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Physical Activity and Physical Fitness in Children Schooled at Home and Children Attending Public Schools

Gregory J. Welk, Jodee A. Schaben, and Mack Shelley

Homeschooling is increasingly popular, but little is known about how homeschooling affects physical activity patterns or fitness levels. This study compares patterns of physical fitness, physical activity, and psychosocial correlates of physical activity in homeschooled youth and youth attending public school. Fitness levels were obtained using the PACER aerobic fitness test, physical activity levels were assessed with 3 days of accelerometry, and psychosocial correlates were assessed with the Children's Physical Activity Correlates scale. There were no significant main effects for fitness comparisons, but significant age and gender interactions indicate that variability exists within these samples for fitness. No school-type effects were evident for the physical activity measures or the psychosocial correlate measures, but trends in the data suggest the possibility of age-related interactions for the psychosocial measures. Additional research on possible differences between homeschooled youth and youth attending public school is needed to better understand these trends.

Increasing attention has been given to the importance of regular physical activity for youth (1,7,8,35). Most studies suggest that children and adolescents are not getting sufficient amounts of physical activity (9,19). Low levels of physical activity in youth have been linked to increasing levels of obesity in both cross-sectional (13,14,21) and longitudinal studies (4,16). Because physical activity has important public health significance, it is important to understand factors that influence activity patterns in youth.

A population that is understudied and potentially at greater risk for inactivity and obesity-related conditions is the expanding number of homeschooled children. It is estimated that between 1.5 and 2 million children are currently being homeschooled in the United States, and this number increases by 7–15% each year (22). Research has generally supported the contention that homeschooled students perform as well or better than public school students in most academic subjects (29). Research has also refuted the popular notion that homeschooled children become socially isolated or emotionally withdrawn (30). Research, however, has not systematically examined the effects of homeschooling on children's levels of

The authors are with the Dept of Health and Human Performance, Iowa State University, Forker Bldg., Ames, IA 50011.

physical activity or physical fitness. School provides opportunities for children to be physically active during physical education and recess, as well as through unstructured play before and after school (25,33). School physical education also provides training in the physical and behavioral skills needed to be active later in life (27). Reduced opportunities for physical education and recess in homeschooled youth might cause homeschooled youth to be less active and less fit than age-matched public school youth.

The study of children's physical development is complicated by the interacting effects of genetics and maturation, as well as by innate gender and individual differences. Regular physical activity can improve aerobic fitness, but children are known to be less responsive to physical activity than adolescents or adults (28). Because fitness and activity might be only weakly correlated, it is important to study physical fitness and physical activity as separate outcomes. Psychosocial correlates of physical activity are also important indicators of children's development because they reflect the child's overall attitude toward activity, which might influence his or her future involvement as an adult.

The purpose of this study is to compare physical activity, physical fitness levels, and psychosocial correlates of homeschooled children and children attending public school. The Youth Physical Activity Promotion (YPAP) model (38) provides the theoretical basis for studying these relationships. This social–ecological model integrates social and environmental influences on children's physical activity into a unifying framework (the adapted version of the model is shown in Figure 1). *Predisposing factors* represent the overall predisposition a child has to be active, and these factors are viewed from a social cognitive theory perspective (3). Children who have positive outcome expectancies (operationalized as

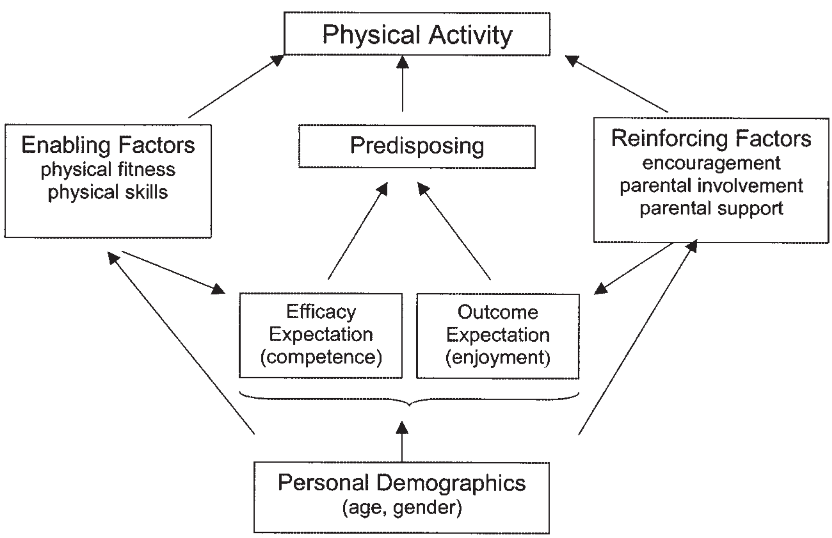

Figure 1 — Hypothesized links among factors in the Youth Physical Activity Promotion model (Welk, 1999).

enjoyment) and positive efficacy expectations (operationalized as competence) are more likely to be predisposed to be physically active. *Enabling factors* refer to attributes or characteristics such as motor skills and fitness that influence a child's ability to learn and participate in physical activity (10,15,37). *Reinforcing factors* refer to support or reinforcement that increases the likelihood of physical activity. A variety of parental-influence measures have been associated with physical activity, including parental encouragement (5,6,47), direct support (2), and parent involvement in activity (32). These are the main predisposing factors examined in the present study. Recent work with the YPAP model (47) has supported its use for studying correlates of physical activity in children.

Methods

Participants

The sample included a total of 117 homeschooled children (75 boys and 42 girls) from four different homeschool cooperatives in central Iowa and a comparison sample of 1,234 children (743 boys and 608 girls) from a public school district in Central Iowa. The ages of the original homeschool sample ranged from 7–18, but only students from 9–16 were used in the present study. The distribution of males in the homeschool sample was slightly higher (62%) compared with the public school sample (55%). The sample of homeschooled children was a bit younger on average compared with the more balanced distribution in the public school sample. Approximately 60% of the homeschool sample was between 9 and 12 years of age, whereas the public school sample was divided more evenly between the 9–12 age group (49%) and the13–16 age group. The ethnicity of the individual participants was not tracked in the study, but the overall sample distribution in the local school district is 81% White, 6% Black, 8% Asian, 4% Hispanic, and 1% other. The homeschool population was less heterogeneous (95% White), but this distribution is similar to the overall demographics in the state (90% White) and also typical for homeschool families nationally (29). Anthropometric data on height, weight, and body composition are also not tracked in the school district, so it is not possible to further characterize the sample with these types of measures. The Institutional Review Board for our University approved the overall procedures for the study and the Curriculum Evaluation Committee from the participating school district approved the specific inclusion of the public school data in the project.

Measures

***Physical fitness: enabling factor*.** Health-related fitness was assessed with the *FITNESS*GRAM® fitness battery (11), but results are reported only for the aerobic capacity assessment provided by the PACER aerobic shuttle-run test. This test requires children run a series of 20-m laps to a timed cadence—the speed increases each minute until the child cannot complete the lap in the designated time (20). Validation studies with the test have shown it to yield valid estimates of $VO_{2\,max}$ ($r = .72$, $SEE = 5.26$ ml·kg·min) in both children (44) and adolescents (23). Test–retest reliability estimates (intraclass correlations) have ranged from .89 to .93 in previous studies (20,23,24). Power calculations (18) indicated that a sample size of 117 would allow us to detect a significant difference in $VO_{2\,max}$ with a power of .97 at a Type I error level of .05 for a two-tailed test and a moderate effect size of .50 as measured by Cohen's *d*.

Psychosocial correlates of physical activity. A self-report battery of psychosocial scales known as the Children's Physical Activity Correlates (CPAC) was used to collect data on possible correlates of physical activity. The survey instrument includes items that assess the predisposing and reinforcing constructs described in the Youth Physical Activity Promotion model: see Figure 1 (38). The constructs in this model are based on principles from social cognitive theory but are operationalized to be more relevant to children. Each of the constructs in the instrument is assessed using a four-point (1–4) structured alternative format to reduce tendencies for socially desirable responses. The psychometric properties of the component scales in this battery are described below.

- Attraction to Physical Activity: Predisposing Factor
  Items from the Children's Attraction to Physical Activity (CAPA) instrument (5) were used to assess outcome expectations for physical activity (i.e., the value or benefit associated with regular participation). A previous study (47) found that a composite measure based on a mean of 15 items (3 from each of the original five scales) yields a unidimensional construct with an alpha reliability of .82.
- Perceived Competence: Predisposing Factor
  Harter's Perceived Competence Scale was used to assess efficacy expectations (i.e., confidence in being able to be physically active). The original scale includes 5 items, but our past research (47) found that a reduced scale consisting of 3 items was sufficient to represent the construct. The alpha reliability of the reduced scale was .71.
- Parental Influence: Reinforcing Factor
  Parental influence was assessed with four scales (3 items per scale) that assess different dimensions of parental influence (role modeling, encouragement, involvement, and facilitation). For the present study, a composite indicator of parental influence was computed by taking the mean from the four different scales. The alpha reliability of the composite scale from the past study (47) was .81.

Physical activity. Physical activity of children was assessed with an accelerometry-based activity monitor that provides objective information on overall levels of physical activity. The Biotrainer activity monitor (IM Systems, Baltimore) was selected for this project based on its small size, low cost, and ease of use. Previous studies have validated the Biotrainer as a measure of physical activity (39,40) and reliability of different monitoring units has recently been established (46). Calibration equations have been used in some studies to convert the raw activity counts into more meaningful units of time or energy expenditure, but a raw measure of average counts per day was used in this study to minimize additional error from the use of these prediction equations.

Data-Collection Procedures

The logistics and design of the study necessitated that we use slightly different recruitment and data-collection procedures to accommodate the unique characteristics of the public school and homeschool samples. For the public school sample, we obtained data collected as part of the annual district-level evaluation. Teachers from all 10 of the schools (8 elementary schools, 1 middle school, and 1 high school) received training by the lead author on the administration of the *FITNESS*GRAM assessments. The CPAC instrument is also used across the district to evaluate students' attitudes and beliefs about physical activity and physical education. Data for the present project include representative samples from three elementary schools, the middle school, and a subsample from the high school.

The homeschool data were collected during separate site visits to each of the four participating homeschool cooperatives. Homeschool children in each group typically attend these group sessions every week or every other week to provide time for social interactions and group activities. Parents of children in the homeschool cooperatives were informed about the testing through internal mailings and provided informed consent to allow each child to participate. Children then completed assent forms before participating in the project. For the two local homeschool cooperatives, data on fitness and psychosocial correlates were obtained on separate visits. For the two more distant sites, logistics required that we collect the data all in one visit. Participants from these sites completed the assessments in a station-by-station format. Some students completed the survey first while others started at different fitness stations to complete the different assessments in the *FITNESS*GRAM test battery. The order of data collection varied depending on the population, but the procedures for fitness testing and administration of the survey were similar to what was used for the public school children.

It was not possible to obtain objective data on physical activity from all study participants. A total of 24 public school and 39 homeschool children provided separate consent and assent to wear a monitor for a full week outside of the normally scheduled school (or homeschool) assessments. The participants were asked to wear the devices during all waking activities (except for swimming or bathing).

Data-Processing Procedures

The fitness data for all participants were processed using the *FITNESS*GRAM 6.0 software (11). The export procedure in the software was used to extract individual fitness data and a unique student ID variable. The data on the psychosocial correlates were manually entered into Microsoft® Excel® along with a matching student ID variable. Reverse-coded items were rescored and the composite scale scores for attraction, perceived competence, and parental influence were computed.

The physical activity data from the Biotrainer monitors were downloaded according to the standard guidelines provided by the manufacturer. The raw data files were screened for compliance using procedures described in previous work (42). Individual days of data were flagged if there were four consecutive blocks of time (> 2 hours) with zero counts; participants with at least 3 complete days of physical activity data were included in the final analyses. Only 13 public school and 31 homeschooled children had complete data for 3 full days. If participants had more than 3 clean days of data, 3 days were selected at random. The physical activity data were merged with the psychosocial data and fitness data using the participant's ID number to create the final data set.

Data Analyses

Data were analyzed using a two-way (Gender × School Type) analysis of covariance (ANCOVA) with age as a covariate. Separate analyses were performed for the five different components of the YPAP model assessed in this study (aerobic fitness, attraction to physical activity, perceived competence, parental influence, and physical activity). Because the study is the first to make direct comparisons between homeschool and public school samples, it is important to examine possible differences in each of these outcomes instead of an overall multivariate comparison. There was a greater concern over not missing a significant finding, so a more liberal Type I error level was used for the study (.10). To reduce the likelihood of getting significance by chance alone, however, a Bonferroni correction was still applied. This reduced the significance test to $p < .02$ (.10/5). This approach was deemed to provide an appropriate balance between Type I and Type II error.

Because physical activity patterns and determinants might vary by age, we also sought to test possible age-related differences in outcomes. To accomplish this, the homeschool and public school samples were divided into two age groups (younger: 9–11 and older: 14–16). Students ages 12 and 13 were removed from the analyses so that the groups were clearly distinct in maturation and development. Age was used as the grouping variable in the study because homeschoolers cannot be categorized easily by grade. Three-way analyses of variance (Age × Gender× School Type) were used to examine possible age-related differences between homeschooled and public school children. The primary focus in these analyses was still on possible differences because of school type, so emphasis was placed on the interaction terms involving school type (i.e., the three-way Age × Gender × School Type interaction term and the two-way interaction terms, Age × School Type and Gender × School Type). The three-way analyses were performed only for the fitness measure and the three psychosocial correlates. A univariate analyses on the average activity levels across 3 days was used to analyze the physical activity data.

Because the sample sizes might have been insufficient to detect small differences between them, effect sizes are computed for all comparisons. Effect sizes were calculated according to established procedures (36). A pooled standard deviation was used because there was not a predetermined control group for these comparisons.

Results

The descriptive statistics on the fitness measures and the three psychosocial correlates, attraction to physical activity, perceived competence, and parental influence, are shown in Table 1. Effect sizes are computed for all school-type differences, and these are processed separately by gender, as well as for all students combined.

The two-way ANOVA results allow for comparisons by school type and gender, as well as an examination of interactions between these independent variables. There was a significant Gender × School Type interaction for the number of PACER laps completed [$F(1, 1{,}346) = 5.57$, $p = .018$.]. The interaction term approached our significance level of $p < .02$ when the estimated aerobic capacity (ml·kg·min) was used as the outcome measure [$F(1, 1{,}346) = 4.61$, $p = .032$.]. As

Table 1 Descriptive Statistics for Physical Fitness and Psychosocial Correlates of Physical Activity in Public School and Homeschool Samples

	Public school			Homeschool			
	n	Mean	*SD*	*n*	Mean	*SD*	Effect size
Aerobic fitness (ml·kg·min)							
male	668	46.34	5.23	75	45.44	5.08	.17
female	556	43.41	4.64	42	43.98	4.88	–.12
overall	1,234	44.99	5.18	117	44.92	5.04	.01
Attraction to physical activity							
male	555	3.11	.54	49	3.23	.43	–.23
female	467	2.99	.52	30	3.08	.46	–.17
overall	1,022	3.05	.54	79	3.18	.44	–.24
Perceived competence							
male	555	3.07	.73	49	3.06	.65	.01
female	467	2.76	.70	30	2.70	.58	.09
overall	1,022	2.93	.73	79	2.93	.64	.00
Parental influence							
male	555	3.10	.67	49	3.02	.42	.12
female	467	3.07	.58	30	2.94	.35	.23
overall	1,022	3.09	.63	79	2.99	.40	0.16

seen in Table 1, the values for public school boys were slightly higher than those for homeschooled boys (ES = .17), and the values for public school girls were slightly lower than for homeschooled girls (ES = -.12). The effect sizes for the differences were small, however.

There were no school-type interactions or main effects for the attraction to physical activity or perceived competence measures, but there was a significant school-type main effect for the parental-influence measure [$F(1, 1{,}096) = 8.33$, $p = .004$]. In this case, homeschoolers perceived less parental influence than did public school children. The effect sizes for these comparisons were fairly small (ES ~ .20).

Gender differences were not the primary focus of this study, but the results of these comparisons are briefly described to provide a more complete view of the data. Gender main effects were significant for the PACER aerobic fitness measure, with males having higher fitness levels than females ($p < .001$). This gender difference was primarily because of differences in the public school sample (ES = .61) because there was not a significant gender difference among homeschoolers (ES =

.05). Gender main effects for perceptions of competence were also significant ($p <$ .001), with boys having higher perceptions than girls. For this measure, the effects were consistent for both the public school sample (ES = .43) and homeschool sample (ES = .58). Gender main effects approached significance (p = .038) for attraction to physical activity, with boys reporting higher scores. The effect was small, but similar, for the public school (ES = .23) and homeschool (ES = .34) samples.

Three-way ANOVAs were performed on a reduced set of data to examine possible interactions by age. The descriptive data for the psychosocial data are shown in Table 2. For the fitness comparison, we observed a significant three-way interaction [$F(2, 664) = 8.77$, $p = .002$]. Young homeschooled boys had aerobic capacity values that were similar (only 2% lower) to young public school boys (ES = .24), but values for older homeschoolers were 14% lower compared with the older public school youth (ES = .88). For girls, this age-related effect was not evident. Homeschooled girls had values that were similar to public school girls for both age groups. This interaction is displayed graphically in Figure 2.

There were no other significant three-way interactions for the other comparisons with the psychosocial measures, but the Age × School Type interaction approached significance for both the attraction to physical activity measure (p = .049) and the parental influence measure (p = .063). In both cases the responses for older homeschoolers were more positive than for younger homeschoolers, whereas the opposite was true for public school youth. The differences in outcomes can be seen in the different signs for the effect-size values (see Table 2). For the younger group, the effect sizes are positive, indicating higher values for public school youth. For the older group, the effect sizes are negative, indicating higher values for the homeschoolers.

The physical activity data are shown in Figure 3. For all 3 days, the homeschooled youth had slightly lower levels of physical activity than youth attending public school. The overall statistical comparison based on the average activity level across the 3 days was not significant [$F(1,42) = .80$, $p = .38$). Sample sizes were too low to conduct additional analyses by gender or age group.

Discussion

This study is the first effort to directly compare physical fitness and physical activity measures in homeschooled children and children attending public school. We found that homeschooled males had significantly lower fitness levels than public school males, but no differences were evident in females. Follow-up analyses using a three-way analysis (Age × Gender × School Type) revealed that the difference was evident only for the older male group. The overall effect sizes are small for all of these comparisons and probably not of clinical significance.

The data on physical activity are generally consistent with the lower fitness scores because there was a trend for homeschooled children to be less active than public school children. The mean differences were small and nonsignificant, but the pattern was consistent for all 3 days of monitoring. The differences between homeschooled and public school children on the psychosocial correlates were also modest and not significantly different. Again, we observed a general trend for higher scores among the public school youth, but possible age- and gender-related interactions appear to have obscured these overall effects. In general, values for

Table 2 Means, Standard Deviations, and Effect Sizes for Physical Fitness and Psychosocial Correlates of Physical Activity by Age Group in Homeschool and Public School Samples

	Public school			Homeschool			
	n	Mean	*SD*	*n*	Mean	*SD*	Effect size
Aerobic fitness (ml·kg·min)							
younger male	203	46.61	3.64	21	45.73	3.07	0.24
younger female	186	44.91	3.59	14	45.91	3.34	–0.28
younger all	389	45.79	3.71	35	45.81	3.13	–0.01
older male	130	45.81	6.49	13	40.21	4.77	0.88
older female	96	40.92	5.06	9	39.04	5.08	0.37
older all	226	43.73	6.40	22	39.73	4.82	0.64
Attraction to activity							
younger male	47	3.33	0.45	14	3.17	0.54	0.34
younger female	58	3.09	0.48	12	3.02	0.45	0.15
younger all	105	3.20	0.48	26	3.10	0.50	0.21
older male	191	3.04	0.53	10	3.29	0.45	–0.48
older female	166	2.91	0.53	7	3.09	0.41	–0.35
older all	357	2.98	0.53	17	3.21	0.43	–0.44
Perceived competence							
younger male	47	3.23	0.62	14	3.16	0.61	0.11
younger female	58	2.92	0.67	12	2.76	0.49	0.25
younger all	105	3.06	0.66	26	2.98	0.58	0.12
older male	191	2.98	0.63	10	3.22	0.58	–0.38
older female	166	2.65	0.65	7	2.66	0.76	–0.02
older all	357	2.82	0.66	17	2.99	0.70	–0.26
Parental influence							
younger male	47	3.24	0.44	14	3.11	0.42	0.30
younger female	58	3.25	0.35	12	2.98	0.41	0.75
younger all	105	3.25	0.39	26	3.05	0.41	0.51
older male	191	2.86	0.43	10	2.94	0.52	–0.19
older female	166	2.90	0.46	7	2.95	0.15	–0.11
older all	357	2.89	0.44	17	2.95	0.40	–0.14

Note. Younger = ages 9 to 11; older = ages 14 to 16.

the correlate measures were lower for the older public school children as compared with younger public school children, but this effect was not as evident for the homeschooled children. In fact, older homeschoolers had higher scores on the attraction to physical activity measure compared with the younger homeschoolers. The sample sizes were too low to adequately test the three-way interactions of age, gender, and school type, but trends in the data hint at this interesting possibility.

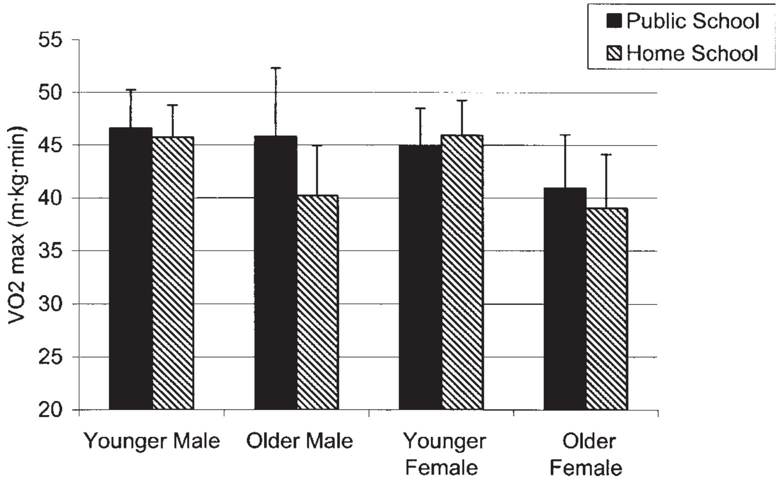

Figure 2 — Estimated aerobic fitness values by age and gender for public school and homeschooled children.

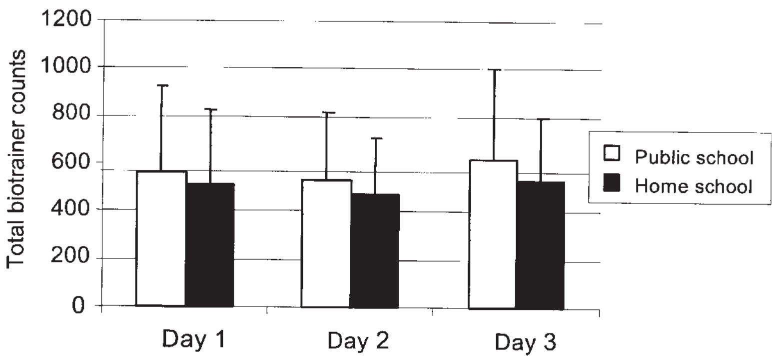

Figure 3 — Comparison of physical activity levels of homeschooled and public school children on 3 different days.

Because this is the first study to make direct comparisons between these samples, it is difficult to make generalizations regarding the results. The more favorable responses on the psychosocial measures among older homeschoolers clearly merit additional study. If homeschoolers develop attitudes and perceptions that are more favorable to physical activity over time (or even exhibit smaller declines), it might offset any deficits in activity or fitness earlier in life. The age-related patterns in correlates observed for the public school children are consistent with another study we recently completed on a much larger sample of public school children (34). Older youth had lower scores on attraction to physical activity and perceptions of competence and corresponding lower scores on an established self-report measure of physical activity (Physical Activity Questionnaire for Children). The fact that we reported similar values on these psychosocial instruments and similar age- and gender-related patterns in public school youth suggests that our public school sample exhibited the typical age-related patterns. Additional work is certainly needed to corroborate the possible differences in attitudes between public school and homeschooled youth.

A factor that complicates this work is that homeschooled and public school youth have different experiences, and this might cause them to respond differently or to appraise themselves differently on psychosocial questions. Among public school youth, social norms might cause some children to become less interested in physical activity with age. Homeschooled youth, in contrast, might not be influenced by social norms to the same extent and might actually come to value physical activity more with age. This might explain why the older homeschoolers had higher scores on the attraction to physical activity measure than both the younger sample and the age-matched public school sample. Another measure, perceived competence, is considered to reflect children's perception of their abilities in the physical domain. Empirical research has demonstrated that perceptions are predictive of children's actual physical activity behavior (45), and perceived competence has been associated in cross-sectional studies with objective fitness levels (41,43). Because homeschoolers would likely have fewer opportunities to make peer-related comparisons, they might also rate themselves more positively than if they were exposed to peers at school.

Different responses might also occur on the construct of parental influence. Studies have demonstrated that parents' willingness to transport their children to sport or fitness activities or to play with their children significantly impacts the child's activity and fitness levels (17,32). Homeschool parents are available during the day to provide access and opportunities for children to be active and are known to be more involved and supportive in their parenting practices (31). If homeschool parents provide more opportunities for their children, it would make sense for older homeschoolers to report greater amounts of parental influence. The data in our study revealed lower levels of perceived parental influence for older public school children, but this decline was not evident for the homeschooled children. Additional work is clearly needed to better understand possible differences in psychosocial correlates of physical activity in homeschoolers. Associations with outcome measures of physical activity and physical fitness would also help to document the possible effects of any differences in these values.

These are very preliminary results and it is important to acknowledge limitations in our design that could have influenced the results. A potential limitation in the study is that we relied on field tests of fitness and used trained teachers to collect the data on public school children. The teachers were trained by the lead author in how to administer the *FITNESS*GRAM test battery, but it is possible that slight differences in protocol could have influenced the fitness results. Another limitation is that we did not obtain information on physical skills. In the YPAP model (38), physical skills are viewed as enabling factors that help a child to be physically active. Motor skills are directly linked to activity because they influence a child's ability to learn and participate in physical activity (10,15,37). Poor skills might also negatively influence a child's perception of competence and make them less interested in physical activity (12). Because homeschooled children are not exposed to motor skills during physical education, it might be possible for them to develop deficits in motor skills during the developmental years. Research comparing actual motor-skill performance in homeschool and public school samples would help to address this issue.

A final limitation is that it was not possible to use completely matched samples of public school and homeschooled children from the same community. The sampling frame of homeschooled children from the local community was too small to allow statistical comparisons so it was deemed important to collect additional data from the other homeschool cooperatives. Studies have shown that region and setting account for some variability in fitness and health indicators in children (26). Although there could have been some bias introduced by using data from multiple communities, it is likely that these effects would be smaller than school-type differences or bias because of differences in parental influence. Research on homeschool parents demonstrates that they are more likely to be married, are more educated, have higher incomes, and have more fundamental religious affiliations than public school parents (31). It was not possible to control for these demographic differences, but subsequent research on this topic should control for family structure and environment because these variables might account for some inconsistency in the data.

In summary, this study found little or no difference in physical fitness and physical activity between homeschooled children and children attending public school. An intriguing trend in the data is that older homeschoolers did not exhibit the same declining interest in physical activity that youth attending public school did. The small sample sizes and scope of this project preclude definitive determinations of these differences, but further research is warranted. Because homeschooled and public school children are exposed to different influences, the systematic study of these groups offers considerable promise to better understand factors influencing physical activity in youth.

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