Parental Support and Objectively Measured Physical Activity in Children: A Yearlong Cluster-Randomized Controlled Efficacy Trial

Arto Laukkanen, Arto J. Pesola, Taija Finni, and Arja Sääkslahti

University of Jyväskylä

ABSTRACT

Purpose: We studied whether physical activity (PA) counseling for parents influenced the level of parental support of children’s PA and leisure-time PA in children of different levels of initial parental support. We hypothesized that the initial level of parental support would moderate the intervention efficacy. Method: Children (n = 44, M_{age} = 6.09 ± 1.17 years) and their parents (n = 61) randomly assigned to an intervention group received counseling for 6 months. Children in the control group (n = 47, M_{age} = 6.12 ± 1.11 years) and their parents (n = 63) did not receive any counseling. Parental support was assessed using the Family Physical Activity Environment Questionnaire, and children’s leisure-time PA was recorded using triaxial accelerometers at baseline, at 6 months, and at 12 months. The efficacy of the intervention was tested by linear mixed-effects modeling adjusted for confounding variables (Model 1) and additionally for children’s participation in organized PA or sports (Model 2). Results: Parents within the lowest initial parental support intervention tertile significantly increased their support, and their children’s mean level of leisure-time PA significantly improved compared with the corresponding controls during the counseling period. On the other hand, intervention was found to have an unfavorable influence especially in the PA of children of initially highly supportive parents. Conclusion: Targeting PA counseling for parents with low support of their children’s PA could contribute to better family-based PA counseling efficacy.

The role of physical activity (PA) in health is well documented already in childhood (Strong et al., 2005). PA may also play a crucial role in cognition (Tomporowski, Lambourne, & Okumura, 2011) as well as in psychosocial well-being (Timmons et al., 2012). Due to a high prevalence of inactivity among children (Spittaels et al., 2012) and tracking of PA behavior over time (Telama et al., 2014), there is a need to identify feasible and effective strategies to influence the early formation of PA habits.

Leisure-time PA has been shown to be low and progressively decreasing during childhood (Telford et al., 2013). Family influence has been recognized as one of the most important predictors of children’s overall, as well as leisure-time, PA. Parental support of children’s PA (Beets, Cardinal, & Alderman, 2010; Cleland et al., 2011; Edwardson & Gorely, 2010; Loprinzi & Trost, 2010; Rhodes et al., 2013), parents’ perceived behavior control over children’s PA (Rhodes et al., 2013), and parents’ participation in PA with a child (Beets et al., 2010; Edwardson & Gorely, 2010) have all been linked to greater PA in children. However, parents’ own PA levels seem to not be a prerequisite for children’s PA nor is parents’ own inactivity a primary barrier for children’s PA (e.g., Iannotti et al., 2005; Yao & Rhodes, 2015), but it is the case that physically active parents tend to more often support children’s PA (Dowda et al., 2011; Loprinzi & Trost, 2010). Sedentary behavior, based on the limited research literature to date, does seem to associate between parents and their children (Jago, Fox, Page, Brockman, & Thompson, 2010), and activities performed together as a family are typically sedentary in nature (Thompson et al., 2010). Therefore, encouraging parental support for children’s PA and limiting coparticipation in sedentary behaviors remain potential intervention strategies for affecting PA in children.

Direct involvement of parents (e.g., parents’ presence at education sessions, parents’ attendance and participation at counseling or training sessions, or phone communication with parents) is known to be a cornerstone of family-based nutrition (Hingle, Connor, Dave, & Baranowski, 2010) and PA interventions (Brown et al., 2016; O’Connor, Jago, & Baranowski, 2015).
Families are known to have heterogeneous work-time demands and free-time interests (Thompson et al., 2010), which may be a reason why focusing on small-step and gradually increasing goal setting and encouragement have been shown to be key methods in family-based PA intervention effectiveness on children’s objectively measured PA (Metcalf, Henley, & Wilkin, 2012). Therefore, there is a great need for examining mechanisms, especially moderators and mediators, of the family-based PA interventions for better understanding how PA in children should be promoted in a family context (Brown et al., 2016; O’Connor et al., 2009).

We conducted a cluster-randomized controlled trial titled, “A Family-Based Tailored Counseling to Increase Nonexercise Physical Activity in Adults With a Sedentary Job and Physical Activity in Their Young Children” (InPact, ISRCTN28668090; Finni, Sääkslahti, Laukkanen, Pesola, & Sipilä, 2011). The InPact study was designed to help parents find ways to decrease sedentary behavior of their own and increase PA in their children. PA counseling in the study was based on social-cognitive theory (Bandura, 1986) and the theory of planned behavior (Ajzen, 1985). The counseling was found to significantly decrease parents’ muscle inactivity and increase light muscle activity in the short term (Pesola et al., 2014). However, PA in children in the intervention group declined statistically significantly compared with their control peers, although the development of some domains of motor competence was positively associated with counseling (Laukkanen, Pesola, Heikkinen, Sääkslahti, & Finni, 2015). Results suggested distinct counseling efficacy for parents and their children’s PA behavior when treated at the same time, which is why we decided to study counseling efficacy on children’s PA behavior in more detail.

The association between parental support of children’s PA and children’s PA has been well documented, but little is known of how to influence changes in these variables (Davison et al., 2013; O’Connor et al., 2009). We hypothesized that the initial level of parental support of children’s PA moderates the efficacy of family-based PA intervention. We based the hypothesis on an assumption that parents who initially provide different levels of support (low or high) for their children’s PA have different potentials for supporting the change in their children’s PA behavior, which may affect counseling efficacy on their children’s PA. Consequently, this study examined whether a family-based PA intervention, consisting of individually tailored face-to-face and phone counseling for parents of children aged 4 to 7 years, influenced parental support of children’s PA and objectively measured leisure-time PA in children with the lowest and highest initial parental support. We aimed to complement interpretation of the intervention efficacy analyses by describing intervention evaluation separately from the view of parents with the lowest and highest initial parental support of children’s PA.

Methods

The local ethics committee approved the study protocol (Dnro 6U/2011), and all parents signed a written informed consent form for their own and their children’s participation in the study. A checklist of the CONSORT 2010 Statement for reporting randomized trials (Moher et al., 2010) guided reporting of the methods and findings of this trial.

Cluster randomization and recruitment

We performed randomization and recruitment in a Scandinavian city with about 133,000 inhabitants living in a relatively small city center and topographically varied suburbs. Based on a city registry and recreational city map, we identified equivalent suburbs in the city in terms of the number of children attending regional kindergarten(s) or day-care center(s) (henceforth referred as day-care center(s) and school(s), mean educational level of the region, and PA possibilities in natural landscapes. We then formed seven balanced counterpart regions (henceforth referred as “clusters”, one to four day-care centers or schools in each cluster) and randomly assigned them to either the intervention or the control cluster. Families were recruited from the intervention cluster regions to the intervention group and from the control cluster region to the control group. Contamination between the intervention and control groups was avoided by forming the balanced intervention and control regions in geographically opposite sides of the city. Figure 1 illustrates the enrollment and allocation as well as measurement and analysis flow of the present study.

Children attending a day-care center for less than 10 days a month and having a developmental disorder or other disorders delaying motor development were excluded from the study. Because the intervention was not only aimed at affecting children’s behavior, but the behavior of their parents as well, there were also
exclusion criteria for parents. Accordingly, we excluded parents who sat for less than 50% of their work time or who had chronic diseases, as well as pregnant mothers. We accepted families including both parent(s) and a child who fulfilled the study criteria. We recruited participants from April 2011 to April 2012. Altogether, 35 and 36 children and their parents in the intervention and control groups, respectively, began in the study during May 2011 to December 2011. In addition, 16 children and their parents from both randomized groups began in the study during January 2012 to May 2012.

Figure 1. Flow of the study participants Note. PA = physical activity; FPAE = Family Physical Activity Environment.
**Tailored counseling**

**Theoretical framework**

The researchers systematically used behavior change techniques in the counseling process based on social-cognitive theory (Bandura, 1986) and the theory of planned behavior (Ajzen, 1985). Description of the behavior change techniques utilized is reported elsewhere (Laukkanen et al., 2015) and detailed here briefly. We utilized nine behavior change techniques in the counseling process: providing instruction (I), providing information on consequences (IC), prompting identification as a role model (IRM), providing general encouragement (GE), providing information about others’ approval (IOA), prompting intention formation (IF), progressive goal setting (PGS), prompting barrier identification (BI), and self-evaluation (SE). This process included a lecture (I, IC, IRM, GE, IOA), individual face-to-face counseling (GE, IF), and goal setting (PGS) in a university seminar class 2 weeks after the baseline measurements, as well as phone consultation (GE, PGS, BI, SE) at 2 months and 5 months after baseline. The researchers (AL, male, approximately 30 years old, engaged; AP, male, approximately 30 years old, married; TF, female, approximately 40 years old, married, and a parent of two children) received orientation on good practices in PA counseling before the study.

**Lecture**

In an approximately 30-min lecture, one of the researchers (AL) encouraged 1 hr of moderate-to-vigorous PA (MVPA) at leisure time each day to be targeted toward children (I). This target was justified by research evidence indicating the high proportion of children not achieving even half (Spittaels et al., 2012) of the nationally recommended level of 2 hr of MVPA each day (Sosiaali- ja terveysministeriön oppaita, 2005) and by the assumed health and developmental benefits due to increased PA (IC). Specific arguments related to the associations found between PA and health, motor competence, and cognitive functioning. We encouraged parents to give children opportunities for PA in everyday leisure time and to enable PA in nonbuilt environments such as heaths, forests, and hills (Sallis, Prochaska, & Taylor, 2000; GE). We encouraged efforts to increase PA especially in winter time as it has been generally known to be a more inactive season in Northern countries (Carson & Spence, 2010). We emphasized the meaning of role modeling in PA by providing examples where parents act as role models for their children (e.g., situations when they spend time with their children and they have to choose between the lift (elevator) and stairs or between bicycling and taking a car (IRM)). During the lecture, parents and researchers discussed their opinions on and approval of restricting PA in children (e.g., for the sake of convenience) (IOA).

**Face-to-face discussion**

After the lecture, individual face-to-face discussion took place. Following a fidelity checklist, a researcher asked a parent to describe his or her family’s leisure-time PA habits. Next, the same researcher encouraged the parent to identify contexts where PA in their children could feasibly be enhanced, and to set small-step goals aimed at increasing PA in the child(ren) (GE, IF). The small-step goals set were, for instance, “I will let my child walk to the day-care center with me” or, “We will go outdoors as a family.” Every goal was set on a scale from 1 to 4 depending on the frequency of the intended implementation (1 = randomly, 2 = once or twice a week, 3 = three to four times a week, 4 = daily). Gradually progressing goal setting was recommended so that the baseline goals set would likely be achievable and they could be progressively increased later in the phone consultations (PGS). The goals were written into an agreement form signed by the parent and the researcher.

**Phone consultation**

We enhanced compliance with goal implementation by conducting phone consultations at 2 months and 5 months after face-to-face counseling (GE). Compliance with goals and perceived barriers for implementation of goals were discussed, and possible modifications to the goals were suggested (PGS, BI). Furthermore, we promoted self-evaluation of compliance by asking, “Did you do your best to achieve the goal?” with responses rated on a scale from 1 to 5 (1 = not at all, 2 = a little, 3 = moderately, 4 = relatively well, 5 = fully; SE). Monthly e-mails were sent for the first 6 months to reinforce implementation of the goals. Parents were instructed to continue the children’s PA promotion after the reinforced intervention period.

**Parental support**

We used the Family Physical Activity Environment (FPAE) Questionnaire for determining the parental support of children’s PA (Cleland et al., 2011). The test–retest reliability of the questionnaire has been found to be good in 5- to 6-year-old and 10- to 12-year-old Australian children (intraclass correlation coefficient [ICC] = .81–.90). An informed translator and an uninformed translator translated the FPAE
Parents were asked to evaluate the frequency father/mother and socioeconomic status. The second section, direct support on participation in physical activity with your child, such as moving and playing games.” Moreover, the first section included a third item: “Evaluate how often father/mother participates in physical activity with your child, such as moving and playing games.” The second section, direct support on child’s PA, was assessed as follows: “Evaluate how often father/mother provides support for your child’s participation in physical activity, such as taking him/her to a PA hobby or training, providing money for participation, buying sports clothing/equipment.” The third section, reinforcement for PA, was assessed by the following items: “Evaluate how often father/mother praises your child for participating in PA, such as saying positive things to him/her for being physically active.” Parents were asked to evaluate the frequency of support regarding the youngest child of the family participating in the study on a six-step scale for each item (1 = never, 2 = less than once per week, 3 = one to two times per week, 4 = three to four times per week, 5 = five to six times per week, 6 = daily). We asked the same parent to complete the FPAE Questionnaire at baseline, 6 months, and 12 months.

**Assessment of leisure-time physical activity, anthropometrics, and socioeconomic status**

**Leisure-time physical activity**

Children’s PA was measured with triaxial X6-1a accelerometers with a dynamic range of ± 6 g (Gulf Coast Data Concepts Inc., Waveland, MS) at baseline, 6 months, and 12 months for 6 consecutive days at a time. For analysis, we accepted recordings that contained day-care center or school time and leisure time longer than 7 hr a day (420 min) on at least 3 days per measurement point (at minimum 2 weekdays and 1 weekend day; for more, see Penpraze et al., 2006). Because the intervention focused on time the parents spend with their children, we examined changes in PA during leisure time. Based on diaries completed by the parents, leisure-time PA was recorded on average for 5.86 ± 1.51 hr/day (minimum 3.19 hr/day, maximum 9.87 hr/day; referring to out of school or day-care center hours) during 3.35 ± 0.79 weekdays. On average, 1.81 ± 0.39 weekend days with a mean of 11.25 ± 1.43 hr/day (minimum 7.08 hr/day, maximum 15.64 hr/day) were recorded and analyzed. Hence, the measured total leisure-time PA was on average similar between weekdays and weekend days (19.6 hr vs. 20.4 hr). We calculated average counts per minute (henceforth CPM), indicating the mean level of PA (Cardon & De Bourdeaudhuij, 2008), for the leisure time at each measurement point. Also, time (minutes) spent in sedentary, light PA, and MVPA intensities was calculated on the basis of validated cutoff points (Van Cauwenbergh, Labarque, Trost, De Bourdeaudhuij, & Cardon, 2011). We weighted PA data measured on weekdays’ leisure time by 5/7 and on weekend days’ leisure time by 2/7. We assessed children’s participation in organized PA or sports by asking the parents whether their children participating in this study were involved in organized PA or sports out of the day-care center or school time. The answer was coded as “yes” or “no.”

**Anthropometrics and socioeconomic status**

We measured height and body weight in the laboratory at 6 months and calculated body mass index (BMI; kg/m²). The highest achieved educational level was used as a measure of socioeconomic status and we asked parents to evaluate it on the scale from 0 to 4 (0 = elementary school, 1 = secondary school, 2 = high school, 3 = vocational or intermediate degree, 4 = polytechnic or university degree). A mean of the highest educational level of parent(s) was calculated and used for analyses. In addition, to describe the socioeconomic status among parents of the study sample, a dichotomous variable of “higher-level education” (value 4) and “no higher-level education” (values 0–3) was formed.

**Intervention evaluation**

Goals set by parents in the intervention group during face-to-face counseling and in the first and second phone counseling sessions were categorized according to how PA in children was aimed to be enhanced.
Altogether, we formed five categories (PA with family, PA with peers, PA outdoors, PA in the backyard or in the neighboring area, PA indoors) covering 97% to 100% of all the goals set. The proportion of the goal categories among parents of the lowest and highest initial parental support tertiles was then calculated in relation to the total frequency of the goals in the corresponding tertile and in the certain counseling time. We performed similar protocols for evaluating the most common barriers for goal implementation as perceived by parents in the phone counseling. We conducted evaluation of the perceived barriers separately for those considering weekdays and weekend days. During a common feedback session at the end of the study, we asked parents to rate the order of importance of the counseling tools. We evaluated the counseling tool as more important based on the more often parents rated it as the most important intervention tool.

**Statistical analysis**

We found internal consistency for all seven of the FPAE items to be good after testing Cronbach’s alpha at baseline (.83), 6 months (.79), and 12 months (.83). Pairwise correlations ranged from low to moderately high between all seven items at different measurement points (baseline, 6 months, and 12 months; \( .334 < r < .718 \)), and removal of any of the items would not have increased the consistency of the questionnaire. Therefore, we calculated a sum factor of all seven selected FPAE items (\( M = 24.62 \pm 0.88 \), \( 23.81 \pm 1.02 \), and \( 23.39 \pm 0.96 \) at baseline, 6 months, and 12 months, respectively) and used it as a parental support factor for further analysis.

We formed tertiles of low and high initial parental support for examining parental support as a moderator of the intervention efficacy. The use of tertiles was meant to facilitate the drawing of conclusions and practical implications of the study. The tertiles were formed by selecting the lowest and highest thirds (33%) of the intervention and control groups based on the sum factor of the FPAE at baseline. There were higher FPAE sum factor scores among the intervention group compared with the control group, \( t \) = 2.77 \( \pm \) 0.33, min = 2.14, max = 85) and families were nested within randomized clusters (\( n = 14 \)). The children, families, and clustered samples were considered in the models as random grouping effects. However, we found the effect of family level and clustered samples to be insignificant, and they were therefore left out from the final models and tests examining the counseling efficacy. The Group × Time interaction formed a base for all autoregressive covariance models examining the efficacy of intervention on parental support and on the mean level and specific intensities of PA in children with different levels of initial parental support between baseline and 12 months. Based on this interaction, we calculated mean change from baseline to 6 months and mean difference between groups in these time intervals. We entered theory-based confounding variables (answerer’s sex on the FPAE, BMI, total number of children in the family, age of mother and father, socioeconomic status, age and sex of a child, temperature of the measurement month, season started in the study, participation in organized PA or sports, measurement length of PA per day, parental support items, and sum score), the Mann-Whitney \( U \) test (measurement days of PA), and a chi-square (\( X^2 \)) test (participation in organized PA or sports, higher-level education, being a single parent, answerer’s sex on the FPAE).

We calculated the Cohen’s \( d \) for indicating the effect sizes (ES) of the statistically significant differences in the background variables, and they were interpreted as small when ES \( \geq 0.2 \), medium when ES \( \geq 0.5 \), and large when ES \( \geq 0.8 \).

We analyzed the efficacy of intervention with linear mixed-effects model fit by restricted maximum likelihood using the Statistical Package for the Social Sciences (IBM SPSS Statistics 22). Analysis of counseling efficacy was initially based on a three-level hierarchy where children (\( n = 91 \)) were nested within families (\( n = 85 \)) and families were nested within randomized clusters (\( n = 14 \)). The children, families, and clustered samples were considered in the models as random grouping effects. However, we found the effect of family level and clustered samples to be insignificant, and they were therefore left out from the final models and tests examining the counseling efficacy. The Group × Time interaction formed a base for all autoregressive covariance models examining the efficacy of intervention on parental support and on the mean level and specific intensities of PA in children with different levels of initial parental support between baseline and 12 months. Based on this interaction, we calculated mean change from baseline to 6 months and mean difference between groups in these time intervals. We entered theory-based confounding variables (answerer’s sex on the FPAE, BMI, total number of children in the family, age of mother and father, socioeconomic status, age and sex of a child, temperature of the measurement month, season started in the study, participation in organized PA or sports, measurement length of PA per day, measurement days of PA, and with regard to parental support models, mean level of PA) one by one into the unadjusted Group × Time model. We entered all variables significantly interacting with the unadjusted model into the adjusted mixed-effect models.

Model 1 examining the intervention efficacy on parental support was adjusted (in the order of
statistical significance) for child’s age, PA in leisure time, and average temperature of the measurement month. When we examined the intervention efficacy on PA, we adjusted Model 1 for temperature of the measurement month, the child’s sex, and the sex of the parent answering the parental support questionnaire. Furthermore, we found the child’s participation in organized PA or sports to be a nearly significant confounding variable when examining the intervention efficacy on parental support and a significant variable when examining the efficacy on PA. However, interpretation of the interaction between participation in organized PA or sports and the intervention efficacy on PA can be complex. Therefore, we applied Model 2 when examining the intervention efficacy on parental support and on PA by adjusting apart from other covariates for participation in organized PA or sports. Finally, we performed a three-way interaction of Group × Time × Sex in unadjusted and adjusted models with the whole sample and separately considering the tertiles of parental support for examining whether the intervention efficacy on parental support or PA differed between the sexes of the children.

We reported means, confidence intervals (CI), and p values for statistically significant findings with respect to mixed models. Logistic regression was used to identify significant predictors for dropping out of the study. All predictor variables were entered in the model simultaneously. We set the level of significance to p < .05 for all analyses.

Results

Baseline characteristics of parental support tertiles

According to the whole study sample’s initial parental support (M = 3.52 ± 0.82), parents supported their children in PA approximately two to three times per week. Table 1 shows the frequency of parental support among the tertiles. Initial parental support was higher, F(1, 59) = 4.19, p < .001, ES = 0.89, among the intervention and control tertiles of the highest parental support (M = 4.47 ± 0.50, corresponding to four to five times a week of parental support) compared with the lowest parental support tertiles (mean of sum factor = 2.76 ± 0.35, corresponding to less than once a week up to once a week of parental support). The mothers in the intervention group were significantly younger, F(1, 69) = 8.47, p = .001, ES = 0.37, and participated more in PA with their children, F(1, 89) = 6.20, p = .02, ES = 0.25, compared with mothers of control children. Additionally, girls in the lowest tertile of parental support were significantly older, F(1, 29), p = .045, ES = 0.35, than the boys.

The mean level of leisure-time PA at baseline was 567.70 ± 188.0 CPM, and on average, 421.87 ± 66.82 min, 23.88 ± 9.15 min, and 27.96 ± 14.19 min of free time per day were spent at the intensity levels of sedentary, light PA, and MVPA, respectively. While boys were generally more active, F(1, 89) = 1.58–6.09, p = .001–.007, ES = 0.27–0.35, than girls in all PA measures at baseline, the difference between genders was significant among the tertile of the lowest parental support, F(1, 29) = 1.63–5.65, p = .011–.037, ES = 0.39–0.41, but not among the tertile of the highest parental support. On the other hand, girls were significantly older than boys, F(1, 89) = 1.42, p = .045, ES = 0.21, in general. On average, 63% of the children participated in organized PA or sports at baseline and the prevalence of participation generally showed an increasing trend over time, with a few exceptions: The children in the lowest intervention tertile showed a decreasing trend of participation from baseline (53.3%) to 6 months (38.5%) and an increasing trend to 12 months (80%), while children in the highest control tertile showed a decreasing trend in participation from baseline (84.6%) to 6 months (71.4%) and 12 months (66.7%).

Those families who dropped out of parental support measurements after baseline had more children, F(1, 89) = 0.009, p < .001, ES = 0.71, than families who continued for the full year. There were no other significant predictors for dropping out. In general, parents of the children included in the analyses more often had a university or polytechnic degree when compared with the mean of the whole recruitment region (84%/35%) and were less often single parents (4%/27%).

Efficacy of intervention on parental support

Parental support declined in the intervention and control groups with time, but this overall decline was not statistically significant nor did the change differ between groups (Table 2). A significant decline in parental support took place within the highest initial parental support tertile of the intervention group from baseline to 6 months (unadjusted mean = -0.59, CI [-0.96, -0.20], p = .004; Model 1, M = -0.44, CI [-0.84, -0.05], p = .03; Model 2, M = -0.52, CI [-1.02, -0.01], p = .046) and to 12 months (unadjusted mean = -0.57, CI [-1.01, -0.14], p = .011; Model 1, M = -0.43, CI [-0.86, -0.00], p = .048) and within the corresponding control tertile from baseline to 12 months (unadjusted mean = -0.72, CI [-1.16, -0.29], p = .002; Model 1, M = -0.65, CI [-1.11, -0.19], p = .006; Model 2, M = -0.63, CI [-1.13, -0.13], p = .015). The decrease in parental support was significant.
Table 1. Background characteristics of the study participants for analysis.

| Variables                                    | All Means ± SD (range) | Lowest parental support tertile Means ± SD (range) | Highest parental support tertile Means ± SD (range) |
|----------------------------------------------|------------------------|---------------------------------------------------|---------------------------------------------------|
|                                              | Intervention Control   | Intervention Control                               | Intervention Control                               |
| Children (n)                                 | 44 47                  | 15 16                                             | 16 14                                             |
| Girls (n)                                   | 21 26                  | 8 10                                              | 8 7                                               |
| Age (years)                                 | 6.09 ± 1.17 (3.71)     | 6.12 ± 1.11 (3.48)                                | 6.53 ± 1.26 (3.59)# 6.36 ± 1.19 (3.48)#           |
| Height (cm)                                 | 112.21 ± 8.71 (34.1)   | 113.91 ± 7.79 (28.4)                              | 117.14 ± 8.22 (18.1) 114.26 ± 7.75 (20.1)         |
| Weight (kg)                                 | 20.08 ± 3.47 (14.8)    | 20.31 ± 3.16 (10.2)                               | 20.95 ± 4.24 (11.2) 20.13 ± 3.62 (16.2)           |
| BMI                                          | 15.88 ± 1.2 (4.35)     | 15.6 ± 1.16 (3.9)                                 | 15.17 ± 1.48 (4.35) 15.32 ± 1.3 (3.9)             |
| Participates in organized PA (%)            | 60.5 65.2              | 53.3 68.8                                         | 62.5 84.6                                          |
| Parents involved in the study (n)           | 61 63                  | 19 21                                             | 23 17                                             |
| Mother (n)                                  | 38 33                  | 13 12                                             | 15 8                                               |
| Age                                          | 34.9 ± 4.11 (20)*      | 38.82 ± 5.61 (19)                                 | 35.77 ± 5.56 (20) 39.92 ± 5.52 (19)               |
| Higher-level education (%)                  | 82 72                  | 80 81                                             | 75 57.1                                           |
| Single parent (n)                           | 1 3                    | 0 1                                               | 1 1                                               |
| Father (n)                                  | 23 30                  | 6 9                                               | 8 9                                               |
| Age                                          | 37.22 ± 5.16 (23)      | 39.64 ± 5.36 (20)                                 | 39.84 ± 7.63 (21) 41 ± 4.28 (15)                   |
| Higher level education (%)                  | 55 66                  | 33.3 62.5                                         | 56.3 57.1                                         |
| Single parent (n)                           | 0 0                    | 0 0                                               | 0 0                                               |
| Parental support on PA                      | 72.7 53.2              | 80 62.5                                           | 75 57.1                                           |
| Answerer sex female (%)                     | 3.48 ± 1.21 (5)        | 3.11 ± 1.05 (5)                                   | 2.53 ± 0.64 (2) 2.63 ± 0.81 (3)                    |
| Father participates in PA with a child      | 3.64 ± 1.13 (4)*       | 3.13 ± 0.88 (4)                                   | 2.93 ± 0.45 (2) 2.63 ± 0.62 (2)                    |
| Mother participates in PA with a child      | 3.61 ± 1.13 (4)        | 3.38 ± 1.08 (4)                                   | 2.87 ± 0.64 (2) 2.56 ± 0.52 (1)                    |
| PA together as a family                     | 3.27 ± 1.09 (5)        | 3.23 ± 1.22 (5)                                   | 2.4 ± 0.64 (2) 2.69 ± 0.3 (3)                       |
| Father provides support for PA              | 3.23 ± 1.06 (5)        | 3.3 ± 1.02 (5)                                    | 2.47 ± 0.75 (3) 2.75 ± 0.69 (3)                    |
| Mother provides support for PA              | 3.95 ± 1.38 (4)        | 3.72 ± 1.38 (5)                                   | 2.87 ± 0.75 (2) 2.81 ± 0.75 (3)                    |
| Father praises for PA                       | 4.23 ± 1.2 (4)         | 4.04 ± 1.31 (4)                                   | 3.33 ± 0.62 (2) 3.13 ± 0.81 (3)                    |
| Mother praises for PA                       | 3.63 ± 0.82 (3.58)     | 3.42 ± 0.82 (3.29)                                | 2.78 ± 0.33 (1) 2.75 ± 0.38 (1.29)                 |

Note. PA = physical activity. Data are presented as mean ± SD and range (in parentheses) from baseline measurements, except height, weight, and body mass index (BMI; kg/m²) for children, which are presented from midline measurements. Scale for parental support on PA is 1 to 6. Statistically significant differences at the level of \( p < .05 \) between intervention and control groups (*) and between sexes (#). Statistically significant values are shown in bold.
support did not differ between the highest intervention and control group tertiles. On the other hand, parental support increased significantly within the lowest intervention support tertile from baseline to 6 months (unadjusted mean = 0.29, CI [0.04, 0.53], \( p = .021 \); Model 1, \( M = 0.27, \) CI [0.03, 0.52], \( p = .032 \); Model 2, \( M = 0.33, \) CI [0.06, 0.61], \( p = .018 \)), although this change was not significant either when compared with the corresponding control tertile. The three-way interaction of Group × Time × Sex indicated no differences between sexes in the intervention efficacy on parental support.

**Efficacy of intervention on physical activity**

The control group had an increasing, yet insignificant, trend in the mean level of PA and MVPA during the study year in comparison with the intervention group (Tables 2 and 3). However, children in the lowest intervention tertile of initial parental support significantly increased in the mean level of PA between baseline and 6 months (unadjusted mean = 160.17, CI [56.27, 264.06], \( p = .003 \); Model 1, \( M = 154.07, \) CI [41.69, 266.44], \( p = .008 \); Model 2, \( M = 192.90, \) CI [76.90, 308.89], \( p = .002 \)), and this change was also significant compared with the lowest control tertile (unadjusted mean = 160.30, CI [15.68, 304.93], \( p = .030 \); Model 2, \( M = 173.24, \) CI [16.18, 330.31], \( p = .031 \)). The mean level of PA increased in that case approximately by 29% in children in the lowest intervention tertile from baseline to 6 months. In the same time period, time spent in MVPA significantly increased within the lowest intervention tertile of parental support (unadjusted mean = 12.32, CI [2.62, 22.01], \( p = .014 \); Model 1, \( M = 11.50, \) CI [1.07, 21.92], \( p = .031 \); Model 2, \( M = 15.09, \) CI [4.46, 25.72], \( p = .006 \)), although this change was not significant compared with the corresponding control tertile. On the other hand, children in the highest control tertile significantly decreased the time spent sedentary compared with the corresponding intervention tertile. The three-way interaction of Group × Time × Sex indicated no differences between the sexes in the intervention efficacy on PA.
## Table 3. Changes in daily minutes spent at different physical activity intensities within and between intervention and control support tertiles.

| Outcome          | Unadjusted mean (SD) | MODEl 1          | MODEl 2          | \( p \) value | \( p \) value | \( p \) value |
|------------------|----------------------|------------------|------------------|---------------|---------------|---------------|
|                  | Time (months) | Intervention | Control | Adjusted change between groups [95% CI] | Adjusted change between groups [95% CI] | Adjusted change between groups [95% CI] |
| Sedentary        |             |               |          |                                              |                                        |                                           |
| All              | 0          | 414.64 (71.83) | 428.63 (61.77) | .721              | .941              | .848          |
|                  | 6          | 407.84 (75.44) | 419.06 (60.03) | .721              | .951              | .768          |
|                  | 12         | 398.65 (67.11) | 412.42 (67.02) | .871              | .964              | .919          |
|                  | Lowest parental support tertile | 0 | 440.30 (55.05) | 439.52 (74.63) | .405              | .537              | .381          |
|                  |            | 6          | 423.40 (64.98) | 440.46 (54.45) | .405              | .537              | .381          |
|                  |            | 12         | 419.28 (61.53) | 425.15 (64.26) | .792              | .815              | .925          |
|                  | Highest parental support tertile | 0 | 385.36 (63.63) | 407.95 (64.77) | .405              | .537              | .381          |
|                  |            | 6          | 412.44 (86.18) | 375.64 (58.31) | .097              | .534              | .304          |
|                  |            | 12         | 379.13 (69.53) | 395.51 (58.10) | .889              | .958              | .866          |
| Light            | All        | 24.28 (9.67)   | 23.50 (8.72)    | .753              | .181              | .766          |
|                  |            | 6          | 24.92 (10.44)   | 23.38 (8.62)     | .753              | .181              | .766          |
|                  |            | 12         | 25.57 (10.25)   | 23.60 (7.89)     | .684              | .514              | .719          |
|                  | Lowest parental support tertile | 0 | 25.13 (12.49)   | 25.23 (11.78)    | .105              | .443              | .064          |
|                  |            | 6          | 27.24 (14.19)   | 22.74 (10.29)    | .105              | .443              | .064          |
|                  |            | 12         | 28.53 (10.28)   | 24.47 (9.97)     | .362              | .430              | .402          |
|                  | Highest parental support tertile | 0 | 22.28 (7.04)    | 24.87 (7.17)     | .941              | .279              | .784          |
|                  |            | 6          | 23.33 (8.50)    | 25.74 (7.46)     | .941              | .279              | .784          |
|                  |            | 12         | 34.41 (10.77)   | 26.42 (7.62)     | .899              | .133              | .557          |
| MVPA             | All        | 30.32 (15.57)  | 25.74 (12.53)   | .782              | .512              | .666          |
|                  |            | 6          | 33.69 (20.49)   | 27.91 (17.84)    | .782              | .512              | .666          |
|                  |            | 12         | 27.10 (13.12)   | 28.46 (13.68)    | .167              | .636              | .106          |
|                  | Lowest parental support tertile | 0 | 27.33 (13.69)   | 27.77 (14.58)    | .178              | 6.54              | .147          |
|                  |            | 6          | 25.42 (21.89)   | 30.56 (28.15)    | .178              | 6.54              | .147          |
|                  |            | 12         | 27.54 (12.12)   | 25.24 (13.25)    | .854              | .035              | .869          |
|                  | Highest parental support tertile | 0 | 27.92 (10.73)   | 26.05 (14.22)    | .912              | -6.59             | .610          |
|                  |            | 6          | 30.00 (16.18)   | 28.26 (9.72)     | .912              | -6.59             | .610          |
|                  |            | 12         | 25.33 (12.71)   | 33.52 (14.97)    | .131              | -9.04             | .093          |

### Intervention evaluation

The initial goals set by the parents in the lowest and highest tertiles concerned PA with family (27% and 30% set this goal, respectively), PA with peers (21% and 12%), PA outdoors (19% and 28%), PA in the backyard or in the neighboring area (18% and 28%), and PA indoors (12% and 2%). The goals remained relatively stable both in the lowest and highest support tertiles, although the frequency of the goals for PA with peers showed an increasing trend in the phone consultations at 2 months (25% and 14%) and at 5 months (24% and 18%) among the parents of the lowest and the highest tertiles, respectively. We found the compliance rate of phone consultations to be generally high for parents in both the lowest and the highest tertiles at 2 months (95% and 92%), but there was a decreasing trend to 5 months (74% and 83%). Parents in the lowest and highest support tertiles who were reached once or twice for the phone consultations perceived being busy and other tasks (40% and 19% of all barriers), weather (30% and 24%), either their own or their children’s tiredness (20% and 33%), and sickness (10% and 19%) as the most common barriers against meeting the goals on weekdays. Correspondingly, the lowest and highest tertile parents most often mentioned being busy and other tasks (40% and 28%), tiredness (20% and 33%), and sickness (10% and 16%) as barriers for meeting the goals on weekend days. Parents perceived face-to-face counseling (32%) as the most useful intervention tool in general followed by feedback from measurements (25%), counseling lectures (21%), phone consultations (7%), printed material (4%), e-mails (4%), and the project Web site (0%). However, parents in the lowest intervention tertile perceived the face-to-face counseling and feedback from measurements clearly more often as the most important tool compared
with the parents in the highest tertile (44% vs. 14% and 33% vs. 21%, respectively). On the other hand, 14% versus 0% of parents in the highest and lowest tertiles, respectively, rated phone counseling as the most important intervention tool.

**Discussion**

Even though parental support has been documented as a key variable interacting with PA behavior in children (Beets et al., 2010; Edwardson & Gorely, 2010; Loprinzi & Trost, 2010), there is a lack of knowledge of how to affect parental support of children’s PA for enhancing PA in children (Brown et al., 2016; O’Connor et al., 2009). Family-based PA counseling was previously shown to negatively influence children’s MVPA (Laukkanen et al., 2015), and this study aimed to examine whether the initial level of parental support for children’s PA moderated the intervention efficacy on the parental support and objectively measured PA in the children. We hypothesized that the initial parental support for children’s PA would moderate the intervention efficacy because parents with low or high initial levels of parental support probably have different potential to benefit from the tailored counseling. The novel finding of this study relates to the children with the lowest parental support at baseline who significantly increased their objectively measured mean level of leisure-time PA during the counseling period in the intervention group when compared with their control peers. Importantly, parental support provided to these children significantly increased within the lowest intervention tertile, although this change was not significant compared with the corresponding control tertile. This study showed that the unfavorable intervention influence found on children’s MVPA (Laukkanen et al., 2015) may be partly explained by allocation of counseling to initially highly supportive parents. Overall, the findings suggest that initial parental support may be a significant moderator of family-based PA intervention efficacy on children’s objectively measured PA.

The mean level (two to three times per week) and declining trend of parental PA support along the child’s age are equivalent with the findings in Australian children with the same measurement tool (Cleland et al., 2011). A unique finding of the present study was that the initial level of parental support on a child’s PA was found to moderate the efficacy of family-based PA intervention on children’s objectively measured PA. Parents who reported the lowest baseline level of PA support were also those who seemed to be the most sensitive to PA counseling. Although regression to the mean probably explains part of the increase of parental support in the lowest tertiles (both intervention and control), the increase was significant only within the lowest intervention tertile. In contrast, we found individual counseling not to be an influential procedure for positively affecting parents in the highest support tertile. One explanation for the common inefficacy of family-based PA interventions on affecting the objectively measured PA in children (Metcalfe et al., 2012; O’Connor et al., 2009) may be therefore actually the lack of potential for change in parents’ support of children’s PA. Without an appropriate screening, family-based PA interventions may be overrepresented by parents with high initial support of their children’s PA, a fact that may attenuate the intervention efficacy. Thus, efficacy of family-based PA counseling on 4- to 7-year-old children’s PA should be further researched among parents in the lowest third when it comes to the validated measure of support of their children’s PA.

Promoting parental support in childhood would be important for maintaining the level of PA across childhood to adolescence (Kahn et al., 2008). Earlier evidence has shown this would be important especially in girls (Davison & Jago, 2009). We found intervention efficacy to be independent of children’s sex in the present study, so family-based PA counseling may offer a suitable tool for enhancing parental support in both girls and boys. Additionally, it is important to note that regardless of the low absolute level, the positive change in parental PA support can have a meaningful influence on children’s PA behavior. The 29% increase in PA in children in the lowest intervention tertile at the end of the counseling period can be seen practically meaningful as the mean level of PA in all children at the present (567.70 ± 188.0) was found to be relatively low compared with the level of 701 CPM reported in 4- to 5-year-old children elsewhere (Cardon & De Bourdeaudhuij, 2008).

Interestingly, we found the changes of participation in organized PA or sports to have an opposite trend compared with the objectively measured PA in children in the present study. Children in the lowest initial parental support intervention tertile declined participation in organized PA between baseline and 6 months, at the same time when parental support showed an increasing trend and their measured PA was found to significantly increase compared with the control peers. It can be speculated that the increase in physically active family time and encouragement for PA in contrast to the declined participation in organized PA or sports contributed to the increase in measured PA in these children. Further, we found children in the
highest control tertile to decline participation in organized PA or sports during the study year, at the same time when their measured PA increased compared with their corresponding intervention peers. It may be that the parents of the intervention group who already provided high support for their children’s PA found organized PA or sports as the only feasible way to further enhance PA in their children, a solution that was found to negatively influence measured PA in their children.

**Future directions of family-based physical activity interventions**

Behavioral theories (e.g., Bandura, 1986) as well as quantitative (e.g., Cleland et al., 2011; Telford et al., 2013) and qualitative (Thompson et al., 2010) research evidence state that family is a primary context for enhancing habitual PA in children. With the exception of some promising findings, attempts to enhance PA in children via the family context have been inefficient (Brown et al., 2016; Davison et al., 2013; Metcalf et al., 2012; O’Connor et al., 2009; Van Sluijs, Kriemler, & McMinn, 2011). Consequently, there is a great need to find efficacious and well-detailed family-based PA intervention methods and, on the other hand, to reveal those found to be inefficacious. This study suggests that affecting parental support of children’s PA would be a key factor in family-based PA interventions. It could be crucial to allocate family-based PA counseling on the basis of initial parental support level as it may be an important moderator of the intervention efficacy. Influence of family-based PA counseling on parental PA support should be further examined in fully powered efficacy trials with optimal and highly controlled PA counseling circumstances and, if found consistently efficacious, in fully powered effectiveness trials (e.g., in community-based lifestyle programs).

It has been shown that perceived control over supporting a child in PA may be a primary outcome on which to focus in family-based PA interventions. Although the attitude toward providing support for children’s PA is a strong correlate of the intention of providing support on children’s PA, especially the parent’s perceived confidence in supporting PA has been shown to be associated with the child’s PA (Rhodes et al., 2013). Therefore, it can be assumed that the mode of delivery may play a crucial role in PA intervention counseling. Almost half of parents in the lowest initial parental support tertile rated the individually tailored face-to-face counseling as the most important intervention tool in the present study. It is possible that the confidence in providing support on children’s PA was best promoted through individual face-to-face discussions where a parent had the possibility to freely and without a feeling of hurry to tell a researcher about, for example, the barriers against PA promotion. Although direct involvement of parents has been generally shown to be a key factor for successful PA and nutrition programs (Hingle et al., 2010; O’Connor et al., 2009), there is a need to find both efficacious and efficient (i.e., cost-effective) ways for promoting parental support of children’s PA. Therefore, research on alternative methods to face-to-face PA counseling and on an optimal combination of face-to-face counseling and other intervention delivery methods is needed. In more detail, there is a need to examine ways to effectively support behavior change in PA parenting via general encouragement, progressive goal setting, and other behavior change techniques that have a solid social-cognitive theory basis on behavior formation.

Parental support on children’s PA may not be well explained by volitional intention (Rhodes et al., 2013). Parents in the present study reported similar barriers against PA promotion than did parents of 10- to 11-year-old children in the United Kingdom (Thompson et al., 2010). However, the barriers reported were somewhat different between the lowest and highest tertiles of parental support in the present study. Although individualization of PA intervention is most likely important, it would be beneficial to further research the challenges systematically faced in everyday family life by parents providing low support for their children’s PA. In addition, positive intervention influences were found among the lowest parental support tertile during the 6-month counseling period but not during the follow-up period. Therefore, it is likely that these families would need continuous reinforcement for maintaining the intended behavior.

**Study limitations and strengths**

When evaluating the contributions of this study, several aspects should be considered. The FPAE Questionnaire used in the present study has been validated (Cleland et al., 2011), but not in the country where the present study was conducted. However, we performed careful translation into the local language and suitability testing for the local culture, and the translated questionnaire was found to have acceptable internal consistency. Second, the intervention efficacy analyses were hindered by the small number of participants in the tertiles of lowest and highest initial parental support. Therefore, the results of the present study should be confirmed by larger and fully powered interventions. Third, the findings of the study should be generalized to the population with care, because the families randomly assigned in this study represented mainly highly educated families. Regardless, it is important to note that intervention efficacy was seen in the
children with the lowest initial parental support. It can therefore be assumed that the intervention strategies used could be transferred to the families of children with lower parental support regardless of socioeconomic status, but further examination is needed.

The strength of the present study was accelerometer-derived PA assessment in children, which enables objective assessment of the changes in habitual PA. Moreover, a study design with a 6-month reinforced intervention period followed by a 6-month follow-up period was sufficient to enable observations in changes of long-term behavior. This element of the design is important because the focus on lifestyle interventions should be primarily on long-term behavior changes, which may take a long time to realize.

What does this article add?

Family involvement has been proposed to be a primary component when intervening in children’s PA (Brown et al., 2016; O’Connor et al., 2009; Van Sluijs et al., 2011). However, family-based PA interventions have not been successful in increasing objectively measured PA in children (Metcalfe et al., 2012), suggesting that more research is needed on how to successfully involve families in PA interventions with children. Parental support has been found to be a consistent correlate of children’s PA, and the present study showed that individually tailored counseling for parents led to positive short-term changes in parental support and objectively measured PA in children aged 4 to 7 years with the lowest parental support level initially. Therefore, identifying and counseling parents who provide their children with low support could be an efficacious way to enhance PA in children at least in the short term. On the other hand, family-based PA interventions may not positively affect PA in children with a high initial level of parental support.

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ORCID

Arto Laukkanen http://orcid.org/0000-0002-9722-0258
Arto J. Pesola http://orcid.org/0000-0002-2984-9847
Taija Finni http://orcid.org/0000-0002-7697-2813
Arja Sääkslahti http://orcid.org/0000-0003-4354-0990
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