Special Issue published for Xmas Conference,
Held on December 1-3, 2021

DIFFERENCES IN PHYSICAL FITNESS AND BODY MEASURES BETWEEN CHILDREN WITH AND WITHOUT OLDER SIBLINGS

Ivan Šerbetar, Patricija Peharda & Anamarija Plečko

Faculty of Teacher Education, University of Zagreb, Dept Čakovec, A. Starčevića 55, Croatia
Corresponding author: ivan.serbetar@ufzg.hr

Abstract

Deterioration in children's physical fitness accompanied by unhealthy weight is a globally recognized problem. Among many other research directions related to factors that cause/influence a decline in physical fitness, there is presently an increase in the number of studies linked to family relationships and especially the influence of older siblings on the fitness of the younger children. The study attempted to determine whether having an older sibling(s) influences the physical fitness and anthropometric measures of the younger siblings, as compared to the children without older siblings. The study included 108 children aged 9 and 10, 55 of them with an older sibling(s). Height, weight, and 4 skinfolds were measured, and BMI was computed. Physical fitness was assessed by pull-ups, curl-ups, V-sit and reach, shuttle run, one-mile run, and handgrip strength. ANCOVA's on body measures as well as on physical fitness were applied. Based on the BMI values, results indicated that 40.7% of the overall sample of the children were in the categories of overweight or obesity and that on average, results in fitness tests were modest. The ANCOVA's, controlling for age, were computed with the intention to discover whether gender and/or the presence of older siblings influences physical fitness or body composition. Interactions were not significant, though, a significant main effect of having older siblings was obtained for the sum of skinfolds ($F (1, 103) = 5.097$, $p = .026$, partial $\eta^2 = .047$) in ANCOVA computed for body measures. In ANCOVA for fitness measures significant main effects of having older sibling were obtained for pull-ups ($F (1, 103) = 5.736$, $p = .018$, partial $\eta^2 = .053$) and shuttle run ($F (1, 103) = 4.633$, $p = .034$, partial $\eta^2 = .043$), while the main effect of one-mile run was near statistical significance ($p=.082$). The results mostly support previous studies where the children with older siblings were at an advantage over the children without older siblings. Considering body composition, children with older siblings had significantly less subcutaneous body fat. The level of physical fitness was on average modest, children with older siblings outperformed children without older siblings in pull-ups and shuttle run, while the endurance test was near statistical significance. Older siblings may positively influence the healthy behavior of younger children in physical activity and siblings' relationships may be one of the agents for improving the health-related fitness of the children.

Keywords: *children, physical fitness, siblings, obesity,*

Introduction

It is well established that insufficient physical activity has many damaging effects on health. Cardiovascular diseases, type-2 diabetes, stroke, but also many other health conditions are in the literature commonly related to the sedentary lifestyle (Booth et al., 2002). Physical activity has proven to be a reliable strategy against noted conditions in adults but also in children.

Considerable effort is invested in attempts to understand various factors related to a gradual decrease in physical activity and physical fitness of the children. Nutrition, sedentary behavior, and socioecological factors are just a few of the many common subjects in research related to the globally recognized problem of deterioration of children's fitness. There is significant growth in studies indicating that social relationships are also strongly related to the health and well-being of the individual (Cohen et al., 2000). In the realm of family relationships and family dynamics, along with the primary influence of the parents, siblings' relationships may also influence health and exercise behavior (Senguttuvan et al., 2014).

Siblings are important in the context of development as the characteristics and dynamics of their relationships substantially influence developmental outcomes (Feinberg, Solmeyer, & McHale, 2012). The sibling relationship is a natural laboratory for learning about the social and cognitive world (Howe & Recchia, 2014, p. 155). Older siblings serve as models, sources of advice, and caregivers for their younger siblings (Slomkowski et al., 2001; Tucker et al., 2001).

The intensity of sibling bonding and their interrelations may have positive benefits for children. Sibling interactions provide an arena for developing and practicing relationship skills (Dunn, as cited in Feinberg et al., 2012), but most likely motor skills as well. Numerous studies have showed that guidance of the younger children by their older siblings is an effective strategy for health-enhancing habits of children. The level of younger children's physical activity has been positively related to the physical activity levels of their older brothers, sisters, and parents (Hands et al., 2002). In support, studies have repeatedly shown that children without siblings spend more time in low-intensity physical activity (PA) and less time in moderate to vigorous PA, than children with siblings (Meller et al., 2018, Sisson et al., 2014).

Over the last several decades, considerable effort has been made by exercise scientists to try to understand the impact of parents on the physical activity level (i.e., physical fitness) of their children. Adversely, interest to enlighten other important family relationships, such as the one between the siblings, was far smaller. Since the large majority of studies on the role of siblings in health enhancing physical activity of children are based on data providing details of the quantity or quality of physical activity, or of sedentary behaviour, it was decided that the approach applied in this current study would comprise of objectively measured motor and anthropometry variables. Hence, the purpose of the current study is to determine whether children with an older siblings differ from the children without older siblings in physical fitness and body measures.

Methods

Sample

One hundred and eight children (67 girls and 41 boys) were recruited from three elementary schools in Northern Croatia to participate in the study. They were 9 and 10 years old (mean age = 9.45, SD=.50), the age was also calculated in months with the mean average being noted as 115.27 months (range 102-129 months). Within the total sample, 53 children had no older siblings and 55 had older siblings. All the children were in normal development and without any known health issues.

Measures and assessment

Measures of *height* and *weight* were taken as well as *subscapular, triceps*, and *thigh skinfolds*. BMI was calculated from height and weight while skinfolds measures were summarised in the composite score.

Motor fitness was assessed by using items from the *Presidents Challenge battery* (Franks & Safrit, 1999).

1. *Pull-ups* - indicated by the maximum number of pulls completed from the hang position on the horizontal bar with the feet elevated from the ground and arms fully extended at the beginning of the test.

2. *Curl-ups* - measured by a maximum number of curl-ups reached in one minute from a lying position with arms crossed on the chest, feet 30 cm apart, and the knees flexed.

3. *V-Sit and reach* measured in a sitting position with the legs placed in a V shape, heels 20-30 cm apart and knees straightened, the subject reaches forward measuring line positioned perpendicularly to the feet and in the middle of the line connecting the soles, with the "0" mark on the crossing of the lines. Attempts with the reaches beyond "0" are positive scores and those below "0" are negative.

4. *Shuttle run* - the subject has to run two times back and forth between starting and opposite lines, distanced 9.1 m one from the other, picking each time one wooden block positioned on the opposite line and carrying the block to the start line.

5. *One-mile run* (1600 m) – running was performed outside on a grass-covered soccer field. The health status of the students was additionally controlled before the race and students were encouraged to run as far as they could, but walking was also allowed.

6. *Handgrip strength* - measured using a *Lafayette dynamometer*. Students were instructed to make a maximal squeeze movement with the dominant hand holding the instrument with the forearm flexed.

Ethical considerations

Parents were provided with information about the study and signed an Informed Consent form. All the participating children gave their verbal assent before their involvement in the tests.

Statistics

Descriptive statistics were calculated for anthropometric and motor fitness variables for groups organized by the criteria of gender and having or not having older siblings. Two Analyses of Covariance (ANCOVA) on dependent variables of motor fitness and anthropometry were computed separately. In both ANCOVAs, effects of gender and older siblings on dependent variables was of interest and in both analyses age in the month was applied as a covariate.

Results

The descriptive results of the motor fitness and anthropometry are presented in Tables 1 and 2 respectively. Based on BMI, 14.8 % (n=16) of the children were categorized as overweight and 25.9 were obese (n=28), one child was under-weight (0.9%). In the categories of overweight and obese there were more girls than boys, although that was not statistically significant.

In the results related to physical fitness, on average, neither boys nor girls reached the 50^{th} percentile of *Presidents Challenge* norms in any of the tests. Of particular concern was the fact that 25% of the children (n=27) from the overall sample were not able to lift their own body (pull-ups) to the level of

the chin, not even once. Besides that, average results in a *one-mile run* were for both genders two minutes worse/slower than the *Presidents Challenge* 50th percentile norm.

Table 1. Descriptive statistics of the anthropometric measures

	Girls		**Boys**	
	Without an older sibling (n=34)	**Having an older sibling (n=33)**	**Without an older sibling (n=19)**	**Having an older sibling (n=22)**
Anthropometric measures	**MEAN (SD)**	**MEAN (SD)**	**MEAN (SD)**	**MEAN (SD)**
Height	140.43 (7.11)	139.47 (7.09)	139.92 (5.02)	140.66 (7.09)
Weight	40.22 (10.95)	37.14 (11.56)	38.16 (9.28)	39.00 (8.90)
BMI	20.16 (4.09)	18.85 (4.58)	19.36 (4.05)	19.62 (3.83)
Sum of Skinfolds	66.38 (23.57)	55.42 (23.47)	59.32 (24.07)	51.68 (23.16)

Table 2. Descriptive statistics of the motor fitness measures

	Girls		**Boys**	
Physical fitness	**Without an older sibling (n=34)**	**Having an older sibling (n=33)**	**Without an older sibling (n=19)**	**Having an older sibling (n=22)**
	MEAN(SD)	**MEAN(SD)**	**MEAN(SD)**	**MEAN(SD)**
VSit&Reach	3.76 (2.23)	4.26 (3.07)	1.89 (2.53)	2.86 (2.61)
PullUps	1.21 (1.45)	2.97 (3.54)	2.37 (2.24)	3.09 (2.02)
ShuttleRun	13.60 (1.05)	12.84 (1.50)	13.10 (1.43)	12.51 (1.27)
CurlUps	29.03 (8.31)	29.45 (8.36)	33.05 (6.84)	35.32 (9.74)
***OneMileRun**	860.56 (93.38)	807.15 (118.16)	819.16 (98.27)	790.09 (94.45)
GripStrength	12.50 (3.03)	13.39 (3.35)	15.11 (2.69)	16.14 (3.86)

*Expressed in seconds

Effects of gender and the presence of an older sibling on the anthropometric and motor fitness variables after controlling for age were investigated. The central interest of the study was to establish whether having or not having older siblings influenced the fitness of children assessed by the previously mentioned tests. The study also aimed to ascertain whether gender and/or the presence of older siblings influenced physical fitness or body composition of children. Considering age differences between the subjects, age stated in months was utilized as a control variable.

Prior to the analysis, the theoretical assumptions of the Analysis of Covariance (Tabachnick & Fidell, 2001), including normality, homogeneity of variance, and homogeneity of regression slope were verified. All the assumptions were met.

In the ANCOVA performed on anthropometric measures (Table 3), controlling for age, the interaction effect was not significant, nor were the main effects for *gender*. Nonetheless, significant main effect of *having an older sibling* was obtained for composite measure of *skinfolds* (F (1, 103) = 5.097, p = .026, partial η^2 = .047) whilst controlling for age. Pairwise comparisons showed that the sum of skinfolds of children with older siblings was on average 10.58 mm smaller than in children without an older sibling.

Table 3. Main effects for conditions of *Gender*, *Older sibling*, and interaction for anthropometric variables

	Gender		**Older sibling**		**Gender X Older Sibling**	
Anthropometry	**F**	**p**	**F**	**p**	**F**	**p**
Height	.029	.865	.931	.337	.487	.487
Weight	.083	.774	1.01	.317	.934	.336
BMI	.019	.891	.718	.399	.887	.349
SumOfSkinfolds	1.71	.194	5.10	**.026**	.125	.725

In the ANCOVA performed on motor tasks (Table 4), whilst controlling for age, interaction effect was not significant. Though, significant main effect of *gender* was obtained for the *flexibility* test (F (1, 103) = 9.444, p = .003, partial η^2 = .084), for the *strength - resistance test (curl-ups)* (F (1, 103) = 8.083, p = .005, partial η^2 = .073) and for the *grip strength* (F (1, 103) = 16.24, p = .000, partial η^2 = .136). Examination of pairwise comparisons indicated that in the flexibility test girls outperformed boys on average by 1.6 cm while boys were better in *curl-ups* (4.73 attempts more) and grip *strength* (2.5 kg more).

Significant main effects of *having an older sibling* were obtained for dependent variables of *pull-ups* (F (1, 103) = 5.736, p = .018, partial η^2 = .053) and *shuttle run* (F (1, 103) = 4.633, p = .034, partial η^2 = .043). The main effect of *one-mile-run* was near statistical significance (p=.082). Pairwise comparisons showed that children with older siblings on average made 1.2 pull-ups more and they were half a second faster in the *shuttle run*. Children with older siblings also finished the *one-mile run* 36 seconds earlier on average than children without older siblings, but that difference only approached statistical significance.

Table 4. Main effects for conditions of *Gender*, *Older sibling*, and interaction for motor fitness variables

	Gender		**Older sibling**		**Gender X Older Sibling**	
Motor fitness	**F**	**p**	**F**	**p**	**F**	**p**
Vsit&Reach	9.44	**.003**	1.97	.164	.205	.652
PullUps	1.57	.215	5.74	**.018**	1.10	.297
ShuttleRun	1.87	.174	4.63	**.034**	.121	.728
CurlUps	8.08	**.005**	.305	.582	.303	.583
OneMileRun	1.70	.195	3.08	.082	.369	.545

GripStrength	16.24	**.000**	1.12	.293	.010	.920

Discussion

The current study attempted to determine whether having an older sibling(s), influenced physical fitness and anthropometric measures of younger siblings, as compared to children without older siblings in our sample of young school-aged children.

The rationale for this study was the fact that siblings provide a primary social context for development. Taking into the account emotional intensity of their relationship and the amount of time they spend together (Feinberg et al., 2012), it is reasonable to expect that there is a possible influence of older children on the motor development (i.e., physical fitness) of their younger siblings.

The results mostly support the comparable study of Rodrigues et al. (2020) where the children with older siblings were at an advantage over the children without older siblings.

Considering body composition, children with older siblings had significantly less subcutaneous body fat. Additionally, girls with older siblings were leaner and shorter than girls without older siblings and they also had lower BMI, however, the differences in the anthropometric variables were not statistically significant. Those findings are consistent with other studies (e.g., Meller et al., 2018) where the authors reported that the rate of obesity in children without siblings is higher than in children with siblings. However, based on BMI, the results indicated that 40.7% of the overall sample in the current study were in the categories of overweight or obesity. Despite this, differences based on gender and the presence of the older siblings, were not statistically significant.

The excess gain in weight may be associated with lower physical activity and increased sedentary behavior (Marques et al., 2016; Clark et al., 2015). Older siblings may motivate younger ones to co-participate in activities and in that way enhance physical activity and lower sedentary behaviour. This was confirmed by Bagley et al. (2015) who found that children without siblings watched television more than children with older siblings.

Excessive food intake may also contribute to the overweight or obesity status of children. In the study conducted by Ikeda et al. (2017), it was established that maintaining appropriate body weight may be controlled and influenced by family members. More specifically, the authors emphasized that living without siblings and living with grandparents may increase the likelihood of overweight and obesity. Correspondingly, Sisson et al. (2014) found that in families with two or more children, children were less likely to have irregular meals with other members of the family, or TV in their room, or elevated TV viewing time.

The level of physical fitness of the current sample was on average modest, even so, children with older siblings outperformed the ones without older siblings in all motor tasks. Nonetheless, the difference was statistically confirmed for *pull-ups* and *shuttle run*, while the *one-mile run* endurance test was near statistical significance. Similar to the influence of peers (Spencer et al., 2014), perhaps facilitation of physical activity of older siblings through mutual involvement and social support may increase the activity level and duration, and accordingly, increase levels of physical fitness.

Kracht and Sisson's (2018) meta-analysis reported that children with siblings had a slight overall increase in moderate-to-vigorous physical activity (MVPA) per day, an average of five more minutes MVPA per day than ‘only’ children. Additionally, there may be a possible dose-response, with more siblings leading to more child MVPA and less sedentary behavior, for each additional sibling, there were 3.13 more minutes of MVPA per day (Kracht & Sisson, 2018).

Sports participation of older siblings may also positively influence younger children's sports involvement. As summarized by Sulloway and Zweigenhaft (2010), studies relating birth order and participation in dangerous sports (N = 8,340) suggested that later-born children are 1.48 times more likely to participate in those sports than first-borns. Furthermore, Heinrichs and Robinson (2014) reported that 95% of US women's national soccer team pool players have a sibling, of which 74% have an older sibling, supporting the potential influence of siblings (especially older siblings) on participation and ultimately performance.

Conclusion

This study investigated the effects of gender and the presence of older siblings on anthropometric and motor fitness variables after controlling for age. Based on the results of the current study, it may be proposed that older siblings are social-environmental determinants of the physical fitness of younger children in families. Although the presence of siblings does not guarantee an increased level of physical fitness and does not eliminate the risk of overweight or obesity, that risk could be diminished.

Sibling relationships are extremely important, as outlined by Feinberg et al. (2012) who stated: "[they are] like the third rail on a subway track that carries the electrical current" (Feinberg et al., 2012, p. 2). Therefore, gaining better insights of sibling relationships may lead not only to a better understanding of social factors which influence physical activity in the family, but also to possible family advisory strategy which may improve health-related fitness of the children.

References

Bagley, S., Salmon, J., Crawford, D. (2015). Family structure and children's television viewing and physical activity. *Medicine* & *Science* in *Sports* & *Exercise*. 38:910–8. DOI: 10.1249/01.mss.0000218132.68268.f4

Booth, F. W., M. V. Chakravarthy, S. E. Gordon, & E. E. Spangenburg (2002). Waging war on physical inactivity: using modern molecular ammunition against an ancient enemy. *Journal of Applied Physiology*, 93:3–30.

Cohen, S., Gottlieb, B.H., Underwood, L.G. (2000). Social relationships and health. In: Cohen, S.; Underwood, L.G.; Gottlieb, B.H., editors. *Social support measurement and intervention: A guide for health and social scientists.* Oxford University Press; p. 29-52.

Clark, B., White, M., Royer, N., Burlis, T., Dupont, N., Wallendorf, M., Racette, S. (2015). Obesity and Aerobic Fitness among Urban Public School Students in Elementary, Middle, and High School. *PloS one*. 10. e0138175. 10.1371/journal.pone.0138175.

Feinberg, M., Solmeyer, A., McHale, S. (2012). The Third Rail of Family Systems: Sibling Relationships, Mental and Behavioral Health, and Preventive Intervention in Childhood and Adolescence. *Clinical child and family psychology review*, 15, 43-57. DOI: 10.1007/s10567-011-0104-5.

Franks, B. D. & Safrit, M. J. (1999). The President's Challenge in the New Millennium. *American Academy of Kinesiology and Physical Education,* 51 (2), 184-190. doi: 10.1080/00336297.1999.10491679

Hands, B. P., Parker, H., Larkin, D. (2002). What do we really know about the constraints and enablers of physical activity levels in young children? *23rd Biennial National/International Conference.* Retrieved from: https://researchonline.nd.edu.au/cgi/viewcontent.cgi?referer=https://www.google.hr/&httpsredir=1&article=1003&context=health_conference (12. 2. 2020.)

Heinrichs, A. & Robinson, M. (2014). The U.S. women's youth national teams program, Finding the next Mia Hamm and Alex Morgan. *Women's Soccer*, 64-71

Howe, N. & Recchia, H. (2014). Sibling Relationships as a Context for Learning and Development INTRODUCTION. *Early Education and Development*, 25, 155-159. 10.1080/10409289.2014.857562.

Ikeda, N., Fuse, K., Nishi, N. (2017). Changes in the effects of living with no siblings or living with grandparents on overweight and obesity in children: Results from a national cohort study in Japan. *PLoS ONE* 12(4): e0175726. https://doi.org/10.1371/journal.pone.0175726

Kracht, C.L., Sisson, S.B. (2018). Sibling influence on children's objectively measured physical activity: a meta-analysis and systematic review. *BMJ Open Sport & Exercise Medicine.* DOI:10.1136/bmjsem-2018-000405

Marques, A., Minderico, C., Martins, S., Palmeira, A. U., Ekelund, L., Sardinha, B. (2016). Cross-sectional and prospective associations between moderate to vigorous physical activity and sedentary time with adiposity in children. *International Journal of Obesity,* 40:28–33.

Meller, F.O., Loret D.M.C., Assunção, M., Schäfer, A.A., Dahly, D.L., Barros, F.C. (2018). Birth order and number of siblings and their association with overweight and obesity: a systematic review and meta-analysis. *Nutrition Review*, 76:117–124. doi:10.1093/nutrit/nux060

Rodrigues, L.P., Lima, R.F., Silva, A.F., Clemente, F.M., Camões, M., Nikolaidis, P.T., Rosemann, T. and Knechtle, B. (2020). Physical Fitness and Somatic Characteristics of the Only Child. *Frontiers in Pediatrics*, 8:324. DOI: 10.3389/fped.2020.00324

Senguttuvan, U., Whiteman, S.D., Jensen, A.C. (2014). Family relationships and adolescents' health attitudes and weight: the understudied role of sibling relationships. *Family Relations*, 63:384–96.

Sisson, S. B., Sheffield-Morris, A., Spicer, P., Lora, K., Latorre, C. (2014). Influence of family structure on obesogenic behaviors and placement of bedroom TVs of American children: National Survey of Children's Health 2007, *Preventive Medicine*, 61, 48-53, https://doi.org/10.1016/j.ypmed.2014.01.010.

Slomkowski, C., Rende, R., Conger, K. J., Simons, R. L., & Conger, R. D. (2001). Sisters, brothers, and delinquency: Evaluating social influence during early and middle adolescence. *Child Development, 72*(1), 271–283. https://doi.org/10.1111/1467-8624.00278

Spencer, R.A, Bower, J., Kirk, S.F., Friesen, C.H. (2014). Peer mentoring is associated with positive change in physical activity and aerobic fitness of grades 4, 5, and 6 students in the heart healthy kids program. *Health Promotion Practice,* 15:803–11. DOI: 10.1177/1524839914530402

Sulloway, F. J. & Zweigenhaft, R. L. **(**2010). Birth Order and Risk Taking in Athletics: A Meta-Analysis and Study of Major League Baseball. *Personality and Social Psychology Review,* 14: 402 DOI: 10.1177/1088868310361241

Tabachnick, B.G., Fidell, L.S. (2001). *Using multivariate statistics* (4th ed.), Allyn and Bacon

Tucker, C. J., McHale, S. M., & Crouter, A. C. (2001). Conditions of sibling support in adolescence. *Journal of Family Psychology*, *15*(2), 254–271. https://doi.org/10.1037/0893-3200.15.2.254