

Only children or children with siblings: who has greater physical activity and healthier weight?

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Abstract

Background: The influence of parents on the physical activity (PA) and body weight of their children is confirmed by scientific studies. However, it is not known whether only children or those with siblings have a higher level of PA and healthier body weight. One aim of this study is to assess whether there are any differences in the achievement of the daily step count (SC) recommendation and in the prevalence of overweight and obesity between only children and children from families with multiple children. Another aim is to investigate whether the achievement of the daily SC recommendation by children/parents and parental overweight/obesity are associated with childhood obesity.

Methods: The analysis included 566 families (10.6% with a single child, 89.4% with two or more children) with complete data of family members for weight status and ambulatory PA monitored with a Yamax pedometer during the spring and autumn in 2013-2019. The cut-point values of the daily SC recommendation amounted to $\geq 13,000/\geq 11,000$ steps per day for 5-12-year-old sons/daughters and $\geq 10,000$ steps per day for 12-16-year-old adolescents and adults. Pearson's chi-square test was used to compare the achievement of the daily SC recommendation and the prevalence of overweight and obesity between only children and those with siblings. Binary logistic regression analyses were used to investigate whether the achievement of the daily SC recommendation by children/parents and parental overweight/obesity were associated with obesity in their offspring.

Results: A significantly higher proportion of children with siblings ($p < 0.01$) achieved the recommended daily SC (51.8% vs. 31.7%) and showed a lower prevalence of overweight (16.2% vs. 20.0%) and obesity (7.1% vs. 20.0%) compared with only children. The achievement of the daily SC recommendation in children significantly ($p < 0.05$) reduced the odds (OR) of obesity (OR=0.22-0.34). The children with siblings had lower odds (OR=0.41-0.54) of obesity than the only children. The overweight/obesity of mothers significantly increased ($p < 0.05$) the odds of obesity (OR=2.07) in their children.

Conclusion: Children with siblings achieve the daily SC recommendation more often at weekends and on average for the whole week and have a lower incidence of overweight and obesity than children from single-child families.

Background

Childhood obesity arises as a result of the interaction between a complex of genetic, environmental, and psychosocial determinants that lead to excessive food intake and insufficient physical activity (PA) [1, 2]. Behavioural individual or family-based energy balance-related changes in diet and PA are currently the primary tools for modifying lifestyles and preventing childhood obesity. However, they show a rather small and short-term effect and a high level of heterogeneity [3, 4]. Weight loss and post-weight loss maintenance are difficult to achieve, and the long-term application of multi-component obesity-reducing interventions of proven efficacy in the short term tends to fail in real life [5]. Thus, from a public health perspective, there is still a relevant demand for identifying the determinants and correlates of childhood

obesity in real-life conditions to formulate preventive recommendations and design effective interventions.

Naturally, research on children's energy balance-related behaviours frequently focuses on the family lifestyle and environment. The family is the setting where the first long-term formation of the dietary and PA patterns of children occurs, and family-based lifestyle interventions are still the cornerstone of weight management in children [6]. Many family-related determinants and correlates of childhood obesity have been uncovered in genetics (e.g. parental overweight), lifestyle (e.g. parental stress, maternal smoking or breastfeeding status), or sociology (e.g. the socioeconomic status of families) [7–10], but there are still incomplete and inconsistent findings regarding the family environment and parenting styles in relation to childhood obesity [11–13]. One of the reasons for the inconsistency between some parental variables and childhood obesity may stem from a change in the structure of families with children in economically developed countries over the past two decades – an increase in the age of mothers at their first pregnancy and the growing number of single-child families [14–17].

The reasons explaining the phenomenon of single-child families include the higher age of parents when starting a family, the increased financial demands of families [15, 18], family caregiving, one or both parents having grown up in a single-child family [15], and the time pressure inherently related to giving birth [19]. In addition, only children are at the centre of parental care [20] and the only recipients of parents' emotional and financial resources, without any sibling rivalry [22]. The comparison between only children and children with siblings is regularly investigated in psychosocial research [15, 16, 21, 22] but rarely in public health-related research [23].

From a psychosocial point of view (psychological distress, susceptibility to negative peer pressure, self-reported school performance, and problem behaviours), only children do not differ from children with siblings and might even have some advantages over 'laterborns' regarding school-related outcomes [16, 21]. However, there are possible indications of differences in the level of PA depending on the number of siblings [23, 24]. For example, growing up in a family with multiple children provides opportunities for engaging in playing and being more physically active, regardless of the birth order of the siblings [24]. Hence, such increased PA might partly explain the observed protective effects of larger sibships [24]. In general, there is a positive correlation between parent-child body weight status and the risk of child obesity when their parents are obese [25, 26]. Similarly, positive associations between the PA of parents and their preadolescent children [27–29], as well as parent-child sedentary behaviour [30, 31], have been observed repeatedly. However, findings on parent-child relationships in PA and obesity relative to the number of children in the family are scarce. Such analysis is desirable in view of the increasing number of single-child families in economically developed countries.

This study attempts to bridge the research gap with information concerning a comparison of lifestyle indicators between single-child families and families with multiple children. One aim of this study is to assess whether there are any differences in the achievement of the daily step count (SC) recommendation and in the prevalence of overweight and obesity between only children and children

from families with multiple children. Another aim is to investigate whether the achievement of the daily SC recommendation by children/parents and parental overweight/obesity are associated with childhood obesity.

Methods

Participants and inclusion/exclusion criteria

This study is part of an extensive cross-sectional study focused on the description of family PA, sedentary behaviour, and obesity in parents and their offspring aged 4-16 from Czechia [32]. Participants were recruited by means of two-stage stratified random sampling. In the first stage, nine out of 14 administrative regions, three of each in the lowest, middle, and highest terciles for gross domestic product in Czechia, were randomly selected. In the second stage, seven public kindergartens located in urban areas and three in rural locations and 36 public primary schools located in urban areas and 15 in rural locations were randomly selected. Private schools/kindergartens were not addressed because public schools/kindergartens prevail strongly, and the number of private schools/kindergartens is still negligible in Czechia [32].

A total of 2,389 families were addressed in writing with an invitation to participate in the cross-sectional study, of whom 65.3% agreed to take part in the research (written informed consent received). The participating children and their parents were predominantly white Caucasian (>98%), which is representative of the ethnic demographics of the Czech Republic [32]. The family dyads consisted of a mother-child or father-child couple. The participation of at least one family dyad was a necessary precondition for being included in the research. In the initial stage of the study, information meetings were held to describe the process of the research. Figure 1 provides a detailed flowchart of the inclusion of the participants in the study. The analysis included 566 families (10.6% with a single child (n=60) and 89.4% with more children (n=506)) with complete data of family members on their weight status and ambulatory PA monitored with a Yamax pedometer during a regular school/work week during the spring and autumn between 2013 and 2019 (Figure 1).

Procedures and measurement

After recruitment and submission of a written consent, each family received a self-monitoring package including: 1) a letter describing the study design and the ethical approval, 2) a family logbook for recording the anthropometric and PA data of all family members, 3) Yamax Digiwalker SW-200 (Yamax Corporation, Tokyo, Japan) pedometers for each participating child and parent, 4) a detailed and illustrated guide describing how to operate the pedometer, 5) an explanatory letter to the teachers/coaches about the study explaining why a pedometer is worn by children during

lessons/training, and 6) an illustrated instruction leaflet for home measurement of the body weight and height of the family participants.

To maintain the comparability of the family-related PA data with previous studies [29, 31, 32], the use of the Yamax Digiwalker SW-200 pedometer and the family logbook for recording the anthropometric and PA data of all family members was retained. The participants were asked to wear the pedometer attached to their right hip for eight consecutive days for at least eight hours per day and record their daily SC and possible active participation in organized leisure-time sport in the family logbook that was provided [33]. The SC data from the first day of PA monitoring was not included in the final analyses because of the novelty of wearing the pedometer, which might have affected the level of the participants' PA [34, 35]. The inclusion of participants in the analyses was subject to a record of valid PA data for at least six days, including both weekend days. The parents and children were instructed to wear the pedometer throughout the whole day (during their journey to school/work, during classes and breaks, and during participation in organized leisure-time sport or leisure organizations) except when dressing, performing personal hygiene, and showering/bathing. The elimination of seasonal differences was sought by choosing spring and autumn months in weeks without excessive examinations in schools and without multi-day school holidays and public holidays. The Yamax Digiwalker SW-200 pedometer is an unobtrusive, simple, valid, and reliable quantifier of all-day ambulatory PA across a wide population of children, adolescents [34, 36], and adults [37] designed for an analysis of the relationship between daily SC and health outcomes [38].

The parents were asked to fill in the anthropometric data (date of birth of child/children, age of parents, gender, body height/weight (with 0.5-cm/kg accuracy)) of all the participating family members in the family logbook before the start of the eight-day SC monitoring. The parents were thoroughly instructed how to measure their own body height and weight, as well as the height and weight of their offspring, according to the illustrated instruction leaflets for home measurement. Parental measurement of the body height and weight of their offspring at home [39–42] seems to be a sufficiently valid method to identify overweight/obesity according to the calculated BMI compared with objective or laboratory/researcher measurements [39, 40, 43]. Although self-reported body height and weight is a widely used method for determining underweight, normal body weight, overweight, and obesity, previous studies point to possible inaccuracies compared with laboratory/researcher measurements and the absence of a uniform measurement consensus [43–46]. The chronological age of all family members was calculated from the date of birth until the starting day of the PA monitoring.

Ethics

The study design, all procedures, and the measurement and method of feedback were approved by the Ethics Committee of the Faculty of Physical Culture, Palacký University Olomouc separately for families with preschool children (ref. No.: 57/2014 on 21 December 2014), families with 6-11-year-old children (ref. No.: 20/2012 on 12 December 2012), and families with 12-15-year-old adolescents (ref. No.: 14/2018 on 21 February 2018). The parents' written consent was obtained prior to the start of the data collection. The

parents of the children gave their consent to participation in this study. Participation in the project was voluntary and without financial incentives.

Data management and statistical analysis

All data management and statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) for Windows, v.22 (IBM Corp. Released 2013. Armonk, NY, USA). To maintain the comparability of the prevalence of childhood BMI categories with previous studies [29, 31, 32], the BMI categories (underweight, normal weight, overweight, or obese) were derived using age- and gender-specific WHO growth charts [47, 48]. Overweight and obesity in the children was represented by a BMI from the 85th to 97th and >97th percentile of the WHO growth charts, respectively [47, 48]. Overweight and obesity in the parents was classified using a BMI from 25 kg/m² to 29.9 kg/m² and greater than or equal to 30 kg/m², respectively [49]. The daily step count variable represented the mean difference between the morning (pedometer turned on) and evening (pedometer turned off) step counts on the days of the week that were monitored. Daily SC values below 1,000 and above 30,000 were truncated to these recommended values, respectively [35, 50], and included in the analyses. If step counts were recorded during four weekdays, data for the one missing weekday that was based on the participant's personal mean scores was added. The participants whose step count data was missing for more than one day were excluded from the analysis. The average daily SC was calculated separately for school/workdays and for weekends as the sum of the individual daily SC divided by the number of days. The daily SC recommendation was set at a value of $\geq 13,000/\geq 11,000$ steps/day for 5-12-year-old sons/daughters and $\geq 10,000$ steps/day for 12-16-year-old adolescents [51] and adults [52]. The percentage of achievement of the recommended daily SC by individual family members was quantified separately for school/workdays, weekends, and the whole week. Pearson's chi-square test (χ^2) was used to compare the prevalence of obesity, overweight, normal body weight, and underweight, achievement of the daily SC recommendation, and frequency of participation in organized leisure-time sport between the single children and children with siblings. Neither the Shapiro-Wilk test nor the Kolmogorov-Smirnov test confirmed the normal distribution of SC variables. As a result of the non-normal distribution of SC variables, the Mann-Whitney U test was used to compare workday and weekend SC. The parent-child daily SC (BMI or BMI-for-age Z score) relationship was quantified using the Spearman's r_s correlation coefficient. Binary logistic regression analyses (Enter method) were used to investigate whether the achievement of the daily SC recommendation by children/parents and parental obesity were associated with the obesity of offspring in single-child families and families in which the children had siblings. Because of previous differences in the relationships between the PA of mothers/fathers and their offspring [29, 31, 32], regression models were calculated separately for mother-child and father-child dyads. The results of the logistic regression analyses were expressed using the odds ratio (OR) and 95% confidence interval (95% CI). The alpha level of significance was set at the minimum value of 0.05.

Results

The children who had at least one sibling had a significantly higher percentage of compliance with the recommended daily SC ($p<0.01$) at weekends (43.1% vs. 23.3%) and as a weekly average (51.8% vs. 31.7%) compared with only children (Table 1). The children with siblings had a healthier body weight than the children from single-child families. In particular, the children with siblings showed a lower prevalence of overweight (16.2% vs. 20.0%, $p<0.01$) and obesity (7.1% vs. 20.0%, $p<0.01$) and, analogously, a higher proportion of normal body weight (71.1% vs. 56.7%, $p<0.05$) than the only children (Table 1).

Table 1 Comparison of achievement of daily recommended step counts (SC)[#] and body weight levels (%) for children from single-child families and families with at least two children

Families	Meeting daily SC recommendations [†]			Body weight level [‡]			
	week	workdays	weekends	underweight	normal	overweight	obesity
single-child (n=60)	31.7%	46.7%	23.3%	3.3%	56.7%	20.0%**	20.0%**
≥2 children (n=506)	51.8%**	56.3%	43.1%**	5.6%*	71.1%*	16.2%	7.1%

SC – step counts; [#] daily step counts recommendation represents $\geq 13000/\geq 11000$ steps/day for 5–12-year-old boys/girls and ≥ 10000 steps/day for 12–16-year-old adolescents [51, 52]; ^{†,‡} binomial variables ([†]3 on achieving SC recommendations during the week and on workdays and weekend days, [‡]4 on body weight categories); * $p<0.05$, ** $p<0.01$

The children with a sibling significantly ($p<0.05$) exceed the only children in their daily weekend SC. Similarly, in the mothers of children with siblings a significantly higher daily SC at weekends was observed compared with the mothers of only children (Fig. 2). The absence of participation in organized leisure-time sport was recorded in 40.7% of the single children and 34.7% of the children from families where there were siblings.

A closer relationship concerning the daily SC was revealed between the parents and children with siblings on workdays and weekend days than in the single-child families. These closer relationships were found in both fathers and mothers on workdays and throughout the whole week (Table 2). An interesting finding concerns the differences in parent-child PA relationships according to the parents' gender. In the families with more children, the fathers have a closer relationship with the PA of their offspring on weekdays, at

weekends, and in the total for the whole week. However, in the single-child families, the mothers have a closer relationship with their offspring's weekly/workday PA than the fathers do. But the closest correlation between the PA of parents and their children was found in the case of fathers and only children at weekends (Table 2).

Table 2 Parent-child associations (r_s) in daily step counts and body weight level (BMI for parents and BMI-for-age Z scores for children) from single-child families and families with two or more children

Families	Daily step counts						Body weight level	
	week		workdays		weekends		mother	father
	mother	father	mother	father	mother	father		
single-child (n=60)	0.19	0.10	0.14	0.04	0.23	0.31	0.34*	0.40*
≥2 children (n=506)	0.21***	0.29***	0.20***	0.23***	0.25***	0.27***	0.30**	0.36**

r_s – Spearman's correlation coefficient; BMI – Body Mass Index; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 Association (odds ratio and 95% confidence intervals) between family lifestyle indicators and obesity of family offspring

Obesity of offspring in single child families and families with siblings									
	Model with PA level				Model with PA level and overweight/obesity of parents				
	Mother-child dyads		Father-child dyads		Mother-child dyads		Father-child dyads		
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	
Families	-	-	-	-	-	-	-	-	-
single-child	Ref.		Ref.		Ref.	-	Ref.		
with more children	0.41*	0.18-0.91	0.45	0.16-1.24	0.49	0.19-1.23	0.54	0.18-1.62	
Children's SC recommendation					-	-			
not achieved	Ref.		Ref.		Ref.		Ref.		
achieved	0.34**	0.17-0.71	0.32*	0.12-0.85	0.28**	0.12-0.64	0.22*	0.07-0.68	
Parental step counts					-	-			
<10,000 steps/day	Ref.		Ref.		Ref.		Ref.		
≥10,000 steps/day	0.97	0.51-1.98	0.54	0.20-1.44	1.08	0.53-2.10	0.49	0.17-1.40	
Parental weight status					-	-			
non-overweight					Ref.		Ref.		
overweight/obesity					2.07*	1.02-4.19	1.31	0.41-4.14	

The binary logistic regression models presented in Table 3 were adjusted for gender and age category of offspring; PA – physical activity; SC – step counts (daily step counts recommendation represents $\geq 13000/\geq 11000$ steps/day for 5–12-year-old boys/girls and ≥ 10000 steps/day for 12–16-year-old adolescents [51, 52]); OR – odds ratio; 95% CI – confidence interval; Ref. – reference group; The statistical significance is expressed as * $p < 0.05$, ** $p < 0.005$

Positive relationships between the BMI of parents and BMI-for-age Z scores of their children were found in both single-child families and families with multiple children. In addition, children from single-child families had a negative correlation between the mean daily SC for week-long monitoring and BMI-for-age Z score that was twice as great ($r_S = -0.29$ $p = 0.05$) as was the case for children with siblings ($r_S = -0.13$

$p=0.003$). The achievement of the recommended daily SC by children was associated with significantly lower odds of obesity in all the models presented (Table 3). The odds of obesity occurring in the children with siblings were half those of the only children; this was, however, only significant for mother-child dyads in the PA model not adjusted for parents' weight. Excessive body weight of mothers doubled the odds ratio of the occurrence of obesity in their children (Table 3).

Discussion

The present study reveals the fundamental differences in the prevalence of overweight, obesity, and daily PA between the children with siblings and only children. The children with siblings have a "healthier" body weight and achieve the recommended all-day PA more often than the only children. In addition, in the families with more children, there seems to be a closer relationship between the PA of the parents and their children. However, the achievement of the recommended daily amount of PA is associated with lower odds of obesity regardless of the number of offspring in the family.

PA, represented by the daily SC, is higher for all family members on school/working days than on weekend days, regardless of the number of children in the family. However, a greater decrease in the amount of PA on weekend days compared with school days is observed in the members of single-child families (child: -1,776 steps per day; mothers/fathers: -2,270/-764 steps per day). Although it seems that it should be easier for single-child families to organize and implement PA to a greater extent than is the case with families with more than one child, this is not the case. This reasoning is supported by the lower correlation coefficients for parent-child daily SC found in the single-child families compared with the families with more than one child. In addition, the relationships between parent-child PA in families with more children are more coherent, with no significant differences with regard to parents' gender in comparison with single-child families. The school regime, together with participation in organized leisure-time sports for children and a paid employment regime for parents, co-creates all-day PA on school/working days similarly for all the participants, but weekend days show a critical decrease in PA, especially among the members of single-child families.

As in similar studies from Belarus [53], Canada [25], or the United States of America [26, 54], a positive relationship between the BMI of parents and their children, as well as an increased risk of obesity in children in the event of their parents' obesity [25, 26, 53], has been confirmed in both single-child families and families with at least two children. Given the significantly lower likelihood of obesity in children achieving the recommended daily SC regardless of the number of children in the family, sufficient PA is still an effective preventive factor in the development of childhood obesity. Thus, in accordance with a previous study [55], weekend days still have underutilized potential for stimulating family PA-enhancing programmes. In addition, family PA enhancement programmes do not necessarily need to be long per occasion but regular and long-term. Even replacing ten minutes of sedentary time in adolescents with ten minutes of moderate-to-vigorous PA (MVPA) daily has a positive effect on waist circumference reduction (0.5-1%), and a long-term replacement of 60 minutes of sedentary time with MVPA daily exercise can bring the waist circumference reduction up to 3 cm [56].

Suitable opportunities for the realization of MVPA can be seen in higher levels of participation in organized leisure-time sport or leisure organizations, as most of the children declared no participation in organized leisure-time sport or interest organizations. The use of multiple-purpose sports facilities and centres offering a variety of physical activities for the whole family would be a suitable complement to the increase in habitual PA provided that there were low admission fees. Because of the closer relationship between parent-child daily SC in families with more children, as well as the lower likelihood of obesity in children from families with more children than those from single-child families, PA-enhancing programmes with an aspiration to reduce excessive body weight among children would be encouraged by the participation of all family members, or classmates or neighbourhood children in the case of single-child families. However, it should be noted that positive parental social control or overall parental support may be ineffective in children with higher BMI who are in need of increasing their PA [57]. In addition, it is also documented that parenting style is associated with childhood obesity – authoritarian and negligent parenting are associated with an increased likelihood of childhood obesity [12], while warm parenting is associated with a decline in or stable child BMI during a family-based weight control programme [58]. Therefore, from a public health perspective, it is necessary to shed light on existing parental influences on the incidence of obesity in their offspring, as well as the behaviour of family members participating in family-based energy balance-related programmes.

Although siblings are described as the building blocks of the family structure and the key players in family dynamics [59], their role has been relatively neglected in exploring family PA and sedentary behaviour. The results of public health-related research suggest a positive influence of older siblings on the motor development of younger siblings [24, 60] and a positive factor of higher weekend MVPA [23]. Given the higher level of PA found in families where the children have siblings and the closer linking to the PA of their parents than in single-child families, further studies should illuminate the mediating and moderating mechanisms by which parents may influence sibling PA.

Strengths and limitations of the study

A major strength of the present study is the involvement of all family members in the all-week monitoring of all-day PA, including school hours, leisure time, and both weekend days. Wearing a pedometer for at least eight hours allows the relevant capture of all-day PA.

However, the conclusions of any study need to be formulated in the light of existing methodological limitations. Firstly, a waist-worn spring-suspended pendulum pedometer was used. Although suspended pendulum pedometers are considered to be sufficiently valid to summarize all-day free-living PA optimally during continuous seven-day monitoring [34], they are limited when it comes to detecting the intensity or pattern of PA [36]. However, despite PA monitoring constraints, daily SC from a pedometer are a suitable, easily imaginable, and interpretable marker of daily PA, allowing a comparison to be made between children, adolescents, and adults [38, 61]. Although the ideal location for accurate step determination seems to be the ankle or foot, a waist strap-fastened pedometer is accurate enough and can yield useful

information on the relationship between daily SC and health outcomes (including body weight) [38]. Another possible limitation is the intentional non-inclusion of holidays or winter/summer seasons in the period of PA monitoring, which could have affected the level of PA [62, 63]. However, our aim was to capture the habitual family PA regime, including both weekend days, which prevails during the school year. Finally, it is necessary to accept the possible influence of social desirability, reactivity, or competitiveness in monitoring the free-living PA of children and adolescents resulting from the display of wearable devices. However, none of the participants was given the cut-off figure of the recommended daily SC, no reactivity was detected on six or more days of PA monitoring [35, 64], and no differences were found in SC measured using sealed and unsealed pedometers [65].

Another potential limitation could be the home measurement of the body weight and height of family members. However, parental home measurement of children's weight and height according to researchers' instruction sheets is sufficiently accurate compared with laboratory measurement [40] for subsequent BMI calculations and the classification of overweight and obesity [66], for example according to the WHO percentile growth charts. Moreover, none of the family members was given the cut-off values to classify body weight levels according to the WHO percentile growth charts for the classification of obesity. The difference in the prevalence of obesity in the only children compared with the children with siblings could be influenced by bias resulting from non-response or missing data on body weight/height, confounding by measured and unmeasured factors as well as residual confounding. Finally, the cross-sectional design of this study does not allow the causality of the parent-child relationships concerning PA or body weight to be ascertained, despite their statistical significance. However, verified theoretical models [67, 68] indicate the prevailing influence of obesity/PA of parents on their child's obesity/PA, not vice versa.

Conclusions

Children with siblings reach the recommended amount of daily SC at weekends and on average for the whole week significantly more often and have a lower incidence of overweight and obesity than children from single-child families. Achieving the recommended amount of daily SC in children significantly reduces their likelihood of obesity. Children with siblings have a lower likelihood of obesity than only children, but significantly only in the mother-child model. Maternal overweight/obesity more than doubles the likelihood of obesity in the woman's offspring.

List Of Abbreviations

BMI, Body Mass Index; CI, Confidence interval; kg, kilogramme; m, metre; Max, Maximum; Mdn, Median; Min, Minimum; MVPA, Moderate-to-vigorous physical activity; OR, Odds ratio; PA, Physical activity; Q₁, First quartile; Q₃, Third quartile; Ref., Reference group; r_s, Spearman's correlation coefficient; SC, Step counts; SPSS, Statistical Package for the Social Sciences; WHO, World Health Organization

Declarations

Ethics approval and consent to participation

The study design, all procedures, and the measurement and method of feedback were approved by the Ethics Committee of the Faculty of Physical Culture, Palacký University Olomouc separately for families with preschool children (ref. No.: 57/2014 on 21 December 2014), families with 6-11-year-old children (ref. No.: 20/2012 on 12 December 2012), and families with 12-15-year-old adolescents (ref. No.: 14/2018 on 21 February 2018). Parental written consents were obtained prior to the data collection. The parents of the children gave their consent to participation in this study. The participants were allowed to quit the monitoring at any time without being sanctioned by the investigators. A possible loss of the pedometers or damage to them was not to be reimbursed by the participants. All family members with valid data were provided with individual feedback on the research results.

Consent to publication

Not applicable.

Availability of data and material

The datasets analysed during the current study are not publicly available because of the rules for funded projects but are available from the corresponding author ES upon reasonable request.

Competing interests

The authors declare that they have no conflict of interest.

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Authors' contributions

ES conceptualized and designed the study and drafted the initial manuscript. DS carried out the data analysis and interpreted the results. DS critically read the initial manuscript and commented on all parts of the text. Both authors have read and approved the manuscript.

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Figures

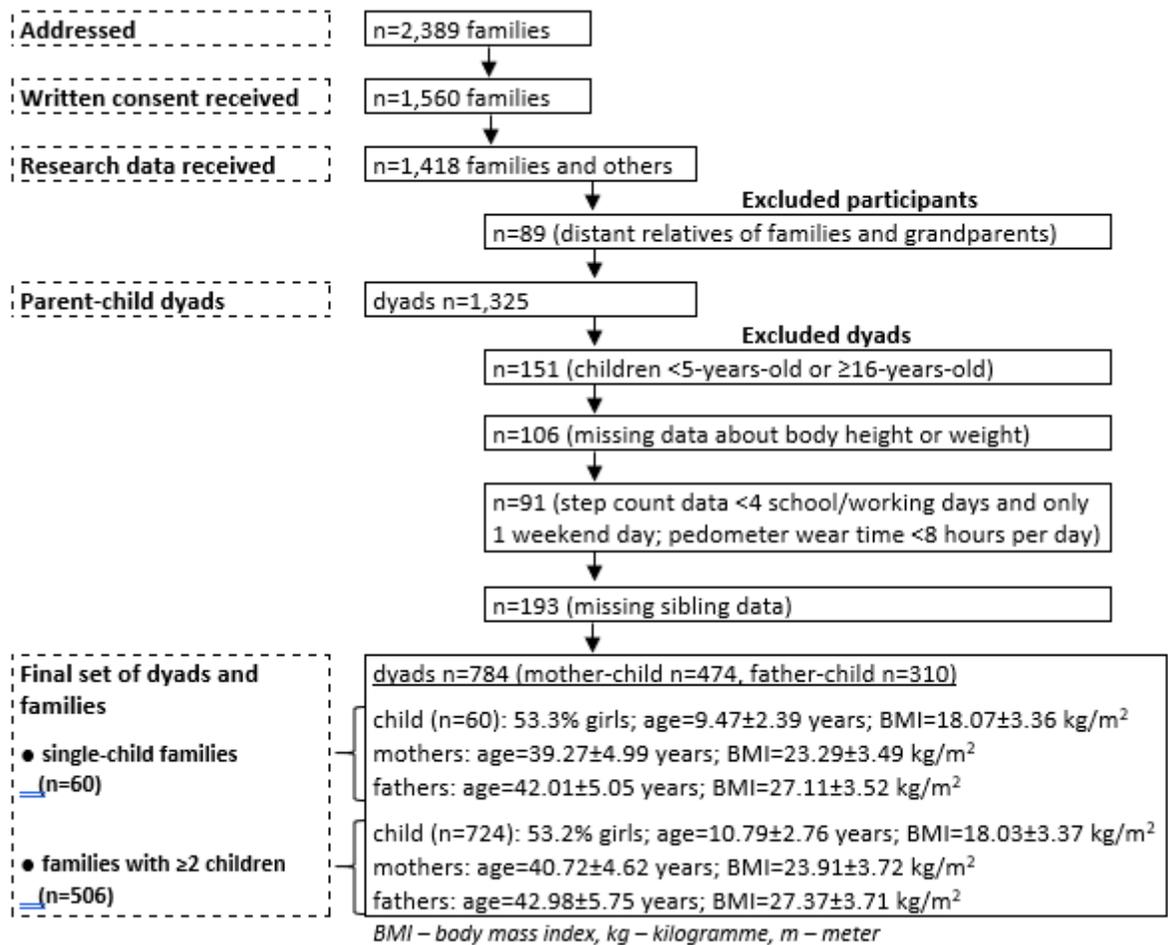


Figure 1

Summary of the study sampling strategy and the demographics of the participants

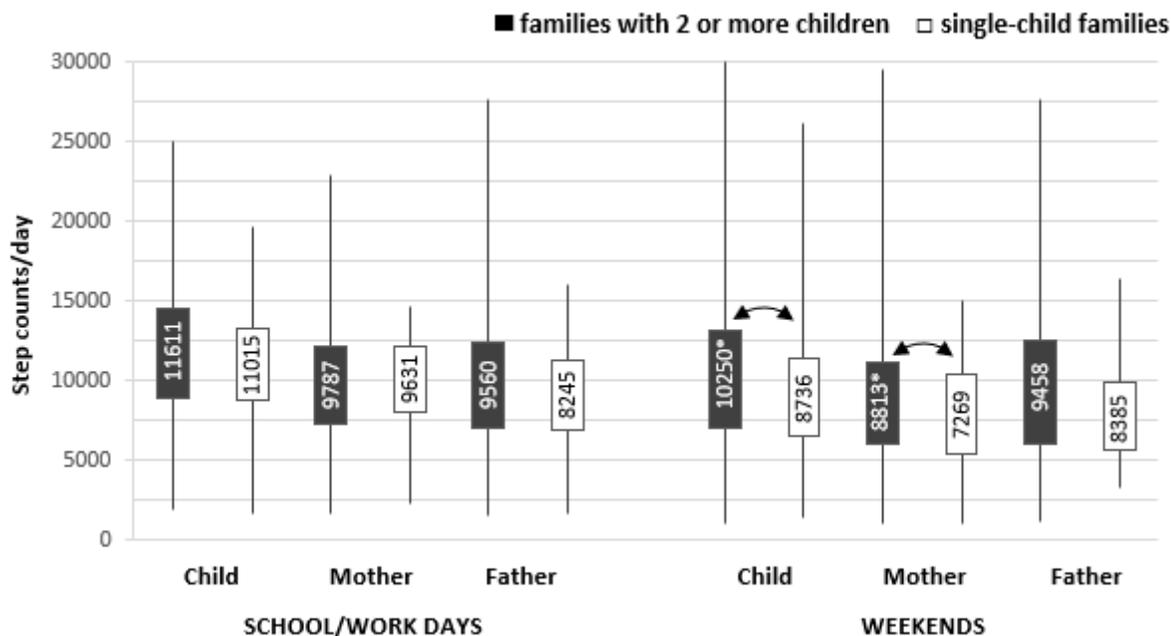


Figure 2

Comparison between family members of parents' and children's pedometer-determined daily step counts (Mdn and Max, Q3, Q1, Min) on workdays and weekend days in families with at least two children and with a single child (* $p < 0.05$; Mann-Whitney U test)