i> ”  • Unnamed; scale assesses parent involvement in physical activity (Swedish) <sup>91</sup>  • Unnamed; no specific construct reported (Norwegian) <sup>92</sup>	5-point response scale; ranging from not at all or never to very much or $\geq 4$ times a week	2 studies; Finland <sup>91</sup> and Norway <sup>92</sup>  Age range; 11-13 years  - Pre-school ✓ Primary school - Secondary school
Frequency	Child reported; two items in questionnaire	“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 <sup>38</sup>	5-point response scale; ranging from not at all to about every day	1 study; USA <sup>38</sup>  Age range; 11-12 years  - Pre-school ✓ Primary school - Secondary school

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Frequency	Child-reported; multiple items in questionnaire	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) <sup>49</sup>	5-point response scale; ranging from never to every day	1 study; Europe (multiple countries) <sup>49</sup>  Age range; 13-15 years  - Pre-school  - Primary school  ✓ Secondary school
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Frequency	Parent-reported; “In [ <i>period of time</i> ], how often are you	4 to 6-point response scale;	23 studies; Australia <sup>68,93,92,95,103,104</sup> ,
1	single-item in	[ <i>and/or your partner/another</i>	Canada <sup>105,106</sup> , Europe (multiple
2	questionnaire	<i>parent/guardian/another member of your</i>	countries) <sup>41,76,77,107</sup> , USA
3		<i>household/your child’s siblings]</i>	96,98c,99,100,101,102d,108,109,110, and
4		very often	
5	physically active/playing sports with your		UK <sup>97,111</sup>
6	child?”		Age range; 2-18 years
7	• Unnamed; scale assessed physical		✓ Pre-school
8	activity social interaction and support		✓ Primary school
9	70		✓ Secondary school
10	• Unnamed; scale assesses family co-		
11	participation in physical activity <sup>93,94</sup>		
12	• Unnamed; scale assesses		
13	social/family/parent support for		
14	physical activity <sup>95,96,97,98,99,100,101,102</sup>		
15	• Unnamed; scale assesses parent		
16	encouragement for physical activity		
17	103		
18	• Unnamed; scale assesses parental		
19	interaction in physical activity <sup>104</sup>		
20	• Adapted Activity-Related Parenting		
21	Practices Scale <sup>105,106</sup>		
22	• ENERGY-Child Questionnaire		

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5	Frequency	Parent-reported;	“In [ <i>period of time</i> ], how many days did	7-point response scale to
6		single-item in	you or another adult in your household do	indicate number of days per
7		questionnaire	any physical activities with child	week or free text option
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12	(cont. from		including things like active games, sports,	- Pre-school
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14	previous page)		or other physical activities, and so	✓ Primary school
15			forth?”****	✓ Secondary school
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19			• Maternal Parenting for Physical	
20			Activity Scale <sup>112</sup>	
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22			• Unnamed; scale assesses co-physical	
23			activity/social support for physical	
24				
25			activity <sup>113,35,114,114</sup> (French <sup>114</sup> )	
26				
27			• Unnamed; no specific construct	
28			reported <sup>115</sup>	
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Frequency	Parent-reported; single item in questionnaire	“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 <sup>65,117,118,119,120</sup> (Dutch <sup>120</sup> )	4-point response scale; ranging from rarely to frequently	5 studies; USA <sup>65,117,118</sup> , UK <sup>119</sup> , and Belgium <sup>120</sup>  Age range; 6-12 years  - Pre-school ✓ Primary school - Secondary school
<hr/>				
Frequency	Parent-reported; single-item in questionnaire	“Do you ever do sports or exercise together with your child in 7th grade?”  • Unnamed; no specific construct reported (Norwegian) <sup>92</sup>	5-point response scale; ranging from never to 4 times a week or more often	1 study; Norway <sup>92</sup>  Age range; 13 years  - Pre-school ✓ Primary school - Secondary school

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	Frequency	Parent-reported; single item in questionnaire	“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 <sup>70</sup>  Age range; 3-5 years  ✓ Pre-school  - Primary school  - Secondary school
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35	Frequency	Parent-reported; two items in questionnaire	“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?” ****  • Adapted Family Food Environment Scale and Food Involvement Scale  121,122	5-point response scale; ranging from never to more than 4 times per week	2 studies; Australia <sup>121,122</sup>  Age range; 5-11 years  - Pre-school  ✓ Primary school  - Secondary school

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Frequency	Parent-reported; two items in questionnaire	“My child participates in physical activities with parents/caregivers”, and “I participate in physical activity with my child”  • Family Health Behavior Scale <sup>123</sup>	5-point response scale; ranging from almost never to nearly always	1 study; USA <sup>123</sup>  Age range; 5-12 years - Pre-school ✓ Primary school - Secondary school
Frequency	Parent-reported; multiple items in questionnaire  <i>(cont. from previous page)</i>	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.**  • Unnamed; no specific construct reported <sup>51</sup>  • Unnamed; scale assesses family social support for physical activity <sup>50,52</sup>  • Preschooler Physical Activity Parenting Practices Scale <sup>53</sup>	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	4 studies; Australia <sup>51</sup> , UK <sup>50,52</sup> and USA <sup>53</sup>  Age range; 3-12 years ✓ Pre-school ✓ Primary school - Secondary school

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	Frequency	Parent-reported; multiple items in questionnaire	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) <sup>124</sup>	No complete response scale given, but described as 'never, once a week, etc.'	1 study; USA <sup>124</sup>  Age range; 3-5 years  ✓ Pre-school  - Primary school  - Secondary school
23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49	Duration	Parent-reported; single-item in questionnaire	"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 <sup>125</sup>	Hours per week; entered as free text	1 study; USA <sup>125</sup>  Age range; 11-14 years  - Pre-school  - Primary school  ✓ Secondary school



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Duration	Parent-reported; single-item in questionnaire	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 <sup>126</sup>	Minutes per week; entered as free text	1 study; Australia <sup>126</sup>  Age range; 4-19 months  ✓ Pre-school  - Primary school  - Secondary school
Duration  <i>(cont. from previous page)</i>	Parent-reported; two items in questionnaire	“How many days per week and how many minutes per day do [you and/ or spouse/significant other] engage in physical activity together with your child?”***  • Adapted Godin Leisure-Time Exercise Questionnaire (GLTEQ), International Physical Activity Questionnaire and Behavioral Risk Factor Surveillance System Survey	Minutes per week; entered as free text	2 studies; Canada <sup>45</sup> , USA <sup>115</sup>  Age range; 4-15 years  - Pre-school  ✓ Primary school  ✓ Secondary school

		Questionnaire <sup>45</sup>		
		<ul style="list-style-type: none"> <li>• Unnamed; no specific construct reported<sup>115</sup></li> </ul>		
Duration	Parent-reported; multiple items in questionnaire	Mothers indicated the number of times and actual time per week during the morning, afternoon and evening, that they walked or cycled to/from places with their child and participated in active play with their child indoors/outdoors.**.***	Minutes per week; entered as free text	2 studies; Australia <sup>36,127</sup> Age range; 1-3 years ✓ Pre-school - Primary school - Secondary school
	(cont. from previous page)	<ul style="list-style-type: none"> <li>• Unnamed; scale assesses co-participation in physical activity<sup>36,127</sup></li> </ul>		
Duration	Child and parent-reported; ecological momentary assessment	Electronic surveys assessed primary activity (e.g. active play/sports/exercise), physical location (e.g. home, outdoors), social context (e.g. friends, alone), current mood (positive and negative	Possible responses <sup>58</sup> ; alone, class, friends, boy/girlfriend, family, teacher, stranger, or other adult. Possible responses <sup>57</sup> ; alone,	2 studies; USA <sup>57,58</sup> Age range; 9-13 years - Pre-school ✓ Primary school ✓ Secondary school

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<i>(cont. from previous page)</i>	(EMA) and accelerometry	affect), and enjoyment.**	with your mom or dad, sister(s) or brother(s), other family members, friends, classmates, people you don't know (yes/no). For this study, responses were time- matched to the number of steps and minutes of moderate-to-vigorous physical activity (measured by accelerometer) in the 30 minutes before each survey.
	Duration	Child and parent; child- reported diary and	Family dog-walking behaviour assessed by ActiGraph data from parent, child, and dog. Periods of simultaneous activity identified from child-dog walking

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	accelerometry	diary.**		- Secondary school
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 <sup>44,56</sup> 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. • Unnamed; no specific construct reported <sup>128</sup>	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 <sup>128</sup> Age range; 9-11 years - Pre-school ✓ Primary school - Secondary school
Type	Parent-reported; two items in	Parents report the number of times they were physically active with their child	Not reported	1 study; USA <sup>129</sup> Age range; 5-10 years

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	questionnaire	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"> <li>• Unnamed; scale assesses parent physical activity with child <sup>129</sup></li> </ul>		<ul style="list-style-type: none"> <li>- Pre-school</li> <li>✓ Primary school</li> <li>- Secondary school</li> </ul>

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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.***. ****	Possible responses; on my own, with friend, with brother/sister, with mum or dad, with another grown up	1 study; UK <sup>130</sup> Age range; 10-11 years
				<ul style="list-style-type: none"> <li>- Pre-school</li> <li>✓ Primary school</li> <li>- Secondary school</li> </ul>

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	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.*** *****  • Adopted Parental Influence on Physical Activity Scale (Turkish and/or Greek) <sup>43</sup>	Possible responses; alone, brothers or sisters, friend(s), parents, or other adult.	1 study; Cyprus <sup>43</sup>  Age range; 11-12 years  - Pre-school ✓ Primary school  - Secondary school
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35	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 <sup>131</sup>  Age range; 9-11  - Pre-school ✓ Primary school  - Secondary school
36 37 38 39 40 41 42 43 44 45 46 47 48 49	Type	Child and parent-reported;	Both parents and children were asked to report on the type of activities they had	Not applicable	1 study; USA <sup>46</sup>  Age range; 7-14 years

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	event history	engaged in as a family over the past two		- Pre-school
	calendar (EHC)	months (may include non-active time).		✓ Primary school
		Also answered, “what does your family		✓ Secondary school
		do to play or be active?” as free text		
		question.		
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 <sup>47</sup> Age range; 4-7.5 years - Pre-school ✓ Primary school - Secondary school

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previous page)

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 <sup>48,132,133</sup> Age range; 10-12 years - Pre-school ✓ Primary school - Secondary school
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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

<sup>a</sup> General familial support was not assessed in Lampard et al (2014)

<sup>b</sup> 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)

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



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

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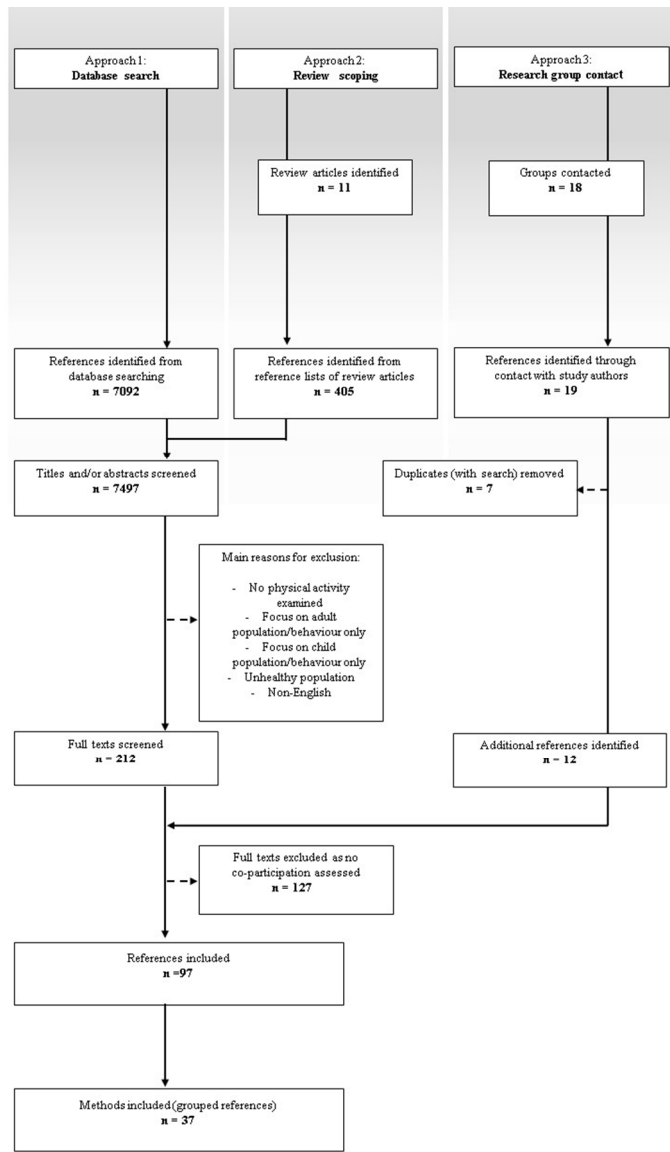


Figure 1. Flow chart for selection of references

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# PRISMA 2009 Checklist

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Section/topic	#	Checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4-5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
<b>METHODS</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	NA
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7-8
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5-7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supp.
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6-8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	NA
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ ) for each meta-analysis.	8



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Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
<b>RESULTS</b>			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	9
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	9-11
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	NA
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	9-12
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	9-12
<b>DISCUSSION</b>			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	12-15
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	16-17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17-18
<b>FUNDING</b>			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	NA

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: [www.prisma-statement.org](http://www.prisma-statement.org).

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3 **A Systematic Review of Methods to Measure Family Co-Participation in Physical**  
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5 **Activity**  
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### Supplementary File 1. Details of search strategy for databases

The search strategy consists of 3 different search term blocks:

#1	
<b>Construct</b>	Physical activity OR exercise OR energy expenditure OR sport OR active travel OR walking OR cycling
#2	
<b>Population</b>	Family OR family-based OR parent OR mother OR father OR primary caregiver OR guardian OR sibling OR brother OR sister OR aunt OR uncle OR cousin
#3	
<b>Instrument</b>	Questionnaire OR accelerometer OR proxy-report OR parent-report OR child-report OR observation OR pedometer

#1, #2 and #3 are combined with AND terms in the respective databases.

‘Motor activity’, ‘Sports’, ‘Exercise’, ‘Family’, ‘Data collection’, ‘Accelerometry, and

‘Observation’ are used as MESH terms in PubMed.

To illustrate, the following search was performed in PubMed:

Search (((((((((((("motor activity"[MeSH Terms]) OR "sports"[MeSH Terms]) OR "exercise"[MeSH Terms]) OR physical activity[Title/Abstract]) OR exercise [Title/Abstract]) OR energy expenditure[Title/Abstract]) OR sport[Title/Abstract]) OR active travel[Title/Abstract]) OR walking[Title/Abstract] OR cycling[Title/Abstract]))) AND (((((((((((("family"[MeSH Terms]) OR famil\*[Title/Abstract]) OR family-based[Title/Abstract]) OR parent[Title/Abstract]) OR mother[Title/Abstract]) OR father[Title/Abstract]) OR primary caregiver[Title/Abstract]) OR guardian[Title/Abstract]) OR sibling[Title/Abstract]) OR brother[Title/Abstract]) OR sister[Title/Abstract]) OR aunt[Title/Abstract]) OR uncle[Title/Abstract]) OR cousin[Title/Abstract]))) AND (((((((((((("data collection"[MeSH Terms]) OR "accelerometry"[MeSH Terms]) OR "observation"[MeSH Terms]) OR questionnaire[Title/Abstract]) OR accelerometer[Title/Abstract]) OR proxy-report[Title/Abstract]) OR parent-report[Title/Abstract]) OR child-report[Title/Abstract]) OR observation[Title/Abstract] OR pedometer[Title/Abstract]))))

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3 Co-participation in physical activity is the main focus of the review, but the term co-  
4 participation does not adequately fit in the search term blocks described above. Therefore, in  
5 addition to the comprehensive search, a simple search across all databases was performed  
6 combining the terms co-participation/cooparticipation and physical activity.  
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14 To illustrate, the following search was performed in PubMed:  
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16 Search (((co-participation[Title/Abstract]) OR cooparticipation[Title/Abstract])) AND  
17 physical activity[Title/Abstract]  
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23 The full search strategy for all databases can be obtained upon request from the first author.  
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