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Resemblance in Physical Activity in Families with Children in Time Segments during the Week: The Lolland–Falster Health Study

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ABSTRACT

PETERSEN, T. L., J. C. BRØND, P. L. KRISTENSEN, E. AADLAND, A. GRØNTVED, and R. JEPSEN. Resemblance in Physical Activity in Families with Children in Time Segments during the Week: The Lolland–Falster Health Study. *Med. Sci. Sports Exerc.*, Vol. 53, No. 11, pp. 2283–2289, 2021. **Purpose:** Evidence of shared physical activity (PA) habits within families is inconsistent. The present study aimed at examining intrafamily resemblance in PA during different time segments of the week. **Method:** This cross-sectional study used data from the Danish household-based population study Lolland–Falster Health Study. We assessed time spent in various PA intensities and behaviors using a dual-accelerometer system (Axivity AX3). At least one parent and one child per household provided data for a minimum of three weekdays and one weekend day. We analyzed three time segments: early weekdays, late weekdays, and weekends. A linear mixed model regression analysis was used to estimate intraclass correlation coefficients (ICC) of the total family, parent–child dyads, siblings, and parent–parent dyads for PA outcomes, adjusting for sex, age, parental education, and the interaction between sex and age. **Results:** We included 774 parents (57.9% female, 42.8 ± 7 yr) and 802 children (54.2% girls, 11.1 ± 4.3 yr) nested within 523 families. The clustering among the total family was stronger during late weekdays (ICC = 0.11–0.31) and weekends (ICC = 0.14–0.29) than during early weekdays (ICC = 0.02–0.19). We found stronger clustering among siblings (ICC = 0.08–0.47) and between parents (ICC = 0.02–0.52) than between parents and children (ICC < 0.01–0.37). Generally, the clustering was strongest for light PA, and among PA behaviors, walking showed the highest resemblance across all subgroups. **Conclusion:** Initiatives to promote children's PA that involve parent or sibling coparticipation may focus on the time segment and activity types with the highest resemblance. For the family as a whole, promoting walking or limiting sedentary activities may be a potential target for interventions during late weekdays and weekends. **Trial registration**: Clinicaltrials.gov (NCT02482896). **Key Words:** ACCELEROMETER, WEEKDAY, WEEKEND, LOFUS, DENMARK

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Prolonged sedentary time is a risk factor for disease and early mortality (1), whereas physical activity (PA) is known to have many positive effects on physical and mental health and well-being both in children and adults (2,3). Children and adults engage in PA in day care, school, at work, and at home, when commuting, and during leisure time. Compared with past times, technological and societal developments of modern time have reduced the need of PA in many everyday life situations, implying that PA behaviors requiring low energy expenditure have become predominant (4). At a population level, studies have reported high levels of sedentary behavior and low levels of moderate to vigorous PA (MVPA) and vigorous PA (VPA) in all age-groups (5,6), which is concerning from a public health perspective (6).

Studies of PA focusing on time segments of the week have revealed higher levels of PA on weekdays compared with weekends in preschool-age children (7), school-age children (8), and adolescents (8). Intrafamily factors may be a contributor to these differences. Fuemmeler et al. (9) observed a positive association in device-based measured MVPA between school-age children and their parents on weekday mornings, during afternoon hours of weekdays, and during weekends. Unlike this, Garriguet et al. (10) found stronger correlations between parent and children's device-based measured MVPA during weekday afternoons and weekends compared with the total PA of the week. With respect to sedentary time during the week, Fuemmeler et al. (9) found the highest similarities between parents and children during weekday afternoons and weekends compared with weekday mornings, whereas Garriguet and colleagues (10) reported opposite results. Dlugonski et al. (11) found that the majority of self-reported coparticipation in device-based measured PA between parents and children was of sedentary or light nature. Siblings may also exhibit similar PA behaviors. A recent review by Kracht and Sisson (12) reported inconsistent findings across studies, but their analysis of pooled data from nine original studies indicated that having siblings as a child was associated with overall higher levels of MVPA compared with not having siblings. There may also be similarities between spouses/partners as proposed by Chen et al. (13), who reported resemblance in overall PA between husbands and wives in a survey using self-reported data. Seabra et al. (14) found weaker between-generation than within-generation associations in self-reported PA in an analysis among parents and children, among siblings, and between parents. Intra- and extrafamily environmental factors are assumed to explain most of the variance in these relationships, whereas genetics seems to have lesser impact on the associations between biologically related family members (14).

In summary, evidence of intrafamily resemblances in PA is inconsistent, and to the best of our knowledge, no single studies have examined resemblance in PA during specific time segments of the week between parents and children, among siblings, and between parents. The evidence is also limited by frequent use of self-report to assess PA. Moreover, previous association studies in the family PA context have focused on the intensities of PA, especially MVPA (9,10,12), and not on specific types of activity such as sitting, walking, and biking. Using combined lower back and thigh-worn accelerometer provides the possibility to assess other dimensions of PA such as specific common behaviors within families both requiring low (such as lying, standing, and sitting) and high energy expenditure (such as running or biking). Partitioning segments of time during a week of assessment of these activity behaviors in all family members allows us to gain a unique insight into activity patterns of families with children. Family members may be most alike in activities requiring low energy expenditure because they appear naturally and are easier to perform together as a family. In a public health perspective, knowledge about intrafamily resemblance in both PA intensities and specific PA behaviors is needed to improve our understanding of how PA habits are shaped by the family.

Therefore, the present study aimed at examining the degree of resemblance in PA intensities and specific PA behaviors within the total family, between parents and children, among siblings, and between parents considering different time segments of weekdays and weekends. Based on previous studies, suggesting that the activities of family members could be more alike in weekends compared with week days, we hypothesized that the PA of family members would be more similar during late weekdays and weekends than during early weekdays.

METHOD

Study design. The present study has a cross-sectional design, including a subsample of the Lolland–Falster Health Study (LOFUS), which is a Danish household-based population study (15,16). LOFUS recruited 19,000 participants 0–96 yr of age between February 2016 and February 2020. Invitations were sent to randomly selected adults and their household members, if any, among the 103,000 inhabitants on the two Danish islands Lolland and Falster. Participation was optional for each invited individual. The data collection encompassed a questionnaire, a series of physical examinations, and biological samples. More information about LOFUS has been published elsewhere (15). At the end of the physical examination, subsamples of LOFUS participants were included in accelerometer-based recording of PA. The exclusion criterion was the inability to walk. Between February 1, 2017, and November 30, 2018, the inclusion criterion was that at least one child and one adult per household should agree to wear accelerometers. From December 1, 2018, onwards, all LOFUS participants were eligible to participate in the measurement of PA. Preferably, all household members should wear accelerometers simultaneously, but occasionally practical matters led to nonsimultaneous wear periods. The present study included families with at least one parent (either a biological parent, a foster parent, a stepparent, or any other legal guardian of an included child) and one son/daughter (≤22 yr) who participated in LOFUS between February 1, 2017, and October 2, 2019, and wore accelerometers.

Sociodemographic information. Sociodemographic information was obtained by self-report in LOFUS (15). We used data on parents' civil status (married/cohabiting or divorced/separated/single/widow(er)), educational level (for families including two parents, we used the highest achieved level of education as parental education), and occupational status. Occupational status was categorized from 16 response options as being employed (e.g., self-employed, employers, or employees), student (e.g., high school or vocational training), or out of work (e.g., unemployed or on social benefits).

Anthropometry. Body weight and height were measured at the physical examination using standardized anthropometric procedures (15), and body mass index was calculated ($kg \cdot m^{-2}$).

Assessment of PA. Participants wore two Axivity AX3 accelerometers for 24 h over seven consecutive days; one was attached to the right thigh and the other to the right-side

lower back using adhesive tape. Participants were instructed to replace the accelerometers if they fell off (17). Details of the data reduction procedure have been described elsewhere (17). In short, we used data obtained from the back-worn accelerometer and age-specific cut points to classify PA intensities. The light PA (LPA) cut point was set to 100 counts per minute for all age-groups. The MVPA cut points were set to 1680, 3075, 3522, and 3522, and the VPA cut points were set to 3368, 5543, 5755, and 6016 for individuals 0–6, 7–11, 12–17, and ≥18 yr of age, respectively (17). The raw acceleration data from both accelerometers were used to estimate time spent sitting, lying, sitting/lying, standing, walking, running, and biking. For the determination of the different PA behaviors for each participant, we used the method described by Skotte et al. (18), which uses a simple decision tree in combination with six different signal features generated from the thigh and the back raw data to identify PA behaviors (18). The criterion for a valid day was ≥8 h of wear time (17). LOFUS participants belonging to a family from which at least one parent and one child provided a minimum of three weekdays and one weekend day of valid accelerometer data were included in the present analysis.

Weekdays (Mondays through Fridays) were partitioned into two periods, from 8:00 AM to 4:00 PM (early weekdays) and from 4:00 PM to 10:00 PM (late weekdays), respectively. Weekend days were specified as Saturdays and Sundays from 8:00 AM to 10:00 PM (weekends).

Ethics. In accordance with the Declaration of Helsinki, written consent was obtained at the physical examination after written and oral information. The holders of custody signed the consent form for children 0–14 yr of age (15). Region Zealand's Ethical Committee on Health Research (SJ-421) and the Danish Data Protection Agency (REG-24-2015 and REG-147-2016) approved the study. LOFUS is registered in Clinical Trials (NCT02482896).

Statistics. All analyses were conducted using Stata version 16.0 (StataCorp, College Station, TX). Characteristics of the participants are presented as percentages for categorical variables and mean values ± SD for continuous variables. A sample size calculation with all confounders revealed that with 500 families, we had a power of 80% (alpha = 0.05) to detect a correlation of 0.02 between the PA of parents and children.

We used a linear mixed model regression analysis to estimate the degree of resemblance in intrafamily PA. The analysis was conducted in different family subgroups: 1) total family (including the complete study sample), 2) parent–child dyads (one randomly selected parent–child dyad per family regardless of the age of the child), 3) one randomly selected parent–child dyad per family depending on the age of the child (divided into the age-groups 0–6, 7–11, and 12–22 yr), 4) siblings (including all children from families with two or more children), and 5) parent–parent dyads (random effect) adjusting for sex, age, parental education, and the interaction between sex and age. Stata was used for random selection. Separate models were performed for each PA outcome. Based on the variance components of the estimated random effects, we calculated the intraclass correlation coefficient (ICC) as the ratio of the variance explained by the family to the total variance with 95% confidence intervals (CI). The ICC is a measure of resemblance within a cluster (e.g., within parent–child dyads). An ICC of 0.00 indicates no resemblance, whereas an ICC of 1.00 indicates perfect resemblance (19). We refrained from calculating CI for low ICC values (<0.01) because of a close-to-zero denominator problem in the calculation of 95% CI with the delta method.

RESULTS

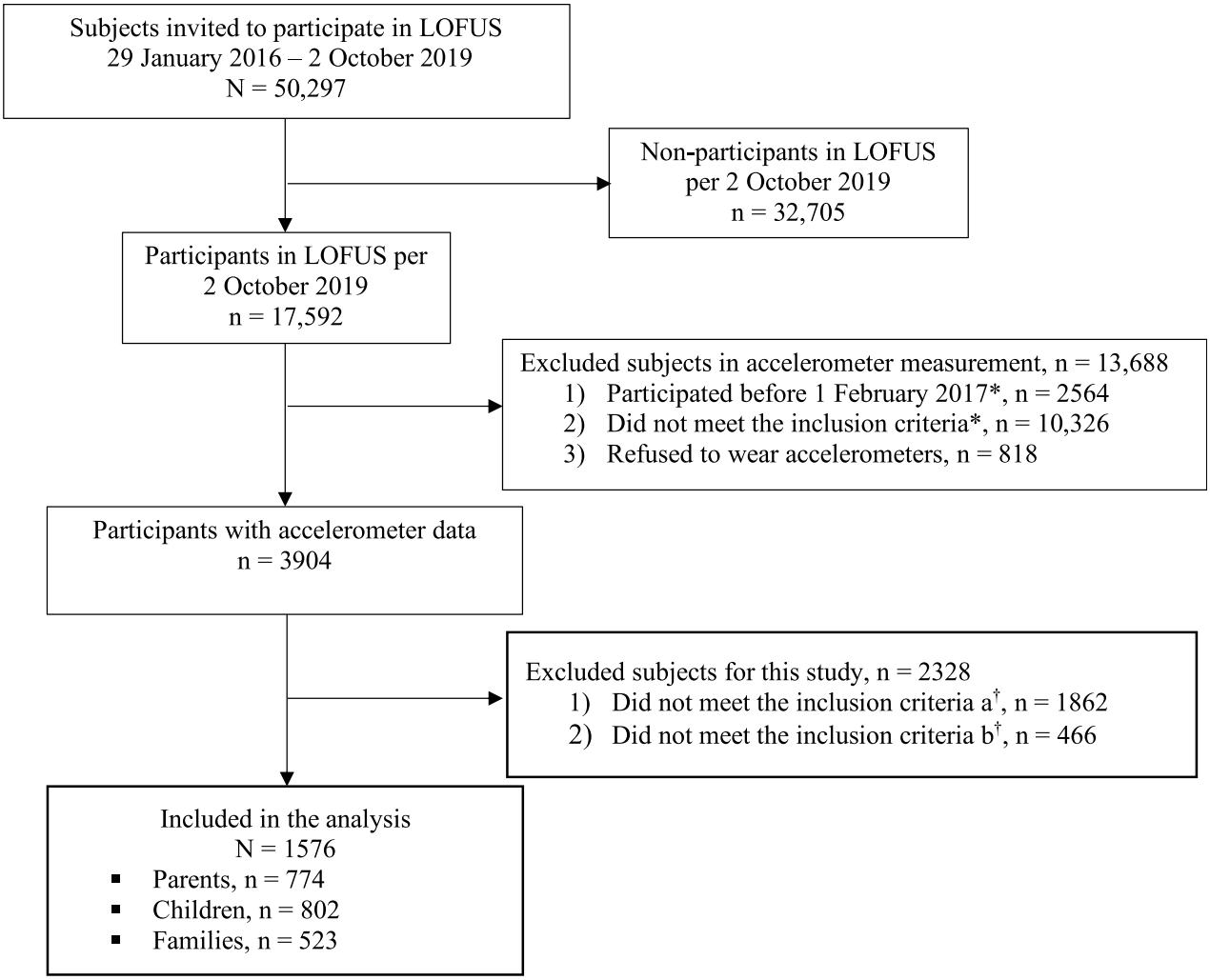
Figure 1 shows a flow chart of the study. A total of 1576 individuals (774 parents and 802 children) nested in 523 families met the inclusion criteria for the present study. The participants' characteristics are shown in Table 1. Across the three time segments of the week, parents spent almost all their active time in LPA. Overall, children accumulated relatively less MVPA during late weekdays and weekends compared with early weekdays. In general, LPA, MVPA, and VPA decreased with the age of children across all three time segments of the week (Table 1).

Resemblance in PA within families. Figure 2A shows the ICC for PA within the total family for the three time segments of the week. Overall, the intrafamily resemblance was higher during late weekdays (ICC = 0.11–0.31) and weekends (ICC = 0.14–0.29) than during early weekdays (ICC = 0.02–0.19). The clustering was strongest for LPA and sitting/lying, standing, walking, and biking. We found a similar pattern with respect to time segments within the parent–child dyads but with lower ICC for almost all outcomes (ICC during late weekdays 0.02–0.37 and ICC during weekends <0.01–0.25) (Fig. 2B). The ICC values for siblings were stronger than for the total family during early weekdays (ICC = 0.08–0.33), late weekdays (ICC = 0.20–0.37), and weekends (ICC = 0.10–0.47) (Fig. 2C). Also for parent–parent dyads, the ICC values were higher compared with the total family (ICC = 0.02–0.26 during early weekdays, ICC = 0.20–0.52 during late weekdays, and ICC = 0.19–0.47 during weekends) (Fig. 2D).

For MVPA, the ICC of the total family during early weekdays was 0.02. It was 0.14 during both late weekdays and weekends. The highest resemblance in MVPA was found during late weekdays and weekends among siblings (ICC values for both time segments 0.32) and within parent–parent dyads (ICC values for both time segments 0.40). During weekends, the ICC values for VPA and running were higher among siblings (ICC = 0.40 and 0.32, respectively) and within parent–parent dyads (ICC = 0.41 and 0.52, respectively) than within parent–child dyads (ICC = 0.04 and 0.11, respectively) (Fig. 2A–D). Among the specific PA behaviors, walking showed the highest resemblance across all subgroups during late weekdays and weekends (Fig. 2A–D). The analysis on parent–child dyads in relation to the age of the child revealed no age-specific differences in ICC (data not shown).

DISCUSSION

The present study provides novel estimates of family members' resemblance in PA across time segments of the day and



*1 February 2017 – 30 November 2018, children (aged 0-17 years) and adults (≥18 years of age) belonging to the same household and participating in LOFUS were eligible for inclusion in accelerometer measurements if they could walk.
†Step-by-step exclusion for this study: a) did not belong to a family including at least one participating child and one participating parent providing accelerometer data, b) participants with less than 3 weekdays and 1 weekend day of valid accelerometer data.

FIGURE 1—Flow chart for the study on resemblance of PA in families with children in time segments during the week: the Lolland–Falster Health Study (LOFUS).

the week. The results confirmed our hypothesis of a stronger intrafamily clustering during late weekdays and weekends than during early weekdays. Moreover, we found higher resemblance among siblings and between parents than for parent–child dyads.

Previous studies comparing different time segments of the week with respect to MVPA correspond with our results; however, they examined only parent–child dyads (9,10). In our study, intrafamily resemblance was observed across subgroups, PA intensities, and specific PA behaviors. It was an interesting finding that clustering among siblings and between parents was stronger than between parents and children. To date, a number of accelerometer studies have examined the relationship in PA between either parents and children (20) or among siblings (12), but to the best of our knowledge, this is the first study that has analyzed intrafamily resemblance in PA between parents and children, among siblings, and between parents in one single study sample during different time segments of the week using accelerometers. Evidence about possibly discordant degree of resemblance in PA across types of intrafamily relations is difficult to establish, when results are generated in nonhomogenous samples using different designs and methods, and thus, the present study provides new insights in this field.

The PA of siblings clustered across PA intensities, PA behaviors, and time segments of the week despite the wide age span of the included children. This result is supported by Maia et al. (21), who found higher correlations in self-reported PA between siblings than between parents and children in nuclear families. Further, our results corresponds with findings in a review and meta-analysis by Kracht and Sisson (12), showing that siblings had higher levels of MVPA than single children independent of age and gender. Resemblance in PA among biologically related siblings may partly be explained by

TABLE 1. Characteristics of the sample of parents and children nested in 523 families.

	n (%)	Mean ± SD		
Parents, *n* = 774				
Sex				
Male	326 (42.1)			
Female	448 (57.9)			
Age (yr)		42.8 ± 7.0		
Body mass index		26.9 ± 5.18		
Civil status, *n* = 584				
Married/cohabiting	537 (92.0)			
Divorced/separated/single/ widow	47 (8.0)			
Educational level, *n* = 752				
Medium to long higher education	311 (41.4)			
Short or vocational education	363 (48.3)			
No formal education	78 (10.3)			
Occupation, *n* = 752				
In work	677 (90.0)			
Student	18 (2.4)			
Out of work	57 (7.6)			
PA early weekdays, min·d^{-1}				
LPA		112.0 ± 49.7		
MVPA		9.9 ± 9.3		
VPA		1.1 ± 3.5		
PA late weekdays, min·d^{-1}				
LPA		74.7 ± 23.8		
MVPA		6.7 ± 7.1		
VPA		1.51 ± 4.0		
PA weekends, min·d^{-1}				
LPA		207.0 ± 66.6		
MVPA		6.7 ± 7.1		
VPA		2.7 ± 8.5		
Children, *n* = 802				
Gender				
Boys	367 (45.8)			
Girls	435 (54.2)			
Age (yr)		11.1 ± 4.3		
PA early weekdays, min·d^{-1}		0–6 yr	7–11 yr	12–22 yr
LPA		147.3 ± 41.4	139.7 ± 38.2	93.1 ± 34.1
MVPA		44.4 ± 24.7	28.0 ± 15.3	16.3 ± 11.5
VPA		12.4 ± 10.1	5.5 ± 5.1	3.9 ± 4.4
PA late weekdays, min·d^{-1}				
LPA		76.6 ± 20.4	78.8 ± 20.6	68.9 ± 23.5
MVPA		20.4 ± 11.4	14.0 ± 9.5	11.2 ± 10.0
VPA		6.2 ± 5.2	3.9 ± 4.7	4.2 ± 6.0
PA weekends, min·d^{-1}				
LPA		232.5 ± 45.1	221.0 ± 66.8	157.7 ± 60.7
MVPA		20.4 ± 11.4	14.0 ± 9.5	11.2 ± 10.0
VPA		20.69 ± 19.0	9.59 ± 13.3	5.6 ± 8.3

genetics as proposed by Seabra et al. (14), who concluded that heritability contributed to 11%–24% of the similarity of PA among biological siblings (14). Accordingly, a diversity of environmental factors are presumed to explain most of the similarities in siblings' PA, for example, shared home environment (22), imitation, modeling, and shared learned behavior (23), shared local community (24), and shared modes of commuting (14,25–27). Importantly, coparticipation in PA (28) may play a role in the resemblance found in siblings' PA intensities and behaviors during late weekdays and weekends because siblings likely share time, activities, and behaviors during these time segments.

Interestingly, parents were even more similar than siblings with respect to MVPA, VPA, running, and biking (i.e., PA types requiring moderate to high energy expenditure) during late weekdays and weekends. This results may relate to the findings from Maia et al. (21) showing that spouses were more alike in, e.g., sports participation than siblings and parent–child dyads. Similarities in health and health-related behaviors in couples have been reported by others (29) and may reflect assortative choice of partner and shared environmental factors such as physical and financial environment (29), social network (29), and family. The overall highest resemblance between parents was found for biking on late weekdays. This may be explained by use of bicycles for commuting (30,31) or for recreational means (31), which is common in Denmark. Especially if families live in a cycling-friendly area, parents may share cycling habits (31). The weak clustering in PA between parents during early weekdays may indicate a substantial diversity in parents' work-related activities (32).

The overall weak clustering in PA intensities between parents and children irrespective of the age of the children corresponds with the findings of a recent review (20). Genetics is considered a relatively weak explanatory factor for similarity in PA behaviors between parents and children (14). Thus, the highest resemblance in parent–child PA behaviors, which was observed during late weekdays and weekends, indicates that shared environment (33) and coparticipation (34) during leisure time may be among the most influential factors. The finding that parents and children shared sitting and standing behaviors during late weekdays may be explained by everyday life routines such as homework, shopping, cooking, and having dinner together (35) and was in line with our assumption that family members would be most alike in activities requiring low energy expenditure. It also corresponds well with findings from Dlugonski et al. (11) that the majority of self-reported coparticipation in PA between parents and children was of sedentary to light intensities.

The finding that walking was the active behavior showing the greatest similarity across all subgroups during late weekdays and weekends may have several explanations. Families with children wanting to share activities could find walking easy to perform because the metabolic and the mechanical costs of walking at self-selected speed are similar across a large age span (36) compared with activities of high intensity, which demand a higher energy cost, especially for children (37). Walking may also constitute a notable proportion of unstructured, shared as well as nonshared everyday life activities performed by adults and children (35). In addition, enjoyment has been found to play a role for coparticipation in MVPA between parents and children (38) and may thus be a contributing factor to our finding of intrafamily similarities in both walking and biking.

Methodological considerations. The use of data from a large household-based population study provided us with data on children of a wide age span and families of all compositions, including single-parent, nuclear, and blended families. However, because of the voluntary participation and exclusion of individuals who did not provide valid accelerometer data, some families were incomplete, which could potentially affect our results. Adult participants in LOFUS were more likely to be older, having higher socioeconomic status, be married, and be of Danish nationality than the average citizen, and women were overrepresented in most age-groups (39). The

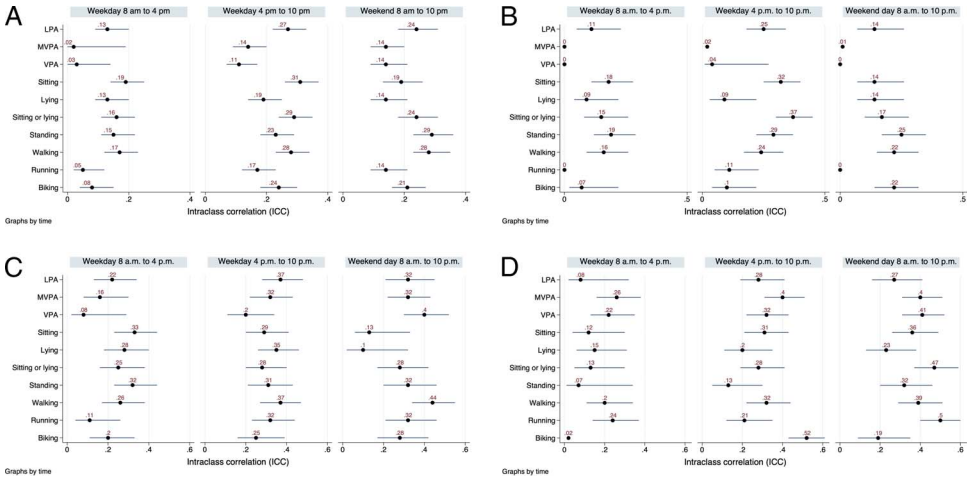


FIGURE 2—A–D, Mixed linear regression analysis of clustering of PA within families during three time segments of the week adjusted for sex, age, parental education, and the interaction between sex and age. A, Total family, *N* = 1576. B, Randomly selected parent–child dyads, *n* = 523 dyads. C, Siblings, *n* = 541 nested within 247 families. D, Parent–parent dyads, *n* = 258 dyads.

selection bias may have increased further when LOFUS participants were asked to volunteer for accelerometer measurement.

Different from most previous device-based studies targeting familial resemblance in PA using an accelerometer or a pedometer (20), the use of a dual-accelerometer system to assess PA in both parents and children allowed for classification of PA intensities as well as PA types under free-living conditions (18). This provided us with information representing actual PA behaviors of daily life such as sitting, walking, running, and biking. Yet, future family studies combining accelerometer measurement with information about context, intra- and extrafamily interactions, and everyday life behaviors and routines could provide a deeper understanding of mechanisms behind intrafamily resemblance in PA.

Because of the combination of the morning segment of weekdays (6:00–8:00 AM) being short and uncertainty about when family members got out of bed and left home and how they traveled to work/school, we excluded data on PA in the early morning hours.

Despite the advantage of the dual-accelerometer system, the use of accelerometer data is generally not without limitations. Data reduction and classification of intensities and PA behaviors are not standardized, which induces uncertainty in comparison between studies (40). Finally, because of the cross-sectional design of the study, causal relationships could not be inferred from our findings.

CONCLUSION

Using LOFUS family data and accelerometer recordings, this study provides new insight in intrafamily similarities in PA intensities and PA behaviors during three different time segments of the week. Overall, a greater proportion of the PA of individual family members was explained by siblings or spouses/partners than by the parent–child relation. Initiatives to promote PA may take advantage of this within-generation resemblance in PA. Because the PA behaviors that are most beneficial for health, such as running and biking, appear to have the highest resemblance among siblings and between parents, these kinds of behaviors may be worth targeting in a family context. Furthermore, our findings suggest that walking may be a potential target for initiatives reaching out to families with children. More studies are needed in this field of research to confirm our results and to develop a deeper understanding of the complexity of factors influencing PA within families.

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The authors declare that they have no competing interests. The results of the present study do not constitute endorsement by the American College of Sports Medicine. The results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

REFERENCES

1. Biswas A, Oh PI, Faulkner GE, et al. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. *Ann Intern Med*. 2015;162(2):123–32.

2. Poitras VJ, Gray CE, Borghese MM, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-age children and youth. *Appl Physiol Nutr Metab*. 2016;41:S197–239.

3. Reiner M, Niermann C, Jekauc D, Woll A. Long-term health benefits of physical activity – a systematic review of longitudinal studies. *BMC Public Health*. 2013;13(1):813.
4. Peters JC, Wyatt HR, Donahoo WT, Hill JO. From instinct to intellect: the challenge of maintaining healthy weight in the modern world. *Obes Rev*. 2002;3(2):69–74.
5. Van Hecke L, Loyen A, Verloigne M, et al. Variation in population levels of physical activity in European children and adolescents according to cross-European studies: a systematic literature review within DEDIPAC. *Int J Behav Nutr Phys Act*. 2016;13:70.
6. Kohl HW 3rd, Craig CL, Lambert EV, et al. The pandemic of physical inactivity: global action for public health. *Lancet*. 2012;380(9838):294–305.
7. Nilsen AKO, Anderssen SA, Resaland GK, Johannessen K, Ylvisaaker E, Aadland E. Boys, older children, and highly active children benefit most from the preschool arena regarding moderate-to-vigorous physical activity: a cross-sectional study of Norwegian preschoolers. *Prev Med Rep*. 2019;14:100837.
8. Kristensen PL, Korsholm L, Møller NC, Wedderkopp N, Andersen LB, Froberg K. Sources of variation in habitual physical activity of children and adolescents: the European youth heart study. *Scand J Med Sci Sports*. 2008;18(3):298–308.
9. Fuemmeler BF, Anderson CB, Masse LC. Parent–child relationship of directly measured physical activity. *Int J Behav Nutr Phys Act*. 2011;8:17.
10. Garriguet D, Colley R, Bushnik T. Parent–child association in physical activity and sedentary behaviour. *Health Rep*. 2017;28(6):3–11.
11. Dlugonski D, DuBose KD, Habeeb CM, Rider P. Physical activity coparticipation among parent–young-child dyads. *Pediatr Exerc Sci*. 2020;32:132–9.
12. Kracht CL, Sisson SB. Sibling influence on children's objectively measured physical activity: a meta-analysis and systematic review. *BMJ Open Sport Exerc Med*. 2018;4(1):e000405.
13. Chen HJ, Liu Y, Wang Y. Socioeconomic and demographic factors for spousal resemblance in obesity status and habitual physical activity in the United States. *J Obes*. 2014;2014:703215.
14. Seabra AF, Mendonça DM, Göring HH, Thomis MA, Maia JA. Genetic and environmental factors in familial clustering in physical activity. *Eur J Epidemiol*. 2008;23(3):205–11.
15. Jepsen R, Egholm CL, Brodersen J, et al. Lolland–Falster Health Study: study protocol for a household-based prospective cohort study. *Scand J Public Health*. 2020;48(4):382–90.
16. Egholm CL, Packness A, Stokholm J, et al. Questionnaire development for the Lolland–Falster Health Study, Denmark: an iterative and incremental process. *BMC Med Res Methodol*. 2020;20(1):52.
17. Petersen TL, Brønd JC, Kristensen PL, Aadland E, Grøntved A, Jepsen R. Resemblance in accelerometer-assessed physical activity in families with children: the Lolland–Falster Health Study. *Int J Behav Nutr Phys Act*. 2020;17(1):161.
18. Skotte J, Korshøj M, Kristiansen J, Hanisch C, Holtermann A. Detection of physical activity types using triaxial accelerometers. *J Phys Act Health*. 2014;11(1):76–84.
19. Lohr SL. Cluster sampling with equal probabilities. In: Blitzstein JK, Faraway JJ, Tanner M, Zidek, editors. *Sampling Design and Analysis*. 2nd ed. Boca Raton (FL): CRC Press; 2019. pp. 165–206.
20. Petersen TL, Møller LB, Brønd JC, Jepsen R, Grøntved A. Association between parent and child physical activity: a systematic review. *Int J Behav Nutr Phys Act*. 2020;17(1):67.
21. Maia J, Gomes TN, Trégouët D-A, Katzmarzyk PT. Familial resemblance of physical activity levels in the Portuguese population. *J Sci Med Sport*. 2014;17(4):381–6.
22. Tandon P, Grow HM, Couch S, et al. Physical and social home environment in relation to children's overall and home-based physical activity and sedentary time. *Prev Med*. 2014;66:39–44.
23. Whiteman SD, McHale SM, Crouter AC. Explaining sibling similarities: perceptions of sibling influences. *J Youth Adolesc*. 2007;36(7):963–72.
24. Davison KK, Lawson CT. Do attributes in the physical environment influence children's physical activity? A review of the literature. *Int J Behav Nutr Phys Act*. 2006;3:19.
25. Franks PW, Ravussin E, Hanson RL, et al. Habitual physical activity in children: the role of genes and the environment. *Am J Clin Nutr*. 2005;82(4):901–8.
26. Fisher A, van Jaarsveld CH, Llewellyn CH, Wardle J. Environmental influences on children's physical activity: quantitative estimates using a twin design. *PLoS One*. 2010;5(4):e10110.
27. Cooper AR, Andersen LB, Wedderkopp N, Page AS, Froberg K. Physical activity levels of children who walk, cycle, or are driven to school. *Am J Prev Med*. 2005;29(3):179–84.
28. Määttä S, Ray C, Vepsäläinen H, et al. Parental education and pre-school children's objectively measured sedentary time: the role of co-participation in physical activity. *Int J Environ Res Public Health*. 2018;15(2):366.
29. Meyler D, Stimpson JP, Peek MK. Health concordance within couples: a systematic review. *Soc Sci Med*. 2007;64(11):2297–310.
30. Andersen LB, Schnohr P, Schroll M, Hein HO. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. *Arch Intern Med*. 2000;160(11):1621–8.
31. Heesch KC, Giles-Corti B, Turrell G. Cycling for transport and recreation: associations with socio-economic position, environmental perceptions, and psychological disposition. *Prev Med*. 2014;63:29–35.
32. Holtermann A, Hansen JV, Burr H, Søgaard K, Sjøgaard G. The health paradox of occupational and leisure-time physical activity. *Br J Sports Med*. 2012;46(4):291–5.
33. Hesketh KR, Lakshman R, van Sluijs EMF. Barriers and facilitators to young children's physical activity and sedentary behaviour: a systematic review and synthesis of qualitative literature. *Obes Rev*. 2017;18(9):987–1017.
34. Edwardson CL, Gorely T. Parental influences on different types and intensities of physical activity in youth: a systematic review. *Psychol Sport Exerc*. 2010;11(6):522–35.
35. Bønnelycke J, Sandholdt CT, Jespersen AP. Household collectives: resituating health promotion and physical activity. *Sociol Health Illn*. 2019;41(3):533–48.
36. Ludlow LW, Weyand PG. Energy expenditure during level human walking: seeking a simple and accurate predictive solution. *J Appl Physiol*. 2016;120(5):481–94.
37. Westerterp KR. Physical activity and physical activity induced energy expenditure in humans: measurement, determinants, and effects. *Front Physiol*. 2013;4:90.
38. Kruk M, Zarychta K, Horodyska K, et al. From enjoyment to physical activity or from physical activity to enjoyment? Longitudinal associations in parent–child dyads. *Psychol Health*. 2018;33(10):1269–83.
39. Jepsen R, Wingstrand A, Abild SL, et al. Socio-economic determinants of participation in the Lolland–Falster health study. *J Public Health*. 2020;28(6):657–64.
40. Migueles JH, Cadenas-Sanchez C, Ekelund U, et al. Accelerometer data collection and processing criteria to assess physical activity and other outcomes: a systematic review and practical considerations. *Sports Med*. 2017;47(9):1821–45.