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Article

Youth physical health and years in American homeschools: are they related?

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Summary

Homeschooling is a growing trend in the USA and abroad with both reported consequences and benefits to youth physical health. The purpose of this study was to examine whether changes in youth physical health could be related to the number of years a student spends in homeschool. Body composition (body mass index and body fat), muscular fitness (lower extremity, abdominal and upper extremity) and cardiorespiratory fitness (Progressive Aerobic Capacity Endurance Run) were assessed in 211 youth ages 5–17. Data analysis showed weak or non-significant relationships between years in homeschool and all aspects of youth physical health. Time spent in homeschool is weakly or not at all related to multiple aspects of youth physical health. Parents and policy makers should not be concerned with detrimental physical health effects of homeschooling on youth.

Key words: health promoting schools, health risk, children, adolescent

INTRODUCTION

Homeschooling, or education provided outside of the traditional public or private school system, is a growing trend in the USA. Currently estimated around 2 million students, the number of American children being educated at home is growing. Recently, the homeschool population measured in 16 states representing all four major US regions showed an average increase in 25% from 2012 to 2016 (Ray, 2018). Outside of the USA, homeschooling is also popular and growing in other countries including the UK and Australia (Home School Legal Defense Association, 2018). Unlike students in public school, homeschool students are not required to participate in organized physical education or health promotion classes and activities (Texas Home School Coalition Association, 2018). This can raise concerns about the physical health of youth in homeschool.

In the literature, research on youth physical health among the homeschool population is scarce. While reported homeschool physical activity levels vary from more to less than public school students (Welk *et al.*, 2004; Long *et al.*, 2010; Cardel *et al.*, 2014), it has been shown that children educated at home have significantly increased central adiposity and lower levels of upper body and abdominal muscular strength and endurance compared to their public school counterparts (Kabiri *et al.*, 2017, 2018). However, homeschool students have also been reported to have better sleep practices (Meltzer *et al.*, 2016), better or equivalent overall body composition and diet (Long *et al.*, 2010; Cardel *et al.*, 2014), and equivalent levels of cardiorespiratory fitness (CRF) (Welk *et al.*, 2004; Kabiri *et al.*, 2017).

The increase in central adiposity among the homeschool population is concerning. Increased visceral, or abdominal, fat has been shown to be a risk factor for early onset type II diabetes, heart disease and metabolic syndrome in youth (Ali *et al.*, 2014; Sahoo *et al.*, 2015). In addition to these health consequences, high levels of abdominal fat have also been associated with poor academic performance (Kamijo *et al.*, 2012). The lower levels of muscular strength and endurance seen among homeschool students are also an issue, as muscular fitness is associated with cardiometabolic disease risk as well as bone health and self-esteem (Artero *et al.*, 2012). Conversely, the improved sleep practices seen among homeschool students are encouraging for the positive effects on youth physical health and development (Meltzer *et al.*, 2016). The better overall body composition and diet reported in the literature for students schooled at home is also notable, as these attributes are associated with decreased risk for and consequences of childhood obesity (Sahoo *et al.*, 2015).

As seen in the literature, both consequences and benefits to youth physical health have been reported among children and adolescents schooled at home. However, it remains to be shown whether these effects are positively or negatively related to the number of years a student has been homeschooled. Otherwise stated, to the best of our knowledge there is no information on whether the positive or negative consequences to youth physical health are exacerbated with increased time spent in homeschool. Thus, the purpose of this study was to examine the association between youth health and the number of years that the student has been in homeschool. It was hypothesized that increased years spent in homeschool would be related to positive effects on overall body composition and CRF and negative effects on muscular fitness.

MATERIALS

Participants

Ethics approval for this research was granted by Texas Woman's University (protocols #18919 and #19376) prior to any participant recruitment or data collection. Participants were recruited from homeschools in the Greater Houston Area (Houston, Texas, USA) 2016 and 2017 using word of mouth, emails and homeschool groups as part of Fitness Assessment in the Homeschooled (The F.A.I.T.H. Study): Parts I and II. Typically developing children and adolescents aged 5–17 years were enrolled in the study. Participants with mental or physical impairments that would prevent them from completing testing were excluded from the study. An informed consent was obtained from a participant parent or guardian as well as an informed assent from each minor participant prior to any data collection. All participants were informed that they could refuse part or all testing for any reason at any time.

Participant parents or guardians completed a demographic survey for each child or adolescent upon enrollment including information on race and how long the participant had been in homeschool. Household data was collected in the same survey as well as annual gross household income.

Instruments

After enrollment, participants completed several tests in a multifaceted assessment of youth physical health among this population. Body composition was assessed using both body mass index (BMI) and percent body fat (%BF). BMI was calculated using height and weight while %BF was calculated using the Tanita BF-689 bioelectrical impedance analysis scale (Tanita Corporation, Tokyo, Japan). This scale has been shown to be both reliable and valid for this age range (Kabiri *et al.*, 2015; Butcher *et al.*, 2018). All body composition testing was done with bare feet and a single layer of light clothing to maximize measurement accuracy. Participants were also asked to fast for 2 h and void the bladder immediately prior to testing. Classifications as underweight/normal/overweight/obese and underfat/normal/overfat/obese were determined as per the Centers for Disease Control and Prevention BMI charts (Centers for Disease Control, 2001) and Tanita BF-689, respectively.

Following body composition analysis, participants completed the standing long jump (SLJ) to assess lower extremity power. This test requires participants to stand with feet together and jump forward as far as possible while keeping feet together and landing upright. Distance from the start line to the lagging heel was measured and the best of two trials was taken. The SLJ is a commonly used and accurate means of assessing lower extremity fitness in youth (Fernandez-Santos *et al.*, 2015). Age- and gender-specific normative data were then used to classify participants by performance percentile (Gontarev *et al.*, 2014).

To measure abdominal and upper body strength and endurance as well as CRF, participants completed the curl-up, 90° push-up and Progressive Aerobic Capacity Endurance Run (PACER) portions of the FitnessGram® test battery, respectively (version 10.0; Human Kinetics, Champaign, IL, USA). Due to normative data limitations, only participants aged 10 years and older performed the PACER. All FitnessGram® tests were performed until two missed repetitions or volitional exhaustion as per administration guidelines (Meredith and

Welk, 2013). Similar to the 20-m shuttle run test or beep test, the PACER is used to provide a reliable and valid estimate of CRF as VO_{2max} (Mahar *et al.*, 2006). The PACER test is widely used among American youth, simple to perform and the recommended field test for aerobic fitness among the FitnessGram® test battery (PACER, one-mile run/walk or walk test) (Meredith and Welk, 2013). FitnessGram® age- and gender-specific normative data were used to classify participants as healthy or unhealthy for all three tests.

Data analysis

Participant demographics were assessed using simple percentages for categorical data and means, range and standard deviations for continuous data. Relationships between years in homeschool and measures of youth physical health were assessed using bivariate correlation coefficients. Spearman's rho was calculated for ordinal dependent variables including body mass classification (underweight, normal, overweight and obese), body fat classification (underfat, normal, overfat and obese), and SLJ percentiles. Point-biserial correlations were used for dichotomous variables including curl-up, push-up and CRF classification (healthy/unhealthy). Pearson's correlation was used to examine a relationship between the two continuous variables: years in homeschool and CRF as estimated VO_{2max}. All data analysis was done using SPSS software (v. 25.0; SPSS, Inc., Chicago, IL) and assumed an alpha value of $p = 0.05$ to indicate significance.

RESULTS

In all, 211 participants were enrolled in the study. One participant declined to participate after enrollment resulting in a final sample size of 210 for testing. Five parents/guardians declined to report their household gross annual household income and one additional participant declined to complete the SLJ and push-up portions of testing. Recall that only participants aged 10 years and older were eligible to complete the PACER resulting in a sample size of 101 for all estimates of CRF.

Participant characteristics and demographics can be seen in Table 1 while performance on specific tests of youth health can be seen in Table 2. Correlation statistic details between length of time in homeschool (years) and specific measures of youth physical health can be found in Table 3.

We found no significant relationship between length of time in homeschool and body composition as BMI ($r_s = 0.107$, $p = 0.124$) nor %BF ($r_s = -0.070$, $p = 0.315$).

Table 1: Participant characteristics and demographics

Characteristic or demographic	Mean or %	Standard deviation or frequency	Range
Age (years) ($n = 210$)	10.28	3.39	[5, 17.9]
Years of homeschooling ($n = 211$)	4.04	2.782	[1, 12]
Gender ($n = 211$)			
Male	48.3%	102	
Female	51.7%	109	
Race ($n = 211$)			
White	83.9%	177	
Hispanic	3.3%	7	
African American	4.3%	9	
Asian	3.3%	7	
Other	1.4%	3	
Biracial	3.8%	8	
Participation in organized sports ($n = 211$)			
Yes	76.8%	162	
No	23.2%	49	
Annual gross household income ($n = 206$)			
<\$100K/<88K Euros	39.4%	83	
\$100K to \$150K/88K to 132K Euros	31.8%	67	
>\$150K/>132K Euros	28.8%	56	

There were significant but weak relationships between length of time in homeschool and lower extremity strength and power ($r_s = 0.197$, $p = 0.004$), abdominal strength and endurance ($r_{pb} = -0.189$, $p = 0.006$) and CRF classification ($r_{pb} = -0.213$, $p = 0.032$). There was no significant relationship between length of time in homeschool and upper body strength and endurance ($r_{pb} = 0.131$, $p = 0.059$) or CRF as estimated VO_{2max} ($r = -0.138$, $p = 0.169$).

DISCUSSION

Our research shows that there is little to no positive or negative relationship between the number of years a child or adolescent spends in homeschool and multiple aspects of youth physical health. Therefore, parents and policy makers should not be concerned with the possibility of detrimental physical health effects of homeschooling on youth. These findings were in direct opposition to our hypothesis. While there were significant relationships between years in homeschool and abdominal muscular fitness and leg muscular fitness, these relationships were weak ($r_{pb} = -0.189$, $p = 0.006$; $r_s = 0.197$, $p = 0.004$ respectively) and therefore unlikely to significantly affect physical health or function. Thus, while

Table 2: Test results for specific measures of youth health

Health measure	Mean or %	Standard deviation or frequency (*n*)	Range
BMI classification ($n = 210$)			
Underfat	4.7%	10	
Normal	81.0%	171	
Overfat	8.5%	18	
Obese	5.2%	11	
Body fat classification ($n = 210$)			
Underfat	17.1%	36	
Normal	63.5%	134	
Overfat	13.7%	29	
Obese	5.2%	11	
SLJ percentile ($n = 209$)			
0–25%	44.6%	94	
>25 to 50%	21.8%	46	
>50 to 75%	17.5%	37	
>75%	15.2%	32	
Curl-up classification ($n = 210$)			
Healthy	46.0%	97	
Unhealthy	53.6%	113	
Push-up classification ($n = 209$)			
Healthy	78.7%	166	
Unhealthy	20.4%	43	
Cardiorespiratory classification ($n = 101$)			
Healthy	67.3%	68	
Unhealthy	32.7%	33	
Estimated VO_{2max} ($n = 101$)	43.89	6.30	[29.4, 59.4]

homeschool children have been shown to have lower levels of abdominal strength and endurance compared to their public school peers (Kabiri *et al.*, 2017), this decrease is not associated with an exacerbation over time.

Furthermore, the weak relationship ($r_{pb} = -0.213$, $p = 0.032$) seen between years in homeschool and CRF classification was contradicted by the lack of a significant relationship between years in homeschool and CRF as estimated VO_{2max} ($r = -0.138$, $p = 0.169$). CRF as estimated VO_{2max} offers more detail and can be considered a statistically stronger assessment of CRF as a ratio level variable compared to the ordinal dichotomous classification (healthy, unhealthy). As such, the lack of relationship between years in homeschool and estimated VO_{2max} may offset the weak relationship seen with CRF classification. Regardless, these findings indicate that CRF is largely unaffected by the number of years a child or adolescent spends in homeschool.

The lack of significant relationship between years in homeschool and upper body muscular fitness ($r_{pb} = 0.131$, $p = 0.059$) further reinforces that youth health is unaffected by the number of years a child or adolescent spends in homeschool. Although it has been reported that homeschooling can lead to decreased upper body strength and endurance in children (Kabiri *et al.*, 2017), this decrease is also unrelated to the number of years a child or adolescent spends in homeschool.

Perhaps most important, the lack of change in body composition classification over years spend in homeschool may indicate a corresponding lack of increased or decreased risk of cardiovascular disease (Sahoo *et al.*, 2015). Our study found no significant relationship between years in homeschool and body composition when reported as BMI ($r_s = 0.107$, $p = 0.124$) or %BF ($r_s = -0.070$, $p = 0.315$). The literature contains conflicting reports of the effect of homeschooling on body composition. Kabiri *et al.* have previously reported increased abdominal fat in homeschool children between the ages of 5–11 years which indicated poorer body composition among homeschool children (Kabiri *et al.*, 2018). Long *et al.* found no difference in body composition from dual-energy X-ray absorptiometry between homeschool and public school children ages 7–11 years (Long *et al.*, 2010). Conversely, Cardel *et al.* reported increased BMI in public school children ages 7–12 years compared to their homeschool counterparts which would indicate improved body composition among homeschool children (Cardel *et al.*, 2014). However, whether or not homeschooling impacts youth body composition positively, negatively or not at all, this study shows that the effect is unrelated or compounded over time.

Of note, this study is not stating a lack of concern over the physical health of youth educated at home. Rather, the shortcomings and benefits noted in the literature do not seem to be associated with change over time. As previously noted, homeschool youth have been shown to have increased risk for cardiovascular and cardiometabolic disease due to increased levels of abdominal fat mass (Kabiri *et al.*, 2017). Their muscular strength and endurance for both the upper body and abdominal muscles are also lower than their public school counterparts (Kabiri *et al.*, 2018). In addition, their overall body composition, sleep practices and diet have been shown superior their public school counterparts offering physical health advantages to homeschool (Long *et al.*, 2010; Cardel *et al.*, 2014; Meltzer *et al.*, 2016). However, the need to address these deficits has previously been reported separately in the literature (Kabiri *et al.*, 2017, 2018). Thus, this study expands our current knowledge of the physical health of homeschool youth by providing reassurance that although deficits and

Table 3: Correlation statistics between length of time in homeschool (years) and specific youth health measures

Health measure	*n*	Correlation	Significance (*p*)
BMI	210	$r_s = 0.107$	0.124
%BF	210	$r_s = -0.070$	0.315
SLJ	209	$r_s = 0.197$	0.004
Curl-up classification	210	$r_{pb} = -0.189$	0.006
Push-up classification	209	$r_{pb} = 0.131$	0.059
Cardiorespiratory classification	101	$r_{pb} = -0.213$	0.032
Estimated VO_{2max}	101	$r = -0.138$	0.169

benefits exist, they appear to be unrelated to the length of time a child spends outside of the public school system.

Strengths of our study include a large sample size ($N = 211$) and multifaceted approach to youth health. Weaknesses include a lack of racial, ethnic and socioeconomic diversity among our sample. However, our largely Caucasian population with high socioeconomic status is representative of the American homeschool population at large (Redford *et al.*, 2017). Furthermore, no data was collected regarding the urban or rural setting of each homeschool. This information could potentially affect results and should be included in future studies. Of note, the relationships between years in homeschool and multiple aspects of youth health were examined independently of age in this study. In other words, a 16 year old who received a public school education for the first 15 years was considered the same as a 6 year old who started homeschool as a 5 year old as their length of time in homeschool was the same (1 year). Future studies may also consider examining the effects of developmental age on these findings.

IMPLICATIONS FOR POLICY

As homeschooling continues to grow in popularity in both America and abroad, it is important that discussions regarding the impact of education outside a regulated system extend beyond academics. The implications to youth physical health should also be of prime consideration. This research would indicate that spending additional time in homeschool is largely unrelated to changes in youth physical health and yields new information that can be used to guide future school policy and legislation. In short, policy makers should not be concerned with detrimental effects on youth physical health when considering homeschooling legislation.

CONCLUSION

While both consequences and benefits to physical health among homeschool youth have been reported in the literature, spending additional time in homeschool is weakly related or unrelated to changes in these aspects of youth health. Thus, educating youth within the homeschool environment for 1 year or many years should not be associated with an increased concern for further decline in their physical health. As the first study to examine these findings to our knowledge, further research will be needed to confirm our initial findings.

ETHICS APPROVAL

This research was approved by the Institutional Review Board of Texas Woman's University (protocols #18919 and #19376) prior to any participant recruitment or data collection.

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