

# Parent–Child Coparticipation in Physical Activity and Its Associations With Daily Physical Activity and Key Correlates: Findings From the Families Reporting Every Step to Health Study

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**Background:** Limited evidence exists for the role of parent–child coparticipation in physical activity (joint light, moderate, or vigorous physical activities involving at least 1 child and a parent) in parents’ and children’s overall physical activity. This study examined the association of parent–child coparticipation in physical activity with parental and children’s daily physical activity and explored correlates of coparticipation. **Methods:** Data were from 149 participants (41 families: 67 parents [30–55 y, 57% female] and 82 children [4–16 y, 40% girls]) in the Families Reporting Every Step to Health pilot study. Families Reporting Every Step to Health was a 3-armed, parallel-group, randomized controlled pilot trial. Participants’ physical activity and location were measured simultaneously with accelerometers and Global Positioning System monitors. Data from 3 data collection points (baseline and 2 follow-ups) were analyzed cross-sectionally using multivariable linear mixed models with random intercepts at the family and participant levels. **Results:** At baseline, children and parents accumulated an average of 70 and 36 minutes per day, respectively, of parent–child coparticipation in physical activity, which contributed 33% and 17% of their daily total physical activity, respectively. For both parents and children, coparticipation was positively associated with daily total physical activity ( $\beta=0.37$ ; 95% CI, 0.19–0.55 min/d) and daily moderate- to vigorous-intensity physical activity ( $\beta=0.10$ ; 95% CI, 0.03–0.16 min/d). Coparticipation in physical activity was on average 28.80 (11.23–46.37) minutes per day lower among parents than among children. **Conclusion:** Parent–child coparticipation in physical activity might be a promising component of family-based interventions to promote physical activity among children and parents.

**Keywords:** family-based intervention, LMVPA, MVPA, accelerometer, GPS

## Key Points

- Parent–child coparticipation was positively associated with daily total physical activity and moderate- to vigorous-intensity physical activity for both parents and children.
- Encouraging coparticipation may be a simple and effective way to increase physical activity across the whole family.

Regular physical activity offers benefits for all population groups. Among adults, a physically active lifestyle reduces the risk of premature mortality and chronic diseases and improves mental

health and quality of life.<sup>1–3</sup> Among children, physical activity is associated with better physical, psychological, and cognitive outcomes.<sup>4,5</sup> However, recent evidence suggests that the majority of children worldwide do not engage in sufficient activity to benefit their health and well-being.<sup>6</sup> As children transition to adolescence, their already low level of physical activity declines further.<sup>7</sup> Healthy movement behaviors (including physical activity) develop in early childhood, track well into adulthood, and predict future health outcomes.<sup>8</sup> Hence, ensuring the early development of healthy behaviors is a public health priority to ensure longer term population health benefits. However, a better understanding of factors that promote children’s physical activity is required to develop effective intervention strategies.

Family-based interventions can be central in developing and sustaining healthy movement behaviors as children spend much time at home with parents/guardians and siblings. There is consistent positive evidence that parental factors, family support, and a supportive home environment can promote physical activity among

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young children.<sup>9–13</sup> Parents can positively influence children's physical activity by positive role modeling, and rules and restrictions around outdoor play and screen time, being active with them (coparticipation), and providing material and moral support.<sup>13,14</sup> Further, dyadic models of health behaviors posit that parents and children bidirectionally influence each other's health behaviors (including physical activity).<sup>15</sup> The Dyadic Health Influence Model suggests that this occurs through the interplay between modeling health behaviors and shaping the shared environment, enacting relationship promoting behaviors and intentionally implementing behavior modification strategies.<sup>16</sup>

Previous studies have shown higher overall physical activity among children who coparticipate in physical activities with their parents.<sup>14,17–19</sup> However, family coparticipation studies have generally overlooked potential associations with parental physical activity. Parents are known to have lower activity levels than their childless peers,<sup>20</sup> and benefits of parent–child coparticipation in physical activity may extend beyond improving children's and parents' physical activity levels, to include improved enjoyment of physical activity, increased communication, and strengthened family relationships.<sup>21</sup> Additionally, parents and children may accumulate different levels of physical activity during coparticipation, due to available opportunities and the intensity of the activities performed. Considering potential benefits and a growing interest in family-based interventions, promoting parent–child coparticipation in physical activity may be a potential strategy to encourage physical activity among children and parents.

To date, coparticipation research and practice has mostly been centered around parent–child coparticipation in digital media use, especially among young children.<sup>22</sup> Further, most of the previous studies investigating coparticipation in physical activity have methodological limitations, such as self-report based assessment of physical activity using questionnaires,<sup>22–25</sup> or, are limited to mothers.<sup>18,26,27</sup> Dyadic relationships present within the family are complex and dynamic. Understanding family members' coparticipation in physical activity and the contribution of coparticipation to family members' overall physical activity might be fundamental to developing effective multimember family-based physical activity interventions. Therefore, this study aimed to examine the association of parent–child coparticipation in physical activity with daily total physical activity and moderate- to vigorous-intensity physical activity (MVPA) among parents and children. A secondary aim was to identify the individual and family-level correlates of parent–child coparticipation in physical activity.

## Methods

### Study Design and Participants

This study used data from the FRESH (Families Reporting Every Step to Health) pilot study, described previously.<sup>28–30</sup> Briefly, FRESH was a 3-armed, parallel-group, randomized controlled pilot trial with a 1:1:1 allocation ratio. Participating families were randomly allocated to either “FRESH intervention,” “pedometer-only,” or “no-intervention” arm. “FRESH intervention” was a child-led family-based goal-setting and self-monitoring physical activity intervention delivered via an online platform.<sup>29</sup> Trained research staff conducted assessments at the participants' home at 3 time points (baseline, 8-wk postbaseline, and 52-wk postbaseline). Assessments included anthropometric measurements, questionnaires, submaximal fitness test, and accelerometer and Global Positioning System (GPS) explanations. In line with the study aims, this work examined

the cross-sectional association of parent–child coparticipation in physical activity with daily total physical activity, and daily MVPA, not the effectiveness of the FRESH intervention which was reported previously.<sup>29</sup> Data from the 3 data collection points were entered into the same analysis model and analyzed cross-sectionally after adjusting for the repeated nature of measurements.

A total of 41 families (149 unique participants) from the counties of Norfolk and Suffolk in East Anglia, United Kingdom participated in the study. Around 53% and 42% of Norfolk and Suffolk residents live in rural areas and are mostly of White ethnicity (>90%).<sup>31,32</sup> Eligible families had at least 1 child aged 7–11 years (“index child”), and at least 1 adult responsible for the child consenting to participate. This age range encompasses all UK key stage 2 students (years 3–6) and was selected because physical activity is known to decline sharply from this age.<sup>33</sup> Besides the index child and a consenting parent, other family members (children ≤ 18 y and other adults) could join if interested. Participants were required to have internet access, acceptable understanding of English language, and be able to perform light-intensity physical activity. Ethical approval for FRESH was obtained from the Ethics Committee for the School of the Humanities and Social Sciences at the University of Cambridge. Participating adults provided written informed consent, while parental consent and child assent were obtained for participating children.

### Derivation of Physical Activity Data

Across all 3 data collection points (baseline and 8- and 52-wk postbaseline), participants' physical activity and location were assessed simultaneously with ActiGraph GT3X+ triaxial accelerometers (ActiGraph LLC) and QStarz Travel Recorder BT1000X GPS monitors (Qstarz) worn on separate hips during waking hours for 7 consecutive days.<sup>28–30</sup> A detailed description of the study methodology, including the accelerometer and GPS protocol, is previously published.<sup>28–30</sup> For both parents and children, valid wear for accelerometer data was defined as at least 600 minutes per day of wear over at least 3 days (including 1 weekend day); consecutive zeros for ≥90 minutes was considered nonwear.<sup>34</sup> At least 1 parent and a child needed to both satisfy these criteria to be included in analyses. Accelerometry cut points (count per 15 s) suggested by Evenson et al<sup>35</sup> were used to classify light (26–573), moderate (574–1002), and vigorous activities (≥1003) for children. For adults, counts-per-minute cut points recommended by Troiano et al<sup>36</sup> were used to identify light (100–2019), moderate (2020–5998), and vigorous activities (≥5999). Average daily minutes spent in light, moderate, and vigorous activity for each parent and child were calculated.

### Parent–Child Coparticipation in Physical Activity

Parent–child coparticipation in physical activity was defined as joint physical activities involving at least 1 child (≤18 y) and a parent within a linear separation distance of ≤50 m.<sup>25,37,38</sup> Previous evidence suggests parents and children mostly engage in sedentary or light-intensity activities when in each other's proximity.<sup>17</sup> Therefore, instead of focusing on the more restrictive coparticipation in MVPA, coparticipation in total physical activity (any form of light, moderate, or vigorous activities) was included. As detailed elsewhere,<sup>29</sup> a novel approach was used to extract the average daily duration of parent–child coparticipation in physical activity. Briefly, this was ascertained by integrating date and time stamps of accelerometer and GPS data using tailored Java software.<sup>29</sup> The accelerometer was initialized to record data at a sampling rate of

50 Hz, and the GPS was set to record a location every 10 seconds with an accuracy of approximately 3 m. Participants were instructed to wear the devices on each hip during waking hours for 7 consecutive days. Data from the accelerometer were then downloaded and interpolated to a 10-second epoch using the ActiLife software. Data from the GPS devices were downloaded and entered into the ArcGIS v10.3 (Esri Inc) Geographical Information System, and then longitude and latitude values were converted to easting and northing values, respectively, in accordance with the British National Grid coordinate reference system. Accelerometer data points were then matched to the closest recorded GPS location based on their date and timestamps using bespoke software written in Java. Matching was only made if the time difference between the 2 sets of points was  $\leq 30$  seconds, as used in previous studies.<sup>39,40</sup> Periods longer than this were coded as “missing” because the participant might have moved to a new unrecorded location. No minimum wear time was specified for the GPS due to the difficulty in differentiating reasons for no signal (eg, being indoors vs being switched off); however, for the accelerometer, participants needed at least 1 valid day ( $\geq 600$  min) of accelerometer wear time to be eligible for inclusion. This was done to maximize the available data for the parent–child coparticipation variable. The GPS provided a location for a mean of 751 (191) minutes for adults and 646 (189) minutes for children at baseline and for a mean of 720 (238) for adults and 587 (263) for children at follow-up. A binary variable was created using valid accelerometer data points to indicate whether the participant was undertaking any physical activity in any 10-second interval. Straight-line distance for all possible parent–child combinations for all 10-second intervals was calculated using a Stata script. This information was then used to create a binary variable for distance to indicate whether the parent–child were within  $\leq 50$  m of each other in any given 10-second interval. Daily minutes of physical activity accrued from parent–child coparticipation were ascertained for all possible parent–child combinations based on whether they were undertaking any physical activity within  $\leq 50$  m of each other in any given 10-second interval. A linear separation distance of  $\leq 50$  m indicates the approximate length of a ball court or a large residential yard and is standard practice in coparticipation literature.<sup>37,38</sup>

## Correlates of Interest

We selected correlates of interest a priori, guided by literature<sup>10,13,15,24</sup> and data availability. Individual-level variables (sex and participant type [parent/child]) and family-level variables (family activities and support) were the correlates of interest. Information on these correlates were collected at all 3 data collection points (baseline and 8- and 52-wk postbaseline). Family activities (defined in the study as participation in joint family activities) was derived using the frequency of doing activities (eg, games, walks, and talks) together as a family. During baseline and follow-up assessments, both parents and children ( $\geq 4$  y) were asked, “In an average week, how often do you do these activities together as a family (ie, joint activities including at least 1 child and 1 other family member)?” Examples of activities, included playing active games, going to the park, going for a walk/bike ride/hike/swimming, watching TV or movies, having family talks, visiting friends/family, walking to school, and so forth.<sup>41</sup> These question items were adapted from the SPEEDY study (Sport, Physical activity and Eating behavior: Environmental Determinants in Young people).<sup>41,42</sup> Participants reported the weekly frequency of performing each of these activities as 0 times (coded 0), 1 to 3 times

(coded 1), and 4 or more times (coded 2). See the [Supplementary Material](#) (available online) for the actual questions used for parents and children. The average frequency of participating in these activities was calculated for children and parents, with a higher score indicating higher family activities.

Family support for physical activity was assessed using a previously validated 6-item question (Cronbach  $\alpha = .772$ ).<sup>43</sup> All participants reported the frequency of support for physical activity, such as being active together, encouraging, watching/cheering, and so forth during baseline and follow-up assessments. Parents were asked, “How often do you encourage someone in your family to be physically active (eg, bike riding walking, playing sports)?,” reporting the frequency of providing support as “never” to “often” (5 categories). Children were asked “How often does someone in your family encourage (or tell) you to do active things (like bike riding walking, playing sports)?” reporting the frequency of receiving support from their family members as never, sometimes, or often. Average scores were calculated, with a higher score indicating higher family support (possible score range: 1–5 for parents, 1–3 for children).

## Analysis

All analyses were performed in Stata (V.17.0 SE, StataCorp), and a  $P < .05$  was considered statistically significant. Analysis was mostly exploratory. Descriptive statistics were calculated for the sample including mean (SD) daily minutes of total physical activity; daily minutes of light, moderate, and vigorous physical activity; MVPA; and parent–child co-participation for children and parents. Percentage contribution of co-participation to an individual’s average daily total physical activity was calculated for the whole sample and separately for children and parents.

Participants with complete data for exposures, outcomes, and confounders were included in the regression analysis. Analysis was accounted for repeated measurements and clustering at the family level.

### **Aim 1: To Examine the Association of Parent–Child Coparticipation With Daily Total Physical Activity and MVPA**

A multilevel mixed model with random intercepts at the family (to account for clustering) and participant level (to account for repeated measurements) was fitted, adjusting for participant type (parent/child), sex, group allocation (FRESH/pedometer/control), and average accelerometer wear time. The models were repeated with a multiplicative interaction term to account for potential interaction between coparticipation and participant type. As decided a priori, stratified analyses were conducted to examine differences in associations between coparticipation and total physical activity or MVPA across participant types (parents and children). Children’s models were additionally adjusted for age, given the wide age range of children in the study.

### **Aim 2: To Examine the Correlates of Parent–Child Coparticipation in Physical Activity**

A multilevel mixed model with random intercepts at the family and participant level was fitted to identify individual and family-level correlates of parent–child coparticipation in physical activity.

## Results

Table 1 presents participant characteristics at baseline. Data from 149 participants across 41 families (2–6 members each) were analyzed. There were 82 children (minimum of 1 in 22% of families and maximum of 4 in 2.4%) and 67 parents (63.4% of families had both parents participate). Mean age of children was 9.3

**Table 1 Participant Characteristics at Baseline**

	Parents (n = 67)	Children (n = 82)
Age mean (SD), y	41.3 (5.8)	9.3 (2.6)
Age range	30–55 y	4–16 y
Sex, N (%)		
Male	29 (43.3%)	49 (59.8%)
Female	38 (56.7%)	33 (40.2%)
Ethnicity, N (%)		
White British	61 (93.8%)	—
Others	4 (6.2%)	—
Marital status, N (%)		
Single or living as single	5 (7.7%)	—
Married or living as married	60 (92.3%)	—
Age education completed, N (%)		
≤16 y	13 (20.3%)	—
>16 y	51 (79.7%)	—
Family activities <sup>a</sup>		
Mean (SD)	0.90 (0.23)	1.00 (0.24)
Range	0.38–1.31	0.54–1.54
Family support <sup>a</sup>		
Mean (SD)	3.77 (0.71)	2.48 (0.33)
Range	1.50–5.00	1.67–3.00

<sup>a</sup>n = 64 for parents and n = 67 for children.

(2.6) years (8 children were <6 y at baseline) and that of parents was 41.3 (5.8) years. Around 90% of parents identified as White British and were either married or were living as married. Parents and children had similar average family activities scores at baseline. The average family support score at baseline ranged between 1.5 and 5 for parents and 1.7 and 3 for children (higher score indicates higher support).

Average daily duration of total physical activity, light, moderate, and vigorous physical activity, MVPA; and parent–child coparticipation in physical activity at baseline and the 2 follow-ups are provided in Table 2. See Supplementary Table S1 in [Supplementary Material](#) (available online) for further detailed breakdown across the intervention and control arms. For both parents and children (Table 2) and across all 3 study arms (see Supplementary Table S1 in [Supplementary Material](#) [available online]), duration of total physical activity and parent–child coparticipation was lower at follow-ups than at baseline. Across all 3 data collection points, children accumulated a higher duration of physical activity from parent–child coparticipation than parents (for eg, 70 min/d for children vs 36 min/d for parents at baseline). On average, parent–child coparticipation contributed between 19% and 33% to children’s daily total physical activity compared with 13% to 17% among parents at baseline and follow-up time points (Table 2).

### Association of Parent–Child Coparticipation in Physical Activity With Daily Total Physical Activity and MVPA

Parent–child coparticipation in physical activity was positively associated with both daily total physical activity and daily MVPA (Table 3). After adjustment for potential confounders, every 1 min/day difference in parent–child coparticipation was associated with

0.37 (95% CI, 0.19–0.55) greater minutes per day of total physical activity and 0.10 (95% CI, 0.03–0.16) minutes per day of MVPA for the entire sample (parents and children combined). Our results indicated no significant interaction between participant type (ie, child/parent) and parent–child coparticipation for both daily total physical activity ( $P = .663$ ) and MVPA ( $P = .222$ ). As none of the interaction terms were statistically significant, they were not included in the final model to ensure parsimony.

Stratified analyses for parents and children showed associations of parent–child coparticipation with daily total physical activity and MVPA were significant among both children and parents. For example, every 1 minutes per day difference in parent–child coparticipation was associated with 0.31 (95% CI, 0.11–0.50) greater minutes per day of total physical activity among children and 0.41 (95% CI, 0.06–0.76) minutes per day among parents. Similarly, every 1 minutes per day difference in parent–child coparticipation was associated with 0.07 (95% CI, 0.01–0.14) greater minutes per day of MVPA among children and 0.16 (95% CI, 0.02–0.30) minutes per day among parents.

### Correlates of Parent-Child Co-Participation in Physical Activity

Table 4 presents the correlates of parent–child coparticipation in physical activity. Our results showed that parents were less likely to participate in a higher duration of coparticipation compared with children. Parent–child coparticipation was 28.80 (95% CI, 11.23–46.37) minutes per day lower among parents than among children, provided other factors in the model remain constant. A significant association between parent–child coparticipation and sex, family support, or family activities was not observed.

## Discussion

This study examined the association of objectively measured parent–child coparticipation in physical activity with daily total physical activity and MVPA among parents and children and identified the correlates of parent–child coparticipation in physical activity. Our results suggests that children engaged in a higher duration of coparticipation than parents and coparticipation contributed a higher percentage to their daily total physical activity. Parent–child coparticipation in physical activity was positively associated with daily total physical activity and MVPA for both parents and children, with a slightly more pronounced association for parents and with total daily physical activity. These findings suggest that parent–child coparticipation in physical activity might potentially be a useful strategy for promoting physical activity among parents and children in a family setting.

Previous studies indicate that parents of young children have lower physical activity levels than nonparents.<sup>20</sup> There is emerging evidence on the importance of involving family members in family-based interventions for long-term positive change in children’s physical activity.<sup>44</sup> However, there is limited information on whether these interventions similarly impact other family members, such as parents. Most previous coparticipation studies have either focused on children’s physical activity only<sup>17,18</sup> and/or have mainly recruited mothers.<sup>14,18,26,27</sup> Our study findings suggest parent–child coparticipation in physical activity is positively associated with overall activity levels, with about one third of the shared time likely translating into their total daily physical activity and one tenth into their MVPA. This highlights the value of shared activities in fostering healthier behaviors. This also indicates that parents and

**Table 2 Mean (SD) Duration (in Minutes per Days) of Total Physical Activity, MVPA, and Parent-Child Coparticipation in Physical Activity at Baseline and Follow-Ups**

	Parents <sup>a</sup>	Children <sup>b</sup>
Baseline	n = 59	n = 70
Total physical activity	211.3 (46.3)	223.3 (55.9)
Light physical activity	160.5 (34.8)	169.2 (43.2)
Moderate physical activity	47.5 (15.8)	33.3 (11.5)
Vigorous physical activity	3.3 (4.0)	20.8 (10.6)
MVPA	50.8 (17.7)	54.1 (20.0)
Parent-child coparticipation in physical activity	36.0 (21.1)	70.2 (43.8)
Contribution of parent-child coparticipation to daily total physical activity, % (SD)	17.2 (9.2)	32.8 (20.9)
8-wk follow-up	n = 52	n = 56
Total physical activity	188.0 (44.9)	206.3 (50.6)
Light physical activity	144.4 (35.5)	159.6 (39.6)
Moderate physical activity	40.9 (16.9)	29.0 (8.9)
Vigorous physical activity	2.7 (3.9)	17.7 (8.9)
MVPA	43.6 (18.1)	46.7 (16.0)
Parent-child coparticipation in physical activity	24.3 (21.5)	39.2 (33.2)
Contribution of parent-child coparticipation to daily total physical activity, % (SD)	13.2 (11.7)	18.6 (14.9)
52-wk follow-up	n = 46	n = 52
Total physical activity	197.2 (56.0)	189.4 (53.5)
Light physical activity	149.1 (43.8)	145.8 (42.0)
Moderate physical activity	44.0 (20.7)	27.3 (10.0)
Vigorous physical activity	4.1 (6.9)	16.2 (8.7)
MVPA	48.1 (23.8)	43.6 (16.2)
Parent-child coparticipation in physical activity	24.8 (24.1)	45.2 (37.1)
Contribution of parent-child coparticipation to daily total physical activity, % (SD)	14.0 (11.7)	23.6 (19.4)

Abbreviation: MVPA, moderate to vigorous physical activity.

<sup>a</sup>n for parent-child coparticipation among parents was 39, 39, and 30 at the 3 time points. <sup>b</sup>n for parent-child coparticipation among children was 36, 27, and 32 at the 3 time points.

**Table 3 Association of Parent-Child Coparticipation in Physical Activity With Daily Total Physical Activity and MVPA (n = 186)<sup>b</sup>**

	Parent-child coparticipation in physical activity $\beta$ (95% CI)
Total physical activity	
Unadjusted	0.37 (0.19–0.56)
Adjusted <sup>a</sup>	0.37 (0.19–0.55)
MVPA	
Unadjusted	0.10 (0.04–0.17)
Adjusted <sup>a</sup>	0.10 (0.03–0.16)

Abbreviation: MVPA, moderate to vigorous physical activity.

<sup>a</sup>Adjusted for participant type, sex, group allocation, and accelerometer wear time.

<sup>b</sup>n = 186 for unadjusted and adjusted analyses for both outcomes.

children who coparticipate in physical activity are more likely to engage in higher overall physical activity levels even when they are not in each other's proximity, a finding consistent with previous studies among children.<sup>14,17–19</sup> Our study appears to expand the evidence base, indicating that this positive association also holds for parents. However, longitudinal studies are needed to strengthen the evidence base, as the cross-sectional design of this study limits our ability to ascertain temporality. Besides the other benefits of parent-

**Table 4 Correlates of Parent-Child Coparticipation in Physical Activity**

	Parent-child coparticipation in physical activity	Unadjusted $\beta$ (95% CI)	Adjusted $\beta$ (95% CI) <sup>a,b</sup>
Participant type			
Child		1	1
Parent		-23.95 (-34.17 to -13.73)	-28.80 (-46.37 to -11.23)
Sex			
Male		1	1
Female		-3.96 (-15.53 to 7.60)	-1.50 (-12.10 to 9.10)
Family support		-8.50 (-14.92 to -2.07)	5.10 (-5.20 to 15.39)
Family activities		23.14 (2.96 to 43.31)	14.43 (-5.63 to 34.49)

<sup>a</sup>Adjusted for all variables in the table and group allocation. <sup>b</sup>n = 198 for adjusted analysis and unadjusted analyses of family support and activities, n = 203 for unadjusted analyses of participant type and sex.

child coparticipation, such as enhanced enjoyment of physical activity, direct observation and role modeling opportunities, increased communication, and strengthened family relationships,<sup>21,45</sup> our findings suggest that parent-child coparticipation might also benefit physical activity levels of both children and parents. A previous

Australian study reported that girls (aged 8–17 y) valued the time spent coparticipating in sports with their fathers and considered that this early socialization would influence their sports participation and physical activity behaviors over a longer term.<sup>46</sup> There is also some evidence from a US-based study among low-income mothers with obesity and their 6- to 12-year-old children that mother–child coparticipation in physical activity reduces children’s sedentary time.<sup>14</sup> Hence, promoting coparticipation might be a simple yet effective family-based intervention strategy for promoting physical activity among multiple family members. The benefits of parent–child coparticipation appear to be attractive and effective for families, especially for parents not currently meeting the physical activity guidelines. The slightly more pronounced association observed for total physical activity than MVPA may imply that parents and children tend to engage in more light-intensity activities when together. This supports our rationale for including all forms of physical activity in calculating coparticipation, rather than limiting it to a more restrictive definition of coparticipation in MVPA. However, the possibility of a healthy volunteer bias cannot be overlooked, as most participants were already meeting physical activity guidelines at baseline. Future studies may benefit from recruiting families with a broader range of baseline physical activity levels.

Earlier evidence suggests that coparticipation constitutes a small portion of parent’s and children’s daily physical activity, and coparticipation is usually directed toward sedentary activities.<sup>18,45</sup> Hnatiuk et al,<sup>26</sup> in their study among Belgian mothers, found that almost half of the participants never, or, seldom participated in a joint activity, such as walking/cycling, playing sports, or going to the park/playground with their 4–6 year-old children. In contrast, in this study, parent–child coparticipation constituted a relatively high percentage of children’s ( $\geq 19\%$ ) and parents’ ( $\geq 13\%$ ) daily total physical activity at all 3 data collection points. Compared with parents, children engaged in a higher duration of coparticipation, contributing a higher percentage to their daily total physical activity. This potentially was due to greater coparticipation opportunities for children than parents. For example, they could coparticipate simultaneously with both parents and separately with either of the parents. Additionally, children, in general, could be more active than parents, even during coparticipation. For example, it is likely that parents will be involved for the entire “coparticipation session,” but they may not be running around in the same way children are. In their qualitative study with Australian parents of preschoolers,<sup>45</sup> Hnatiuk et al also reported that the child’s desire to play together often initiated coparticipation. This study’s methodology, however, did not allow for the examination of the types and context of coparticipation, which would be beneficial to address.

Regarding correlates of parent–child coparticipation in physical activity, only participant type (child/parent) appears to be associated. As explained earlier, children were more likely than parents to engage in a higher duration of coparticipation. No significant associations were indicated for other examined correlates, such as sex, family support, and family activities. Most previous coparticipation studies have examined mother–child coparticipation.<sup>14,18,26,27</sup> Limited available evidence on the difference in coparticipation between girls/boys and mothers/fathers suggests that younger children are more likely to coparticipate in physical activity with mothers<sup>17</sup> (especially mother–daughter dyads<sup>14,19</sup>). The initially observed positive effects of “Run Daddy Run” intervention on father–child coparticipation during weekdays and weekends were only sustained during weekends at 6 months postintervention, potentially due to limited leisure time during weekdays because of work and school-related commitments.<sup>47</sup> Future studies might

consider examining if there are differences in coparticipation based on participating parent–child pairs to identify target participants who might offer greater returns in future interventions.

Family activities were not associated with objectively measured parent–child coparticipation in physical activity. In contrast, a previous US study<sup>17</sup> among parent–child (2–5 y) dyads reported a moderate positive association between objectively measured coparticipation and parent-reported family physical activity, assessed using similar items as family activities that was separately reported by parents and children in this study. The discrepancy might partially be attributed to challenges in recalling the types and frequency of activities by children in this study. There is previous evidence on the positive role of family support in promoting children’s<sup>13</sup> and adults’<sup>48</sup> physical activity; however, this study’s results indicated that family support might not be as important for parent–child coparticipation in physical activity. While the actual reasons for the lack of an association are unclear, a possible explanation might be that coparticipation is usually initiated by children’s desire to play together<sup>45</sup> and might be independent of factors, such as encouragement of physical activity, or watching/cheering that were classified as “family support” in this study.

## Strengths and Limitations

Strengths of the study include the inclusion of both children and parents (mothers and fathers) and accelerometer-measured physical activity. Integration of accelerometer and GPS data to ascertain coparticipation provided a device-based measure of frequency, duration, and intensity in which coparticipation occurred. There are also some limitations to consider. The analyses were primarily exploratory in nature due to the limited sample size. Our analysis sample size was further decreased due to the removal of any matched parent–child pair for whom either accelerometer or GPS data was missing for either the parent or the child. Our methods for assessing parent–child coparticipation, while recommended in the literature,<sup>25</sup> have not been validated. Inherent weaknesses of accelerometers and GPS (such as signal interference, device orientation, user compliance, etc) should be considered when interpreting the study findings. Child’s coparticipation in physical activity could have been double counted if a child was simultaneously active with both parents, which may have led to an overestimation of the associations. Likewise, 1 parent could have been active with multiple children, potentially repeat counting of adults’ activity. Additionally, if a child and a parent were active independently at the same time but were within 50 m of each other, it could have been included as coparticipation. The questions used to assess family support and activities have not been validated among children, and there might have been some variability in their responses across the ages. As previously reported,<sup>29</sup> the FRESH intervention, on which this study is based, had no effect on physical activity or coparticipation. Hence, the associations observed in this study can be considered typical of the population and unaffected by the intervention. However, this still should be considered alongside that FRESH sample was relatively active at baseline when generalizing the findings to the general population. Finally, although we used data from 3 time points, they were analyzed cross-sectionally, which limits inferences about causality.

## Conclusions

Parent–child coparticipation in physical activity constituted more than one tenth of parents’ and children’s overall physical activity. It

may be an accessible way for families to integrate movement while spending time together. Coparticipation in physical activity could be an important component of family-based interventions, potentially offering greater returns by targeting parents. Future studies with a larger sample size, longitudinal design, and examination of context and types of coparticipation activities are recommended.

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