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Health-Related Fitness in Homeschool versus Public School Adolescents

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ABSTRACT

Background: Despite the known benefits of physical fitness in adolescence, the growing and at-risk homeschool adolescent population has been largely overlooked in current research. **Purpose**: The purpose of this study was to compare health-related fitness including body mass index (BMI), cardiorespiratory fitness, and muscular fitness between homeschool and public school adolescents. **Methods**: Homeschool adolescents ages 12–17 years (n = 66) completed the Progressive Aerobic Capacity Endurance Run (PACER), curl-up, and 90° push-up portions of the FitnessGram® to assess cardiorespiratory fitness as well as abdominal and upper body strength and endurance. T-tests and chi-square tests were used to compare results to public school children (n = 66). **Results**: There was no significant difference in BMI between groups. Homeschool adolescents had significantly lower cardiorespiratory fitness and abdominal, but not upper body, strength and endurance. They also showed significantly lower health classification rankings in cardiorespiratory fitness and upper body, but not abdominal, strength and endurance. **Discussion**: Homeschool adolescents showed significant deficits in health-related fitness that could negatively impact both current and future health. **Translation to Health Education Practice**: The homeschool community has a need for health education to address deficits in health-related fitness. This study can aid health educators in planning and implementing targeted, effective interventions in the future.

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Background

Physical fitness, including cardiorespiratory fitness and muscular fitness, is a key indicator of health-related outcomes and quality of life in adolescents, and has become recognized in the pathogenesis and prevention of chronic diseases.[1–5] A literature review of the relationship between physical fitness and several health outcomes in adolescents found that cardiorespiratory and/or muscular fitness levels were associated with decreased total and abdominal adiposity, reduced cardiovascular disease risk factors, improved skeletal health, and less fatigue in pediatric cancer patients.[2] In addition to physical benefits, cardiorespiratory fitness may have positive effects on psychological well-being (e.g., depression, anxiety, self-esteem) and may be associated with higher academic performance.[2]

Furthermore, cardiorespiratory fitness and muscular fitness in youth may be beneficial beyond childhood and adolescence and may be a predictor of health later in life. Higher levels of cardiorespiratory fitness in childhood and adolescence have been associated with healthier cardiovascular disease risk factors in adulthood, as well as reduced risk of metabolic syndrome, arterial stiffness, and changes in blood lipids and lipoproteins.[3] Muscular fitness in childhood and adolescence has been negatively associated with overall adiposity and central adiposity later in life.[4]

Despite the benefits of physical fitness in adolescence and later in life, one population that has been overlooked includes homeschool youth, which has grown in size from 850,000 children in the U.S. in 1999 to 1.7 million children in 2016.[6] Unlike their public school counterparts, homeschool students are not required to participate in physical education classes, physical activity (e.g., recess, school sports), or fitness testing. Because the major determinants of cardiorespiratory fitness and muscular fitness are the amount and intensity of physical activity, exercise training, and muscle-strengthening exercises,[7] the lack of school-based physical activity among homeschool students may have health implications for this population. Previous studies have found homeschool children to be at increased risk for cardiovascular disease, adiposity, and deficits in muscular fitness,[8,9] including lower levels of abdominal and upper body strength and endurance among homeschool children than public school children.[9] However, no difference in cardiorespiratory fitness between the two populations has also been reported.[9,10] In addition, although homeschool students may be involved in sports outside of homeschooling, involvement in organized

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sports alone may not be adequate enough for increasing physical fitness levels.[11]

Purpose

With the growing trend of homeschooling and home education in the U.S. and internationally, more research is needed to investigate the health implications of the lack of school-based physical activity among older homeschool youth.[8,9] The purpose of this study was to compare the health-related fitness including body mass index, cardiorespiratory fitness, and muscular fitness between homeschool and public school adolescents. Due to lack of existing research, the authors formed null hypotheses stating that homeschool adolescents would not exhibit higher levels of body mass index nor lower levels of cardiorespiratory fitness or muscular fitness than public school adolescents.

Methods

Participants

This cross-sectional study was completed as part of Fitness Assessment in the Homeschooled: The FAITH Study – Part II in 2017. Institutional review board approval, parental informed consent, and child assent was secured prior to any subject enrollment or data collection. Homeschool families with children ages 12–17 years old who had completed at least one year of homeschool were recruited by e-mail, homeschool support groups, co-operatives, and word of mouth. Adolescents were excluded if they were unable to complete testing by parental report or were enrolled in online public school or any other form of homeschooling which required physical education and/or formal fitness testing.

Like the original FAITH study comparison, redacted FitnessGram® raw scores from a local school district for adolescents aged 12–17 years were used to create the public school comparison group. This information was provided as an open record request. School demographics including socioeconomic status and ethnic composition and were examined to select a campus which best aligned with the homeschool population. Campus specific data were then sorted into age and gender specific groups from which students were randomly selected to create age and gender matched homeschool and public school pairs.

Procedures

Participants completed all testing during a single test session. Homeschool adolescents had height and weight assessed barefoot and wearing a single layer of light clothing before completing the curl-up test, 90° push-up test, and finally the Progressive Aerobic Capacity Endurance Run (PACER) portions of the FitnessGram® test battery (version 10.0; Human Kinetics, Champaign, IL). These tests were used to assess body mass index, abdominal and upper body strength and endurance, as well as cardiorespiratory fitness respectively. All tests are commonly used in the adolescent population and have been shown to be both reliable and valid in the literature with r values ranging from 0.75–0.93.[12,13]

Tests were completed on homeschool participants as per standardized test protocol.[14] Results placed participants into age and gender specific health risk for FitnessGram® tests (BMI, PACER, curl-up, and 90° push-up).[14] Public school data were collected as per state requirements as part of usual practice by trained test administrators within the public school system. Cardiorespiratory fitness in public school adolescents was measured using the PACER or 1-mile run. The FitnessGram® software allows for interchangeable use of these two tests of cardiorespiratory fitness to create comparable VO_{2max} estimations regardless of assessment method.[14]

Statistical analysis

Descriptive statistics for the sample were calculated using means and standard deviations or simple counts and frequencies. Independent t-tests were used to analyze differences in BMI as well as the estimated VO_{2max} and total number of curl-ups and 90° push-ups. Chi-square tests were used to determine differences in FitnessGram® classification for cardiorespiratory fitness classifications (healthy, needs improvement, needs improvement-health risk) as well as abdominal and upper body strength and endurance classifications (healthy, needs improvement). All statistical analyses were done using RStudio (v. 1.1.463; RStudio, Boston, MA, USA) with an alpha level of $p = .05$ used to indicate statistical significance.

Results

Participants and body mass index

The final sample included 66 homeschool adolescents and a comparison group of 66 public-schooled students matched by age and sex. Descriptive characteristics for both groups can be seen in Table 1. One public school participant was excluded from BMI and BMI based calculations (VO_{2max} estimation) as an influential outlier with a BMI of 3.3. There was no significant difference in BMI between groups ($t(2, 129) = .101$, $p = .920$, 95% CI = − 1.251, 1.385).

Table 1. Descriptive characteristics.

	Homeschool (n = 66)	Public school (n = 65)
Age (years)	14.55 ± 1.65; [12–17.91]	14.06 ± 1.55; [12–17]
Gender (M/F)	50%/50%	50%/50%
Body Mass Index (kg/m^2)	21.38 ± 3.35; [16.6–34.7]	21.44 ± 4.23; [20.39–22.49]

Cardiorespiratory fitness

In the final analysis, 12 public school students took longer than the maximum allotted time of 13 minutes to complete the 1-mile run disqualifying them from data analysis resulting in 53 public school students for this portion of the data analysis. Moreover, one homeschool adolescent declined to complete this portion of testing leaving 65 homeschool participants for data analysis. The mean VO_{2max} estimation for the 64 homeschool participants was 43.26 mL/kg/min and 54 public-schooled participants was 46.66 mL/kg/min. The mean VO_{2max} estimation was significantly different between homeschool and public school adolescents ($t(2, 116) = 3.05$, $p = .003$, 95% CI = 1.19, 5.61) indicating a potential health-related discrepancy in cardiorespiratory fitness. There was also a significant difference in healthy versus needs improvement or needs improvement-health risk $VO_{2\ max}$ classification among schooling type ($\chi^2(2) = 14.43$, $p = .001$). A frequency table of health classification for cardiorespiratory fitness is illustrated in Table 2.

Muscular fitness

The mean number of curl-ups and 90° push-ups among both homeschool and public school adolescents is illustrated in Figure 1 below. Statistical testing showed a significant difference in only two of these comparisons of muscular strength and endurance. The mean number of curl-ups was significantly higher among public school participants ($t(2, 64) = 8.080$, $p < .001$, 95% CI = 20.851, 34.543). Notably, the health classification difference between healthy versus needs improvement or needs improvement-health risk for curl-ups was not significant ($\chi^2(1) = 1.473$, $p = .225$). Conversely, the mean number of 90° push-ups was not significant ($t(2, 64) = 0.689$, $p = .493$, 95% CI = − 2.719, 5.58). However, the healthy versus needs improvement or needs improvement-health risk classification for 90° push-ups was significantly different between homeschool and public school participants ($\chi^2(1) = 39.72$, $p < .001$). A frequency table of health classification for curl-ups and 90° push-ups are also illustrated in Tables 3 and 4 respectively.

Discussion

The researchers' null hypotheses that homeschool adolescents would not have higher levels of body mass index nor lower levels of cardiorespiratory fitness or muscular fitness than public school adolescents were partially rejected. The primary findings of this study

Table 2. FitnessGram® cardiorespiratory fitness classification by schooling type.

	Healthy fitness zone	Needs improvement	Needs improvement-health risk	Total
Homeschool	40	7	18	65
Public school	45	7	1	53
Total	85	14	19	118

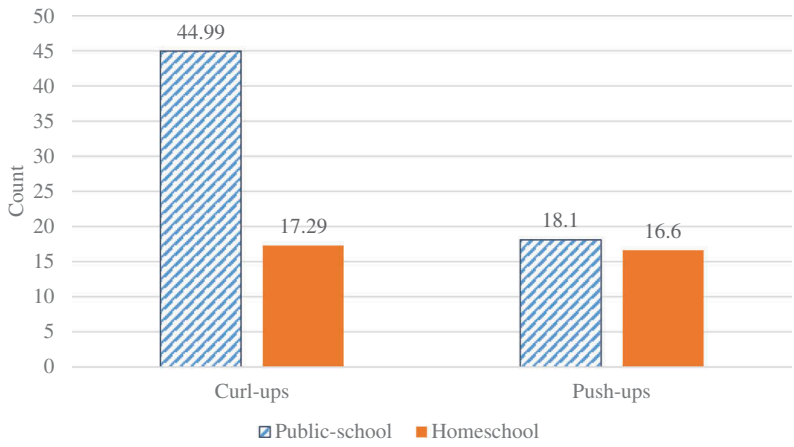

Figure 1. Average fitness test performance by schooling type.

Table 3. FitnessGram® abdominal strength and endurance classification by schooling type.

	Healthy fitness zone	Needs improvement	Total
Homeschool	46	20	66
Public school	59	7	66
Total	105	27	132

Table 4. FitnessGram® upper body strength and endurance classification by schooling type.

	Healthy fitness zone	Needs improvement	Total
Homeschool	11	55	66
Public school	48	18	66
Total	59	73	132

demonstrated no relationship between schooling type and body mass index, abdominal muscular fitness classifications, or upper-body muscular fitness mean scores. Homeschool students did, however, have lower cardiorespiratory fitness scores and classifications, lower abdominal muscular fitness scores, and lower upper-body muscular fitness classifications.

Previous studies have explored the relationship between schooling type and components of health-related physical fitness.[8–11] However, research is limited. As previously stated, there was no significant difference in BMI between groups, with both groups being classified into the healthy fitness zone (HFZ). The limited number of studies exploring the relationship between schooling type and body composition are have yielded mixed results.[9,15] In a younger population, Carde et al.,[15] found that homeschool children were leaner and reported better diets (i.e., fewer calories, trans fat, sugar) than children attending public schools. While dietary habits were not assessed in this study, it is possible that home school adolescents ate healthier diets maintaining their BMIs despite their lack of participation in required physical education courses. This is encouraging considering that childhood obesity continues to be a significant problem in the U.S.[16]

The finding that there was a significant difference in health classifications for 90° push-ups despite there being no statistically significant difference in the mean number of push-ups is particularly interesting. This discrepancy may indicate public school students' prior knowledge of the health classification demarcation, rather than an actual disparity in upper-body muscular fitness. Students in public school may have aimed to meet this boundary while homeschooled adolescents narrowly missed it.

Public school students completed significantly more curl-ups and met the criterion for HFZ classification compared to their homeschool counterparts, indicating that homeschool students had weaker abdominal strength. This may be because public school students may wear backpacks weighing up to 25% of their body weight daily,[17] which engages the core stabilizing muscles.[18,19] It is also worth noting that several homeschool students requested for their feet to be held during test administration. The FitnessGram® curl-up test must be completed without any assistance,[14] therefore practicing the skill with this additional assistance would elicit poorer test administration in the absence of this help.

Finally, homeschool adolescents had significantly lower CRF scores and were classified in the Needs Improvement zone, when compared to public school students. Our findings are in opposition to the recent, albeit limited, research literature. Welk and colleagues[10] found no difference in CRF using the PACER in 9–16 year old boys and girls; and similar results were found when comparing younger homeschool and public school populations.[9] It is worth noting that in the current study 13 public school participants did not complete the test. The FitnessGram® does not allow for including this data into the analysis, so these results should be interpreted with caution.

Formal physical education may provide a valuable setting for improving physical fitness, including cardiorespiratory fitness, among children and adolescents.[20] However, additional work is needed to improve the comprehensiveness and quality of these evidence-based programs.[21] Physical education students may engage in moderate-to-vigorous physical activity less than 50% of lesson time suggesting that physical education alone cannot solely contribute to children's cardiorespiratory fitness.[22] Further, additional studies have yielded mixed results regarding the relationship between sport participation in organized sports and physical fitness among homeschool children and adolescents.[11,23–25] This suggests that physical fitness may be best improved through a combination of physical education and sports participation among adolescents.

Strengths of this study include use of standardized testing protocol and a relatively large sample size (132 participants) as the central limit theorem suggests a sample size larger than 30 to be sufficient.[26] Limitations of the study include lack of direct data collection for the public school comparison group. However, all public school data were collected in accordance with state mandated testing and reporting protocols as per FitnessGram® administration. Moreover, student versus researcher administered health-related testing in school settings was recently shown to have high levels of reliability.[27] Other limitations include

failure to assess the level of physical activity outside of the school setting and a potential performance advantage for public school students who might be more familiar with fitness testing. Future studies are needed to elucidate these and other factors contributing to lower physical fitness among homeschool adolescents.

Translation to Health Education Practice

This study illuminates health education needs in a growing and at-risk population. In short, homeschool adolescents showed significantly lower levels of cardiorespiratory fitness and both abdominal and upper body muscular fitness compared to their age and gender matched public school peers but no difference in body mass index. Thus, the homeschool community has a need for health education to address deficits in health-related fitness. Moreover, the findings from this study can assist health educators in planning and implementing targeted, effective interventions. Based upon results from this research, interventions for this population should include purposeful activities to facilitate muscular strength and endurance of the upper body as well as core strength and endurance. General aerobic conditioning activities should also be included to improve cardiorespiratory fitness. Future investigations should explore how health and physical education programming can be best implemented for this population to address these reported deficits in health-related fitness among homeschool adolescents.

Disclosure statement

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