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Accelerometry measured ethnic differences in activity in rural adolescents

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Abstract

Background—To determine if there are differences in time spent in physical activity and sedentary behavior between African American and Caucasian children.

Methods—Children wore accelerometers for three weekdays. The students were randomly selected from a larger sample of children participating in a weight gain prevention intervention. Usable data was obtained from 272 of the 310 students who agreed to participate. The outcome data included counts per minute (CPM), time spent in moderate to vigorous (MVPA), light (LPA), and sedentary (SED) activity. The equation and cutoff used to analyze national accelerometry data were utilized for the current study.

Results—The sample had an average age of 10.4 (1.1) years and 76% were African American. Lower SES African American boys had more CPM (p = .012) and spent more time in MVPA (p = .008) compared to middle SES African American and lower SES Caucasian children. Lower SES African American children also spent fewer minutes in SED activity (p = .044) compared to middle SES African American children.

Conclusions—These findings support recent results that also used objective activity measures. Children appeared less active and more sedentary than a national sample, warranting interventions in minority and rural populations.

Keywords

Activity monitors; African American; children; exercise; sedentary

Several epidemiological studies have reported that African American children engage in fewer bouts of physical activity [1–4] in comparison to Caucasian children. However, other investigations have shown that ethnicity is not a consistent predictor of physical activity [5, 6]. It should be noted that these studies are based on self-reported behavior, which has been shown to unreliable in children [7]. When objective measures of activity (accelerometers) have been used, studies have shown that African American children engage in more activity compared to Caucasian children [8, 9]. These findings have been tempered by a lack of differences, in terms of gender or the intensity of activity, within the same study. Thus, there is no clear evidence that there are ethnic differences in physical activity in youth.

Epidemiological data clearly indicate that there are ethnic differences in sedentary behavior [2, 10]. African American boys and girls reported spending more hours viewing TV/video and playing games per week in comparison to Caucasian children [2]. Specifically, African American boys and girls spent approximately 28 hours in front of the television per week, in comparison to Caucasian children who spent approximately 21 hours [10]. However, objective data from NHANES 2003–2004 [11] and data from a study of preschool children [9] did not find ethnic differences in the amount of time spent engaged in sedentary behavior. Therefore, there is an apparent discrepancy between self-report and objective measures of sedentary behavior in children.

Ethnicity and socioeconomic position have been shown to interact in terms of disease states 12 13. Therefore, examining ethnicity without simultaneously examining SES may lead to conclusions based on biological differences [12]. However, few studies have addressed the influence of socioeconomic status (SES) on the ethnic variation in physical activity and sedentary behavior. A greater percentage of African American children live in poverty compared to Caucasian children (http://www.cdc.gov/nchs/data/hus/hus07.pdf), and individuals living in rural environments are more likely to live in poverty (http://www.ers.usda.gov/briefing/IncomePovertyWelfare/ruralpoverty/). Investigations of physical activity in rural populations are few, and only one could be found where objective measures were utilized [14]. It has been shown that rural children have elevated prevalence of obesity, putting them at increased risk of developing cardiovascular disease [15]. It is likely that the amount of time spent engaged in physical activity and/or sedentary behaviors place rural children at increased risk for obesity [16]. Furthermore, there is some evidence of ethnic differences in activity in rural environments [10]. Therefore, the purpose of the present study is to determine if there are differences in physical activity and sedentary behaviors between African American and Caucasian children. We conducted the study in rural children while taking SES and gender into account and accelerometers were utilized to provide an objective measure of physical activity and sedentary behavior.

Methods

Participants

The participants for the study were recruited as a sub-study of a larger excess weight gain prevention program, entitled Louisiana Health (LA Health). A detailed description of the design of this cluster randomized study can be found elsewhere [17]. Briefly, the 2079 students in this larger study were recruited from grades 4–6 across 17 school clusters. The study was conducted in schools that were part of the Louisiana Gaining Early Awareness and Readiness for Undergraduate Programs (LA GEAR UP) project. Schools were considered for this program if they met designated criteria: 1) 59% or more of the students are on free lunch, 2) ACT < 19.6, 3) 1st time freshman < 42.7%, and 4) 45.6% require remedial coursework. The LA Health program specifically intervened in rural LA GEAR UP schools, which were located in cities with a population of < 10,000.

A power analysis determined that we would need to recruit 20 students from each of the 17 school clusters in order to detect a 30 minute difference in activity between intervention and control schools. Due to our experiences recruiting for the larger study we over-recruited 10 – 20 students per school, depending on school size, in order to ensure an adequate sample size. Five hundred twenty five children were randomly selected to participate, of which, 215 declined, leaving 310 children who participated in the accelerometer substudy (Figure 1). Written informed consent was obtained from the parents, and assent was given by the students who participated in the study. The study was reviewed and approved by the Institutional Review Board of the Louisiana State University and the Pennington Biomedical Research Center.

Assessment Measures

Body Mass Index Percentile (BMI %ile)—Height was measured to the nearest .5 cm using a portable stadiometer. Weight was measured to the nearest .5 kg using Tanita (model TBF-310) scales. BMI was calculated as kg/m^2 and was then converted into percentile scores based on gender and age using norms provided by Centers for Disease Control (http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/datafiles.htm). The children were classified as underweight (< 5th %tile), normal weight (≥ 5th and < 85th %tiles)

overweight (≥ 85th and < 95th %tiles), and obese (≥ 95th %tile) according to the American Academy of Pediatrics [18].

Estimated Percent Body Fat—The Tanita Body Composition Analyzer (TBF-310) is a foot-to-foot body impedance analyzer. The Tanita has been found to have a mean difference of −1.7% (95% limits of agreement: −3.92 – 0.7) with DXA [19] and is very reliable with a within subjects repeatability 1.4% (95% CI: 1.2% – 1.7%) 19 in children.

Accelerometer—The children wore an ActiGraph GT1M accelerometer for three consecutive weekdays. The 30-second epoch was utilized. Data were included in the analysis if the children wore the accelerometer for at least 2 complete days. A complete day was considered at least 10 hours of wear time. Data were excluded if there were periods of at least 5 minutes of the exact same count (this represented device malfunction), and if there were any periods of at least 60 consecutive minutes of zero counts. At the end of the three day assessment, children were asked to report the amount of time they spent sleeping. Sleep time was estimated to the nearest five minutes. The 10 hour requirement was met after ignoring consecutive zeros, erroneous data, and sleep time.

The equation and cutoff utilized in the analysis of the NHANES 2003–2004 accelerometer study [8, 11] were used in this analysis and are presented below. The Trost et al, 2002 [20] equation is accurate within 1.1 METs of calculated energy expenditure and the Treuth et al, 2004 [21] cutoff has an R^2 of .84 (SEE = 1.36).

Physical activity: Trost et al, 2002 [20]: MET = 2.757 + .0015*count - .08957*age - . 000038*count*age.

Sedentary: Treuth et al, 2004 [21]: counts/min < 100

Socioeconomic Status—Socioeconomic status (SES) was defined using data from the School Lunch program that was provided by the Louisiana State Board of Education. To be eligible for free meals at school, children were required to be from families with incomes at or below 130% of the poverty level. Children from families with incomes between 130% and 185% of the poverty level were eligible for reduced-price meals at school. Children from families with incomes above 185% of the poverty level pay full price for school meals. Thus children were grouped into SES categories based on family income. Seventy-seven percent of the children received free lunch and 23% of the children received reduced price or paid in full. Because so few children qualified for the latter two categories they were combined. Children receiving free lunch were considered “lower SES” and children receiving reduced lunch or having to pay full price were considered “middle SES.” This approach has been used in other school-based studies of childhood obesity [22].

Procedures

Data were collected from September through December, 2006. These data were collected in a secure, private environment at the child’s school as a part of baseline measurement for the LA Health project. Data from the schools and state educational board were gathered independently in order to confirm reports of age, gender, and ethnicity provided by the parents.

Outcomes

Counts per minute (CPM)—Counts per minute were generated by dividing total accelerometer counts by the total number of minutes in the day the accelerometer was worn.

Levels of physical activity—An equation and a cutoff were used to categorize activity into the various levels of activity based on counts. The Trost equation segments activity into three levels: light (LPA), moderate, and vigorous. Vigorous activity accounted for less than 5 minutes per day, and therefore moderate and vigorous activities were combined (MVPA). Sedentary behavior (SED) was also calculated as counts less than 100 in accordance with NHANES 2003–2004 analysis [11, 21].

Percent time in selected activity—Each child wore the accelerometer for a different amount of time. In order to eliminate the difference in time worn, time spent at each activity level was divided by the amount of time that the child wore the accelerometer.

Statistical Analysis

An intraclass correlation was used to assess the reliability of the counts across days. Separate ANCOVAs were used to measure differences in CPM, and time spent in SED, LPA, and MVPA. Ethnicity, gender, and SES served as the independent variables. Both BMI %ile and age were positively correlated with sedentary behavior (r values = 0.23 & 0.16) and age (r = − 0.29) was negatively correlated with physical activity, and therefore, they were used as covariates. The school was entered as a random effect. The effect size for each analysis is reported as eta squared (ε^2). ε^2 values > .138 are considered large, values < .06 are considered small, and values in between considered moderate [23]. The level of significance was set at 0.05 and SAS 9.1 was used to analyze all data.

Results

Parents or guardians of 310 children who signed informed consents. Four children were absent the week of measurement, three had moved, and three had dropped out of the study. During the download and analysis phase, fifteen accelerometers had missing data, one malfunctioned, and a total of nine did not meet the criteria for usable data. Therefore, there were 275 children with usable data. Three children were removed from these analyses because their ethnicity was classified as “Other” (Figure 1). Of the 272 remaining, 233 had three days of usable data and 39 had two days

Demographics

The children’s average age was 10.4 (1.1) years old. The mean BMI was at the 69.6th percentile (29.7) and the median was above the 79.5th percentile (Table 1). Seventy-six percent of the children were African American.

There were no demographic differences in terms of age, ethnicity, BMI %ile, and percent body fat when comparing children who were randomized into the study to those children who chose not to participate. There were also no differences in scores on the Children’s Depression Inventory – Short Form 24 or on the Children’s Eating Attitudes Test [25]. However, there was a higher percentage of boys compared to girls who were approached but did not participate (p = .0012).

Reliability of counts

Intraclass correlations were calculated to determine the reliability for 2 and 3 days of accelerometer measurement. The reliability of daily counts was 0.73 (95% CI: .67 to .78) when derived from 2 days of monitoring, 0.80 for 3 days (95% CI: .75 to .84), and 0.79 overall. The reliability obtained for two days provided evidence for analyzing data for individuals who had only two days of data.

Counts per minute

The ANCOVA for CPM showed that there was an ethnicity by SES ($F(1, 262) = 6.45$; $p = .012$) interaction and a gender ($F(1,257) = 6.16$; $p = 014$) main effect. Lower SES African American children had significantly more daily CPM compared to middle SES African American and lower SES Caucasian children. Boys had significantly more daily CPM than girls (407.6 vs. 359.3). The ε^2 values for the interaction and main effects were .027 and .033, respectively. Age and BMI %ile were also significant covariates. As age and BMI %ile increased, CPM decreased ($r = -.09, -.16$; $p < .05$). No other main or interaction effects were observed. Differences in activity and sedentary behavior by ethnicity and SES are shown in Table 2.

Physical activity

The ANCOVA for MVPA showed that there was an ethnicity by SES interaction ($F(1, 262) = 7.21$; $p = .008$). As with CPM, African American children in the lower SES category engaged in significantly more minutes of MVPA per day compared to middle SES African American and lower SES Caucasian children (Figure 2). The main effect for gender ($F(1,256) = 5.56$; $p = .019$) showed that boys engaged in 8 more minutes of MVPA per day than girls (Table 3). The ε^2 values were .033 and .030, respectively. There was a main effect of SES for LPA ($F(1,229) = 4.78$; $p = .030$), with lower SES children spending significantly more time per day in LPA compared to middle SES children. The ε^2 value for the LPA effect was .014. Age served as a significant covariate for MVPA, indicating that as age increased, MVPA decreased ($r = -.29$, $p < .0001$). There were no other main or interaction effects.

Sedentary behavior

There was an ethnicity by SES interaction ($F(1,254) = 4.11$; $p = .044$) for SED. Lower SES African American children engaged in 36 fewer minutes of sedentary behavior compared to middle SES African American children (Figure 3). The ε^2 value was .010. Both age and BMI %ile were significant covariates and positively associated with SED ($r = .23$, $p < .0001$ for age; $r = .16$, $p < .01$ for BMI %ile).

Percent time

The gender main effects and the ethnicity by SES interaction effects for MVPA and SED remained when analyzed as percent time in the selected activity. The p-value for the SES main effect for LPA bordered on significance ($p = .052$).

Discussion

The major finding of the present study was that rural, lower SES African American children were the most active children in the study, though their activity levels were not statistically different from middle SES Caucasian children. The results remained the same when corrected for differences in wear time. This is one of the first reports to demonstrate higher levels of activity in African American children using objective measures of physical activity when considering SES. Other studies using objective measures of activity have shown ethnic differences. For example, younger (ages 6–11) African American boys were more active than their Caucasian counterparts in the NHANES sample, though there were few consistent ethnic differences in activity 8 or sedentary behavior 11. In a related study in younger children, Pate et al (2004) 9 showed that regardless of gender, African American preschool children engaged in significantly more vigorous activity than Caucasian children. However, there were no differences in moderate or light activity. Taken together, data from objective

measures of activity show that there are some ethnic differences in activity, which are moderated by activity type, SES, and age.

Our study is unique in that it objectively assessed ethnic differences in physical activity in a rural population while also considering socioeconomic factors. The interaction effects for SES and ethnicity were unexpected, yet proved to be important because the present study showed that SES has a differential effect on activity across ethnic groups. In African American children, lower SES had the effect of bolstering activity, while in Caucasian children higher SES is associated with increased activity levels. Previous research has shown that SES affects health behaviors differentially among ethnicities. For example, it has been shown that given the same SES, there are no differences in physical activity between African American and Caucasian girls, though there are for boys [26]. To our knowledge, this is the first report to show such findings using objective measures of activity. However, it is difficult to explain why SES created this differential effect. There could be differences in household chores [27], outdoor play opportunities [28], or safer environments [28]. However, the study design did not allow for measurement of environmental components outside of school. Future research should focus on identifying the specific elements within rural environments that facilitate and hinder physical activity.

African American and Caucasian children in our sample did not differ in the amount of time spent in sedentary behaviors. An analysis of the NHANES 2003–2004 sedentary data also showed that there were no ethnic differences in time spent in sedentary behavior [11]. Again, these data are contrary to a substantial body of self-report research indicating that African Americans are more sedentary than Caucasian children. It should be noted that these previous studies have often defined sedentary behavior as the amount of television and computer viewing time, including playing video games and watching movies. However, this accounts for only a portion (~1 – 5 hrs/day) of children's total sedentary time (~9 hours), which largely involves time spent sitting while doing other activities, such as reading, homework, or class time. Therefore, while it may be possible that African American children spend more time in front of the TV and computer, ultimately, they may spend similar amounts of time in total daily sedentary pursuits compared to Caucasian children. Given the novelty of the findings of the current study, future investigations using objective measures of physical activity are needed to replicate the present results.

The children in our study spend less time in physical activity and more time in sedentary behaviors compared to children from the national sample [8, 11]. The most active children in our sample were not as active as 6–11 year old children in the national sample, in terms of CPM (426 vs. 543). Girls and boys aged 6–11 in the national sample spent more than an hour in MVPA (65 and 80 minutes/day, respectively), while our children spent 41 (girls) to 49 (boys) minutes/day in activity at this intensity level. There were also differences in sedentary behavior, with our children spending an hour more in sedentary behavior compared to the most sedentary children in the national sample (9.0 vs. 7.5). Both physical activity and sedentary behavior contribute to overweight and obesity in children. The children in our sample had an average BMI equal to the 69th percentile, yet the median score was at the 79th percentile, indicating that the data were skewed towards overweight. In comparison to the national sample, these results suggest that our rural children are likely not engaged in enough physical activity to have a positive impact on their health. There are some differences between our sample and the national sample that might explain these differences, including geographic location (statewide vs. nationwide), the number of days of monitoring (3 vs. 7), and the setting (rural vs. urban and rural). Nonetheless, given the sub-optimal activity in this rural population, and data to suggest that rural population are less healthy [16] 15, stronger physical activity promotion efforts should be directed towards rural children in general.

Llimitations

We only assessed activity for three weekdays, which has been shown to lead to reliabilities of 0.70 [29]. However, we achieved an overall reliability of 0.79, which is comparable to reliabilities obtained with four days of measurement [29]. Relatedly, we did not assess weekend days. Weekdays typically allow for increased physical activity and so our estimates of activity may be inflated[29 30 31], and estimates of sedentary behavior reduced [32]. Our generalizability may be limited because the sample was derived from a rural population and because our effect sizes were small. Only one other study of objectively measured activity in rural children could be identified [14]. However, a different accelerometer was utilized, making comparisons difficult. Another limitation is related to the fact that accelerometers do not capture activity for every minute of the day. For example, the children in the present study wore accelerometers for almost 14 hours per day, slept for an average of 9, therefore resulting in approximately 1 hour unaccounted for. Their physical activity and/or sedentary behavior during this time is unknown. Relatedly, accelerometers do not capture activity conducted while bicycling or swimming. Gender, ethnic, or SES differences may influence the selection of these activities; however, research is limited in this regard. Finally, the children could have self-selected into the study. Just over half of those randomly selected and approached actually agreed to participate in the study, and there were more boys who refused to participate in the study compared to girls.

The current study demonstrates that African American children from the lowest SES category spent more time in physical activity compared to their higher SES counterparts, and lower SES Caucasian children. This finding is similar to other studies using objective measures of activity, and dissimilar from a large body of self-report research indicating ethnic differences. In comparison to objective data from a national sample, there is evidence that this bi-ethnic group of rural children are less active and are more sedentary. Clearly there is a need for investigations involving diverse samples to replicate the findings. Furthermore, there will be a need for more focused research to increase physical activity levels in rural children and to elucidate the factors within rural communities that facilitate increased activity.

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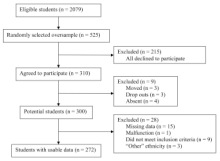

Figure 1.
Study enrollment from eligible students to those who agreed to participate in the study.

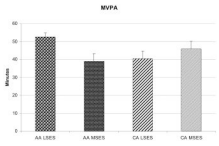

Figure 2.
Ethnicity by SES interaction for MVPA. Lower SES African American children engaged in more MVPA per day compared to middle SES African American children and lower SES Caucasian children.

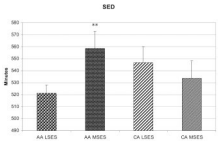

Figure 3.

Ethnicity by SES interaction for SED. Lower SES African American children engaged in more MVPA per day compared to middle SES African American children.

AA = African American; CA = Caucasian; LSES = Lower SES; MSES = Middle SES.

Note. All statistical differences are in comparison to LSES AA

** $p < .01$

Table 1

Demographic characteristics of sample.

		Boys	Girls
African	N	66	141
American	Age	10.6 (1.1)	10.4 (1.2)
	BMI%ile	63.9 (33.9)	72.8 (24.8)
	BMIZ	0.6 (1.3)	0.6 (1.3)
	%BF	23.1 (13.2)	23.1 (13.2)
Caucasian	N	26	39
	Age	10.1 (1.0)	10.2 (0.9)
	BMI%ile	75.1 (27.3)	64.0 (31.5)
	BMIZ	1.0 (1.2)	0.6 (1.1)
	%BF	25.3 (12.9)	22.5 (10.5)

Note. BMI %ile: Body Mass Index percentile; BMIZ: Body Mass Index z-score; %BF: Percent body fat.

Table 2

Adjusted means ± SE for ethnicity and SES on outcome variables.

	AA		CA	
	Middle SES (n = 31)	**Low SES (n = 174)**	**Middle SES (n = 30)**	**Low SES (n = 34)**
CPM	344.3 ± 23.6[b]	426.2 ± 11.8[a]	391.4 ± 24.2[ab]	371.8 ± 22.6[b]
MVPA	39.0 ± 4.3 [b]	52.8 ± 2.1 [a]	46.1 ± 4.4 [ab]	40.5 ± 4.1 [b]
Light	295.3 ± 13.3 [a]	334.1 ± 6.2 [a]	304.0 ± 13.4 [a]	312.0 ± 12.5 [a]
Sedentary	558.6 ± 14.4 [b]	521.2 ± 6.3 [a]	533.6 ± 14.2 [ab]	546.6 ± 13.2 [ab]

Means are compared across rows. Means with different superscript letters indicate significantly different group means.

Table 3

Adjusted means ± SE for gender differences in outcome variables.

	Boys	Girls	Δ
CPM	407.5 ± 17.0	359.3 ± 13.4	48.3 ± 19.4
MVPA	48.7 ± 3.1	40.5 ± 2.4	8.3 ±3.5**
Light	303.2 ± 9.3	319.5 ± 7.2	16.3 ± 11.2
Sedentary	531.7 ± 9.9	548.3 ± 7.6	16.6 ± 12.2

** $p < .01$