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METHODOLOGY

Pedometer-Assessed Physical Activity Levels of Rural Appalachian Youth

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Abstract

The purposes of this investigation were to examine whether pedometer-assessed physical activity (PA) in Appalachian Ohio students differed by body mass index (BMI), school level (middle school vs. high school), and gender during school days and nonschool days and whether students met the recommended PA guidelines. Participants (N = 149) were recruited from four schools in rural southeastern Ohio. PA was assessed using a sealed pedometer with a moderate to vigorous physical activity (MVPA) timer for 7 consecutive days. Univariate 2 × 2 × 2 ANOVAs showed boys and girls did not differ greatly in PA levels in middle school, but high school girls showed a much lower PA level than high school boys and middle school girls. ANOVAs also demonstrated BMI did not affect PA levels. The frequency data revealed that Appalachian Ohio youth showed relatively low PA regardless of BMI category, school level, and gender. However, the participants appeared to be more active during school days than nonschool days. Only 17% of participants met either one or both of the recommended steps per day and MVPA time per day, respectively, during school days. Behavioral interventions and policies are necessary to increase PA for youth in this region, especially high school girls.

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Regularly participating in physical activity (PA) reduces the incidence of developing obesity, diabetes, and other chronic health diseases (U.S. Department of Health and Human Services [USDHHS], 2008). Despite these physical health benefits, PA continues to decline in youth (Pate, Ward, O'Neill, & Dowda, 2007; Riddoch et al., 2007). The USDHSS (2008) recommends that youth engage in a minimum of 60 min per day of moderate to vigorous physical activity (MVPA), but many youth do not currently meet these guidelines (Riddoch et al., 2007; Sanchez et al., 2007; Troiano et al., 2008). In their cross-sectional study, Sanchez et al. (2007) reported that 55% of youth ($N = 878$) aged 11 to 15 failed to meet MVPA time guidelines. Furthermore, in a large cohort study using accelerometers to assess PA levels in 5,595 youth, Riddoch et al. (2007) found that the youth were insufficiently active and a majority did not meet the recommended MVPA time.

Socioeconomically underserved youth are typically not as physically active and more likely to be overweight than youth with a higher socioeconomic status (SES; Bergstrom, Hernell, & Persson, 1996; Hortz, Stevens, Holden, & Petosa, 2009; Riddoch et al., 2007). Other researchers have reported that students from higher SES engage in more PA and more vigorous PA classes and participate in more organized PA programs outside of school (Bengoechea, Sabiston, Ahmed, & Farnoush, 2010; Sallis, Zakarian, Hovell, & Hofstetter, 1996).

The Appalachian region spans from southern New York to northern Mississippi and includes West Virginia and parts of 12 other states. Appalachia is one of the poorest and most medically underserved regions in the United States (Behringer & Friedell, 2006). Individuals residing in Appalachia are known to experience poor health and limited health service disproportionately compared to the rest of the nation (Behringer & Friedell, 2006). For instance, the Appalachian region has the highest level of mortality rates, obesity, and inactivity in the United States (Borak, Salipante-Zaidel, Slade, & Fields, 2012; Gregg et al., 2009; Wewers et al., 2000). Hortz et al. (2009) assessed Appalachian adolescents' PA levels using a self-report PA instrument and reported that most Appalachian adolescents did not meet the recommended 60 min of daily PA time.

The primary goal of Healthy People 2020 is to improve the health of Americans by minimizing health disparities such as income, education, and ethnicity (USDHHS, 2011). According to the U.S. Census Bureau (2013), the median annual household income in 2006–2010 was $51,914. Approximately 69% ($n = 103$) of the

participants in this study lived in homes with an annual income of $35,000 or less; the poverty status of the participating schools ranged from *medium to high* and *high* (Tables 1 and 2).

Table1
Participating Schools' Characteristics (N = 149)

Characteristic	School 1	School 2	School 3	School 4
Average daily student enrollment	430	541	254	570
Grades	6–8	6–8	9–12	9–12
School setting	Rural	Rural	Rural	Rural
Ethnicity	96.9% White	98.9% White	98.8% White	95.8% White
Economically disadvantaged	70%	65.1%	60.5%	61.8%
Poverty status	High poverty	Medium–high poverty	Medium–high poverty	Medium–high poverty

Note. Participating schools' information for 2010–2011 Ohio Report Cards retrieved March 2, 2013, from http://stateimpact.npr.org/ohio/.

Table 2
Descriptive Characteristics by School Level

	Middle school (n = 81)	High school (n = 68)
Variable	**M ± SD**	**M ± SD**
Age (years)	12.6 ± 0.7	15.7 ± 0.7
BMI (kg/m^2)		
Girl	22.7 ± 4.3	26.2 ± 5.6
Boy	23.5 ± 5.9	24.1 ± 4.9
Weight (kg)		
Girl	55.8 ± 13.5	69.8 ± 15.1
Boy	61.6 ± 19.7	74.4 ± 19.2
Height (cm)		
Girl	156.0 ± 6.6	163.4 ± 5.5
Boy	160.8 ± 10.4	174.8 ± 8.3

Table 2 (cont.)

Variable	Middle school (n = 81) M ± SD	High school (n = 68) M ± SD
Gender		
Girl	38	43
Boy	43	25
BMI category		
Nonoverweight	41	34
Overweight	40	34
Parental education		
< High school	7	4
High school	30	20
2 years college	34	30
≥ 4 years college	10	14
Household income		
< $14,999	17	14
$15,000–$25,000	20	14
$25,000–$35,000	23	15
$35,000–$45,000	9	8
$55,000–$64,999	6	9
≥ $65,000	6	8

BMI = body mass index.

Another concern in youth is the recommended amount of PA markedly declines with increasing grade levels (Aaron, Storti, Robertson, Kriska, & LaPorte, 2002; Sirard, Kubik, Fulkerson, & Arcan, 2008). Generally, PA starts to decline during middle school, and the decline is more significant among female students (Parish & Treasure, 2003). Pfeiffer, Dowda, Dishman, Sirard, and Pate (2007) reported that cardiorespiratory fitness in female students changed from middle to high school, declining from ninth to 12th grades. PA decline was also observed in physical education class. Kulinna, Martin, Lai, Kliber, and Reed (2003) reported that elementary school youth showed the highest PA levels, followed by secondary school youth.

Furthermore, inconclusive findings have been reported in students' MVPA levels as a function of gender. McKenzie, Marshall, Sallis, and Conway (2000) reported that boys were more active than girls in terms of PA levels regardless of activity. By contrast, other

researchers have reported no gender differences in PA levels when measured using heart rate monitors (Kulinna et al., 2003) and accelerometers (Laurson, Brown, Cullen, & Dennis, 2008).

In general, families of low SES have more social and psychological challenges than families of middle or high SES (Alaimo, Olson, Frongillo, & Briefel, 2001). The southeastern area of Appalachian Ohio where the current study was conducted is economically disadvantaged. No study has been conducted that has objectively assessed the PA levels of Appalachian southeast Ohio youth using a New Lifestyles NL-1000 pedometer with an MVPA timer. Therefore, the purposes of this investigation were to (a) examine whether pedometer-assessed PA in Appalachian Ohio students differed by body mass index (BMI), school level (middle school vs. high school), and gender during school days and nonschool days and (b) identify whether students met the recommended PA guidelines.

Methods

Participants and Settings

Prior to the study, the research staff determined that 89 participants would be needed to reach a statistical power of 0.80 with an alpha level of 0.05. The number of participants who initially signed up for the study was 215. Approximately 69% of the participants completed the data collection procedures and were used for the final study analyses. The ethnic background of the participants was largely White/non-Hispanic (98%), with 68 boys and 81 girls (M_{age} = 14.1, SD = 1.7). Approximately 54% (n = 81) of the participants were middle school youth and 46% (n = 68) were high school youth.

Procedures

Data collection occurred at two middle and two high schools (Table 1), working with four physical education teachers. The research staff visited schools to introduce the importance of the study and distribute the forms during physical education classes. Data collection was initiated once the participants provided the parental permission and youth assent forms (12 to 17 years) and youth consent forms (18 to 19 years) for the study. The university institutional review board approved the study protocol. Participants who completed the data procedures were given a pedometer as an incentive for their participation in the study.

The participants were asked to wear a sealed New Lifestyles NL-1000 pedometer on their belt or waistband at the midline of the thigh

(right side) all day for 7 consecutive days except while sleeping at night and during water-based activities (e.g., swimming, showering, and bathing). To ensure compliance with the pedometer protocol, the research staff conducted a pedometer instruction session regarding how to wear the pedometer. After the pedometer orientation session, a few practice sessions and oral questioning about the pedometer protocol were conducted to ensure participants understood the pedometer protocol. One week later, the participants returned the pedometer. The research staff collected height and weight after the youth returned their pedometers. The research staff visited the research sites to remind the participants to wear the pedometer and called the physical education teachers of the sites to ensure the students were reminded to follow the pedometer protocol during the pedometer-wearing period.

One trained research staff collected heights, weights, average daily pedometer steps and MVPA time for the 7 days, and general demographics under the supervision of the principal investigator and two faculty members. The trained research staff completed the institutional review board training and reviewed the study protocol with the primary investigator.

Demographic Questionnaire

Parents and youth over age 18 filled out a demographic questionnaire reporting age, gender, parents' annual income, and educational attainment. Participants were excluded if they were physically ill, took medications that could affect their regular PA participation, or had injuries that required daily activity restrictions. Demographic surveys and pedometer-assessed PA data of participants were confidential and used only for data collection purposes.

Anthropometric Measures

Height and weight measurements were conducted in a private room with participants dressed in light clothing. Height was measured to the nearest 0.1 cm using a stadiometer, and weight was measured to the nearest 0.1 kg using a calibrated digital scale. Body mass index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters. Participants were classified as overweight if their BMI was at or higher than the gender- and age-specific 85th percentile and as nonoverweight if their BMI was below the 85th percentile from the Centers for Disease Control and Prevention national standards (Kuczmarski et al., 2002). Based on

this criterion, the number of participants classified as overweight and nonoverweight was 75 and 74, respectively.

Physical Activity Instruments

Self-administered PA questionnaires have been used to assess PA in research; however, Welk, Corbin, and Dale (2000) reported that using these instruments may not respect the broad range of PA levels and are limited when gathering precise daily PA information, especially from younger children. In contrast to self-administered PA instruments, electronic pedometers in PA research have been widely used as an objective assessment tool to monitor steps and MVPA time (Duncan, Duncan, & Schofield, 2008; Hart, Brusseau, Kulinna, McClain, & Tudor-Locke, 2011). Unlike traditional spring-levered pedometers, the New Lifestyles NL-1000 employs a piezoelectric accelerometer mechanism that can accumulate and store in memory up to 7 days of steps and MVPA time in 1-day epochs under free living conditions (Crouter, Schneider, & Bassett, 2005). This particular piezoelectric pedometer has been found to count steps within ± 3% of actual steps accumulated, 95% of the time (Schneider, Crouter, Lukajic, & Bassett, 2003), regardless of body size (Crouter et al., 2005).

Although pedometers are simple to use, small, and lightweight, they cannot be used to assess intensity and type of activity (Bassett, 2000). Hart et al. (2011) compared pedometers to the ActiGraph accelerometer regarding daily step counts and MVPA time and reported the New Lifestyles NL-1000 pedometer used in the current study may be used to assess daily steps and MVPA time in research.

Pedometer-Assessed Physical Activity Levels

Pedometer-assessed PA (average steps per day and average MVPA time per day) were collected over 7 consecutive days. In this study, the pedometer step criteria suggested by Rowe, Mahar, Raedeke, and Lore (2004) were used, where only participants with at least 3 days of monitoring data (i.e., 2 weekdays = 2 school days and 1 weekend day = 1 nonschool day) were included in the final data analyses. Furthermore, as proposed by Rowe et al., participants who wore the pedometer fewer than 1,000 steps and who exceeded 30,000 steps each day were excluded.

Statistical Analyses

Data were entered and results were generated using PASW Statistics (Version 18.0, Chicago, IL). Descriptive data were calculated

as means and standard deviations as well as frequencies. Frequencies were calculated to determine the number of participants who were classified as overweight or nonoverweight, boys and girls, middle school or high school, in household income categories, and in parental education categories.

Pedometer-assessed PA levels were analyzed with univariate 2 × 2 × 2 ANOVAs for each dependent variable. The dependent variables included average steps per day on the weekend, average steps per day during the weekdays, average steps per day for the entire week, MVPA time per day on the weekend, MVPA time per day during the weekdays, and MVPA time per day for the entire week. If a significant interaction was found with an ANOVA, follow-up independent *t* tests were used to decompose the interaction. An alpha level of 0.05 was used for statistical analyses. Effect size for significant results was reported as partial eta squared (partial η^2).

Results

The values for the demographic and anthropometric data are presented in Table 2. Approximately equal numbers of students were in the nonoverweight and overweight BMI categories in middle school and high school. The results of the univariate ANOVAs are displayed in Table 3, which shows mean differences and standard deviations for average daily steps (steps per day) and average daily MVPA time (minutes per day). No significant interactions were found for weekend average daily steps or MVPA time, but significant main effects for average daily steps, $F(1 , 141) = 15.830$, $p < 0.001$, $\eta^2 = 0.101$, and for MVPA time, $F(1, 141) = 8.438$, $p = 0.004$, $\eta^2 = 0.056$, were found between girls and boys, demonstrating that boys had a higher level of activity than girls. No significant interactions or main effects were found for weekday average MVPA time. A significant interaction between gender and school level was found for average weekday steps per day, $F(1, 141) = 5.076$, $p = 0.026$, $\eta^2 = 0.026$, and the only significant difference was in high school, where boys took more steps per day than girls. A significant interaction between gender and school level was found for average total steps per day for the entire week, $F(1, 141) = 7.056$, $p = 0.009$, $\eta^2 = 0.048$. For this interaction, middle school girls took significantly more steps per day than high school girls, and high school boys took more steps per day than high school girls. In addition, a significant interaction between gender and school level was found for average MVPA minutes per day for the entire week, $F(1, 141) = 4.439$, $p = 0.037$, $\eta^2 = 0.031$, where middle school girls performed significantly more

MVPA minutes per day than high school girls, and high school boys performed significantly more MVPA than high school girls.

Table 3
Steps per Day and MVPA Minutes per Day Differences by School Level and Gender During School Days and Nonschool Days

Variable	Middle school (n = 81) $M \pm SD$	High school (n = 68) $M \pm SD$	p
Avg. weekday steps per day			
Girl	9852.5 ± 3869.0	8550.8 ± 1979.3	0.067
Boy	9984.9 ± 2412.7	11028.2 ± 3708.9	0.164
p	0.856	< 0.004[a]	
Avg. weekend steps per day			
Girl	5778.3 ± 3168.5	5688.1 ± 2690.6	
Boy	6951.9 ± 3502.8	8993.6 ± 3791.5	< 0.001[b]
p	No interaction	No interaction	
Avg. weekday MVPA			
Girl	32.4 ± 20.0	25.8 ± 8.5	No interaction
Boy	31.7 ± 12.4	34.3 ± 14.8	No interaction
p	No interaction	No interaction	
Avg. weekend MVPA			
Girl	14.7 ± 11.4	12.3 ± 9.5	
Boy	16.7 ± 12.3	22.2 ± 14.0	< 0.004[b]
p	No interaction	No interaction	
Avg. total steps per day			
Girl	8446.0 ± 3218.4	7119.4 ± 1877.7	< 0.030[c]
Boy	8884.2 ± 2423.9	10010.9 ± 3004.4	0.096
p	0.496	< 0.001[b]	
Avg. total MVPA			
Girl	26.4 ± 15.2	19.1 ± 7.5	< 0.010[c]
Boy	26.8 ± 11.4	28.2 ± 12.0	0.617
p	0.878	< 0.001[b]	

Note. Avg. weekday = Average weekday; Avg. weekend = Average weekend; Avg. total steps = Average steps for entire week; Avg. total MVPA = Average MVPA time for entire week.
[a]Female value significantly different from male value. [b]Main effect between males and females. [c]Middle school value significantly different from high school value.

To examine the recommended amounts of PA, cut points of 15,000 steps per day for boys and 12,000 steps per day for girls (Tudor-Locke et al., 2004) and 60 min per day MVPA time for both genders (USDHHS, 2008) were used. The frequency of youth meeting or not meeting the PA requirements were reported (Table 4). Few participants in any category met these recommendations. For the average steps per day for the entire week and MVPA time (minutes per day) for the entire week, only 11 youth met the steps per day recommendation, and only two youth met the MVPA minutes per day recommendation. A slight improvement occurred during the school days compared to nonschool days (Table 4).

Table 4
Frequency of Participants Who Met or Did Not Meet Recommended Amounts of Physical Activity During School Days and Nonschool Days

	Recommended pedometer steps				Recommended MVPA time			
	Girls		Boys		Girls		Boys	
Variable	MS	HS	MS	HS	MS	HS	MS	HS
Average weekday								
Yes	11	3	1	3	5	0	1	2
No	27	40	42	22	33	43	42	23
Average weekend								
Yes	1	1	2	1	0	0	0	1
No	37	42	41	24	38	43	43	24
Average total per day								
Yes	7	0	1	3	1	0	1	0
No	31	43	42	22	37	43	42	25

Note. Average weekday = Average school days; Average weekend = Average nonschool days; Average total per day = Average 7 days (entire week). The current study used the recommended cut points of 15,000 steps per day for boys and 12,000 steps per day for girls (Tudor-Locke et al., 2004) and the recommended level of 60 min per day MVPA time for both genders (USDHHS, 2008).

Discussion

The primary aims of the current study were to examine whether pedometer-assessed PA in Appalachian Ohio students differed by BMI, school level (middle school vs. high school), and gender

during school days and nonschool days. Regarding the pedometer-assessed PA on BMI, no significant interaction of overweight status with any other variable was observed. However, PA levels differed by weight status in previous investigations (Bengoechea et al., 2010; Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003). Trost et al. (2003), using the same BMI criterion as the current study, reported overweight children were less likely active than nonoverweight children. The researchers in this study assume the results of the current study could have been influenced by the low SES of the participants, which has been shown to be a contributor to lower PA and overweight status in youth (Bergstrom et al., 1996). Several researchers have reported that youth from low SES families have limited access to PA resources, organized sports, and PA programs (Gordon-Larsen, Nelson, Page, & Popkin, 2006; Sallis et al., 1996). Additionally, youth from low-educated and high minority groups with limited access to facilities have low PA and high overweight status (Gordon-Larsen et al., 2006). Future studies with qualitative methodology (e.g., interview) are needed to explore this phenomenon and determine why this was the case in this region. In addition, it was beyond the scope of this study to determine the contributors of low PA. Regardless of BMI, the participants in this study demonstrated low levels of PA, especially during nonschool days. The findings of the current study are in agreement with a previous study using a self-report PA instrument, indicating that only few Appalachian high school youth have met the MVPA guideline of 60 min (Hortz et al., 2009).

Establishing patterns of PA during childhood and adolescence is critical to developing and adopting positive behaviors that will be used throughout the life span (Dwyer et al., 2006). Although the benefits regularly participating in PA have been repeatedly demonstrated, dramatic declines in PA participation patterns during adolescence have been noted (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; Pate et al., 2007). For instance, Pate et al. (2007) examined PA patterns in female youth and found that participation in vigorous PA declined significantly between eighth and 12th grade. Similarly, the current study demonstrated a lower PA level for high school girls compared to middle school girls, which is consistent with other findings (Nader et al., 2008; Pate et al., 2007; Riddoch et al., 2007). A previous study showed that physical education enjoyment is strongly associated with PA participation in and outside of school (Bengoechea et al., 2010). This could be an interesting variable to investigate in the future to determine whether physical

education enjoyment increases PA levels outside of school in rural Appalachian Ohio youth, especially for high school girls.

In this study, the research staff found that high school girls were less active than high school boys and middle school girls and boys. They also found that middle school boys and girls did not have significant differences in activity levels except on weekends, where boys were more active than girls. The findings of the current study are partly consistent with previous studies (Belcher et al., 2010; McKenzie et al., 2000). However, McKenzie et al. (2000) reported boys were more active than girls in terms of overall PA levels regardless of activity assessed using the System for Observing Fitness Instruction Time (SOFIT) in middle school youth. No difference was found in this study between middle school boys and girls during the weekday or for the 7-day week. The findings of this study were in agreement with previous studies in that girls demonstrated an age-related decline and became much less active than boys in high school (Nader et al., 2008; Pate et al., 2007). Laurson et al. (2008) found no gender and grade influence in PA levels in high school physical education; however, they found PA was strongly associated with activity type, indicating that girls spent more time in individual activities than boys and boys engaged more in team sports than girls. In another study designed to examine PA patterns in female youth, Pate et al. (2007) found that participation in vigorous PA declined significantly between eighth and 12th grades. However, they found the probability of participation in vigorous forms of PA in the 12th grade was strongly associated with participation in vigorous forms of PA in the eighth grade. In a similar study, Pfeiffer et al. (2007) reported cardiorespiratory fitness in girls changed from middle to high school, declining from ninth to 12th grades. They suggested that active sport participation and PA in female students should be encouraged to maintain cardiorespiratory fitness level in high school. These inconsistent results may be due in particular to the instrument used to assess PA, activity type, and/or the characteristics of the study population.

The final goal of this study was to identify whether Appalachian Ohio youth met the currently recommended amount of PA. The USDHHS (2008) recommends youth engage daily in at least 60 min of MVPA. Additionally, Tudor-Locke et al. (2004) recommended minimal daily steps for boys (15,000) and girls (12,000). The results of this study are also consistent with previous studies, in which participants were reported as more active on school days than nonschool

days (Duncan et al., 2008; Treuth et al., 2007). Treuth et al. (2007) reported that participants spent 26 versus 18 min in MVPA time on school days versus nonschool days. The participants in this study spent approximately 48% more MVPA time on school days (30.6 min per day) than nonschool days (15.9 min per day). Also, Duncan et al. (2008) reported that 5- to 16-year-olds took an average number of steps of 12,597 versus 9,528 on school days and nonschool days, respectively. In this study, the participants took approximately 32% more steps on school days (9,712 steps per day) than nonschool days (6,630 steps per day). A possible explanation for this finding is that participants in this study attended physical education classes during the time of data collection, which may have contributed to the higher amount of PA during school days. Additionally, the participants may not have worn their assigned pedometers as much as they should have during the nonschool days (e.g., longer sleeping time on weekend days).

For socioeconomically disadvantaged school youth, physical education may be the primary place to learn motor and lifetime PA skills. According to recent studies, an increase of physical education time decreased BMI among overweight girls (Datar & Sturm, 2004) and physical education enrollment appears to be strongly associated with the increased PA levels among girls (Pate et al., 2007). In another study, Morgan, Beighle, and Pangrazi (2007) reported active students were more active on school days when physical education was scheduled than school days without physical education.

Based on the results of this study, it is highly recommended youth in southeastern Appalachian Ohio spend more time being physically active in physical education classes. Unfortunately, within the state of Ohio, only 23.3% of high school youth attend daily physical education (Ohio Department of Education, 2013), which is lower than the national data of 31% according to the Centers for Disease Control and Prevention (2012). This reduced physical education class time limits the ability of school youth to become physically educated people (National Association for Sport and Physical Education, 2004). Therefore, it is important that adequate amounts of daily physical education time and quality physical education programs are built into school programs since it may be the only time of the day that students participate in PA. Several practical strategies include providing students with opportunities to learn how to monitor their daily PA using simple instruments (e.g., 3-day physical activity log and pedometer activity; Oh & Hovatter, 2010). It

also takes a community to promote PA outside of school, as well as in a physical education curriculum. To achieve this, physical and health educators and policy makers should develop affordable and accessible community and school–led before– and after–school PA programs. For instance, community center staff may reduce prices for those in lower income families. Another strategy may be to have bus routes available until after–school PA programs are over. Finally, it is important to focus on girls and helping them to maintain PA levels by providing enjoyable options beyond elementary and middle school.

This cross-sectional descriptive study limits inference about the causality effect of the study. Therefore, caution is needed when interpreting the findings of this study. This study is limited to participants who were primarily recruited from socioeconomically disadvantaged areas. Although participants from four schools in southeastern Appalachian Ohio are included, more participants are needed to confirm these findings.

Conclusion

This study is unique and contributes to the current body of literature because the research staff were able to capture free-living PA data in southeastern Appalachian Ohio youth despite the identified limitations. The research staff observed a significant PA decline in high school girls needing effective interventions to reduce the age-related decline in PA. The majority of the participants in this study were insufficiently active regardless of BMI, school level, and gender; however, they appeared to be more active during school days than nonschool days. In addition, boys were more likely to be active than girls, particularly in high school. The findings from this study highlight the need for developing behavioral interventions and policies to increase PA through community, before-, during, and/or after-school programs. A future study with qualitative research methods (e.g., in-depth interviews and focus groups) is needed to find more enjoyable PA programs for this population at risk of a sedentary lifestyle.

References

Aaron, D. J., Storti, K. L., Robertson, R. J., Kriska, A. M., & LaPorte, R. E. (2002). Longitudinal study of the number and choice of leisure time physical activities from mid to late adolescence. *Archives of Pediatric & Adolescent Medicine, 156*, 1075–1080.

Alaimo, K., Olson, C., Frongillo, E., & Briefel, R. (2001). Food insufficiency, poverty, and health in U.S. pre-school and school-age children. *American Journal of Public Health, 91*, 781–786.

Bassett, D. R. (2000). Validity and reliability issues in objective monitoring of physical activity. *Research Quarterly for Exercise and Sport, 71*, 30–36.

Behringer, B., & Friedell, G. H. (2006). Appalachia: Where place matters in health. *Preventing Chronic Disease, 3*, A113.

Belcher, B. R., Berrigan, D., Dodd, K. W., Emken, B. A., Chou, C., & Spuijt-Metz, D. (2010). Physical activity in US youth: Impact of race/ethnicity, age, gender, and weight status. *Medicine & Science in Sports & Exercise, 42*, 2211–2221.

Bengoechea, E. G., Sabiston, C. M., Ahmed, R., & Farnoush, M. (2010). Exploring links to unorganized and organized physical activity during adolescence: The role of gender, socioeconomic status, weight status, and enjoyment of physical education. *Research Quarterly for Exercise and Sport, 81*, 7–16.

Bergstrom, E., Hernell, O., & Persson, L. A. (1996). Cardiovascular risk indicators cluster in girls from families of low socio-economic status. *Acta Paediatrica, 85*, 1083–1090.

Borak, J., Salipante-Zaidel, C., Slade, M. D., & Fields, C. A. (2012). Mortality disparities in Appalachia: Reassessment of major risk factors. *Journal of Occupational & Environmental Medicine, 54*, 146–156.

Centers for Disease Control and Prevention. (2012). Youth risk behavior surveillance — United States, 2011. *Morbidity and Mortality Weekly Report, 61*(SS04), 1–162.

Crouter, S. E., Schneider, P. L., & Bassett, D. R. (2005). Spring-levered versus piezo-electric pedometer accuracy in overweight and obese adults. *Medicine & Science in Sports & Exercise, 37*, 1673–1679.

Datar, A., & Sturm, R. (2004). Physical education in elementary school and body mass index: Evidence from the early childhood longitudinal study. *American Journal of Public Health, 94*, 1501–1506.

Duncan, E. K., Duncan, J. S., & Schofield, G. (2008). Pedometer-determined physical activity and active transport in girls. *International Journal of Behavioral Nutrition and Physical Activity, 5*, 1–9.

Dwyer, J. J., Allison, K. R., Goldenberg, E. R., Fein, A. J., Yoshida, K. K., & Boutilier, M. A. (2006). Adolescent girls' perceived barriers to participation in physical activity. *Adolescence, 41*, 175–189.

Gordon-Larsen, P., Nelson, M. C., Page, P., & Popkin, B. M. (2006). Inequality in the built environment underlies health disparities in physical activity and obesity. *Pediatrics, 117*, 417–424.

Gregg, E. W., Kirtland, K. A., Cadwell, B. L., Burrows, N. R., Barker, L. E., Thompson, T. J., . . . Pan, L. (2009). Estimated county-level prevalence of diabetes and obesity–United States, 2007. *Morbidity and Mortality Weekly Report, 58*, 1259–1263.

Kulinna, P. H., Martin, J., Lai, Q., Kliber, A., & Reed, B. (2003). Student physical activity patterns: Grade, gender and activity influences. *Journal of Teaching in Physical Education, 22*, 298–310.

Hart, T. L., Brusseau, T., Kulinna, P. H., McClain, J. J., & Tudor-Locke, C. (2011). Evaluation of low-cost, objective instruments for assessing physical activity in 10–11-year-old children. *Research Quarterly for Exercise and Sport, 82*, 600–609.

Hortz, B., Stevens, E., Holden, B., & Petosa, R. L. (2009). Rates of physical activity among Appalachian adolescents in Ohio. *The Journal of Rural Health, 25*, 58–61.

Kuczmarski, R. J., Ogden, C. L., Guo, S. S., Grummer-Strawn, L. M., Flegal, K. M., Mei, Z., . . . Johnson, C. L. (2002). 2000 CDC growth charts for the United States: Methods and development. *Vital Health Statistics, 11*, 1–190.

Laurson, K. R., Brown, D. D., Cullen, R. W., & Dennis, K. K. (2008). Heart rates of high school physical education students during team sports, individual sports, and fitness activities. *Research Quarterly for Exercise and Sport, 79*, 85–91.

McKenzie, T. L., Marshall, S. J., Sallis, J. F., & Conway, T. L. (2000). Student activity levels, lesson context and teacher behavior during middle school physical education. *Research Quarterly for Exercise and Sport, 71*, 249–259.

Morgan, C. F., Beighle, A., & Pangrazi, R. P. (2007). What are the contributory and compensatory relationships between physical education and physical activity in children? *Research Quarterly for Exercise and Sport, 78*, 407–412.

Nader, P. R., Bradley, R. H., Houts, R. M., McRitchie, S. L., & O'Brien, M. (2008). Moderate-to-vigorous physical activity from ages 9 to 15 years. *Journal of the American Medical Association, 300*, 295–305.

National Association for Sport and Physical Education. (2004). *Moving into future: National standards for physical education*. Reston, VA: Author.

Oh, H., & Hovatter, R. (2010). Monitoring moderate to vigorous physical activity in high school physical education. *Future Focus, 31*(1), 18–25.

Ohio Department of Education. (2013). [Local report card data files for Ohio school districts, and buildings]. Retrieved March 2, 2013, from http://www.ode.state.oh.us/GD

Parish, L. E., & Treasure, D. C. (2003). Physical activity and situational motivation in physical education: Influence of the motivational climate and perceived ability. *Research Quarterly for Exercise and Sport, 74*, 173–182.

Pate, R. R., Ward, D. S., O'Neill, J. R., & Dowda, M. (2007). Enrollment in physical education is associated with overall physical activity in adolescent girls. *Research Quarterly for Exercise and Sport, 78*, 265–270.

Pfeiffer, K., Dowda, M., Dishman, R. K., Sirard, J. R., & Pate, R. (2007). Cardiorespiratory fitness in girls: Change from middle to high school. *Medicine & Science in Sports & Exercise, 39*(12), 2234–2241.

Riddoch, C. J., Mattocks, C., Deere, K., Saunders, J., Kirkby, J., Tilling, K., . . . Ness, A. R. (2007). Objective measurement of levels and patterns of physical activity. *Archives of Disease in Childhood, 92*, 963–969.

Rowe, D. A., Mahar, M. T., Raedeke, T. D., & Lore, J. (2004). Measuring physical activity in children with pedometers: Reliability, reactivity, and replacement of missing data. *Pediatric Exercise Science, 16*, 343–354.

Sallis, J. F., Zakarian, J. M., Hovell, M. F., & Hofstetter, R. (1996). Ethnic, socioeconomic, and sex differences in physical activity among adolescents. *Journal of Clinical Epidemiology, 49*, 125–134.

Sanchez, A., Norman, G. J., Sallis, J. F., Calfas, K. J., Cella, J., & Patrick, K. (2007). Patterns and correlates of physical activity and nutrition behaviors in adolescents. *American Journal of Preventive Medicine, 32*, 124–130.

Schneider, P. L., Crouter, S. E., Lukajic, O., & Bassett, D. R. (2003). Accuracy and reliability of 10 pedometers for measuring steps over a 400-m walk. *Medicine & Science in Sports & Exercise, 35*, 1779–1784.

Sirard, J. R., Kubik, M. Y., Fulkerson, J. A., & Arcan, C. (2008). Objectively measured physical activity in urban alternative high school students. *Medicine in Science & Sports & Exercise, 40*, 2088–2095.

Trost, S. G., Sirard, J. R., Dowda, M., Pfeiffer, K. A., & Pate, R. R. (2003). Physical activity in overweight and non-overweight preschool children. *International Journal of Obesity, 27*, 834–839.

Treuth, M. S., Catellier, D. J., Schmitz, K. H., Pate, R. R., Elder, J. P., McMurray, R. G., . . . Webber, L. (2007). Weekend and weekday patterns of physical activity in overweight and normal-weight adolescent girls. *Obesity, 15*, 1782–1788.

Troiano, R. P., Berrigan, D., Dodd, K. W., Mâsse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine & Science in Sports & Exercise, 40*, 181–188.

Tudor-Locke, C., Pangrazi, R. P., Corbin, C. B., Rutherford, W. J., Vincent, S. D., Raustorp, A., . . . Cuddihy, T. F. (2004). BMI-referenced standards for recommended pedometer-determined steps/day in children. *Preventive Medicine, 38*, 857–864.

U.S. Census Bureau. (2013). State & county quickfacts. Retrieved March 1, 2013, from http://quickfacts.census.gov/qfd/states/00000.html

U.S. Department of Health and Human Services. (2008). 2008 *Physical activity guidelines for Americans*. Retrieved October 2, 2012, from http://www.health.gov/paguidelines

U.S. Department of Health and Human Services. (2011). Healthy People 2020. Retrieved October 2, 2012, from http://www.healthypeople.gov/2020/default.aspx

Welk G. J., Corbin, C. B., & Dale, D. (2000). Measurement issues in the assessment of physical activity in children. *Research Quarterly for Exercise and Sport, 71*(Suppl. 2), S59–S73.

Wewers, M. E., Ahijevych, K. L., Chen, M. S., Drebach, S., Kihm, K. E., & Kuun, P. A. (2000). Tobacco use characteristics among rural Ohio Appalachians. *Journal of Community Health, 25*, 377–387.