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Step Counts of 10- to 11-Year-Old Children by Ethnicity and Metropolitan Status

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Background: The purpose of this study was to conduct a secondary analysis by combining 2 pedometer data sets to describe and analyze pedometer-determined steps/day of children by ethnicity and metropolitan status. ***Methods:*** Participants were 582 children (309 girls, 273 boys; 53% Hispanic, 26% Caucasian, 21% African American) age 10 to 11 years (M = 10.37 ± 0.48) attending 1 of 10 schools located in urban, suburban, and rural settings. Participants wore a research grade pedometer for at least 3 week/school days. Mean steps/day were analyzed by gender, ethnicity, and metropolitan status. ***Results:*** Statistical analyses indicated 1) boys (12,853 ± 3831; $P < .001$) obtained significantly more steps/day than girls (10,409 ± 3136); 2) African American (10,709 ± 3386; $P < .05$) children accumulated significantly less steps/day than Hispanic (11,845 ± 3901) and Caucasian (11,668 ± 3369) children; and 3) urban (10,856 ± 3706; $P < .05$) children obtained significantly less steps/day than suburban (12,297 ± 3616) and rural (11,934 ± 3374) children. ***Conclusions:*** Findings support self-report data demonstrating reduced physical activity among African American children and youth, especially girls, and among children and youth living in urban areas. Possible reasons for these discrepancies are explored.

Keywords: pedometry, adolescent, physical activity

Over the past decade more than 40 published research studies have appeared in refereed journals highlighting the pedometer-determined steps/day (ie, step counts obtained during a 24-hour period) of children and youth. The purpose for most of these studies was to describe and analyze mean steps/day of children and youth on weekdays during the school year (ie, Monday-Thursday) by gender and age/grade level.[1–5] Some consistent findings have emerged across these studies. First, boys have consistently obtained more steps/day than girls across most age/grade levels; although differences have been shown to diminish with increasing age or grade level. Second, girls have demonstrated less variability (ie, smaller standard deviations) in their steps/day than boys.[4] Third, children age 6 to 12 years have generally accrued more steps/day than youth age 13 to 18 years.[4]

What is lacking in the pedometer literature are studies describing the steps/day of children and youth living in different metropolitan regions and of children and youth of various ethnicities. Self-report studies have shown that children and youth physical activity patterns vary by metropolitan region and ethnicity.[6–13] Specifically, these studies have suggested that children and youth living in urban areas report less physical activity than those living in suburban and rural areas[10–12] and African American and Hispanic children and youth report less physical activity than their Caucasian age-related coutnerparts.[6–9,13] Questions as to whether these differences persist when pedometers are employed as the measurement tool remain relatively unexplored.

A primary challenge confronting all researchers who use objective measurement tools to assess physical activity is recruiting and retaining adequate numbers of participants. This is especially so when research questions require splitting data files by gender, age, ethnicity, and metropolitan status to form comparable groups. For example, this challenge has confronted researchers when attempts have been made to include enough male and female participants across all age/grade levels (ie, ages 6 to 18 or grades 1 to 12). This is why Le Masurier and colleagues combined 6 existing pedometer data sets (methods were similar across the 6 studies) to include over 1,800 participants spanning grades 1 to 12.[4] Since 71% of these participants were Caucasian and most lived in suburban neighborhoods, analyses regarding step count patterns by demographic variables such as ethnicity and metropolitan status were not possible. Still, the combining of data sets enabled a better understanding of the step count patterns of boys and girls grades 1 to 12.

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The purpose of this study was to conduct a secondary analysis combining 2 pedometer data sets to describe and analyze pedometer-determined steps/day of children age 10 to 11 years by ethnicity (ie, African American, Caucasian, and Hispanic) and metropolitan status (ie, urban, suburban, and rural).

Methods

This secondary analysis of 2 pedometer data sets included 582 participants (309 girls, 273 boys) age 10 to 11 years ($M = 10.37 \pm 0.48$). Statistical analyses performed here were the first and only conducted on these combined data sets to date. The first data set was collected on participants age 10 to 14 years who attended 1 of 4 schools located in an urban area (see "Participants" section below for descriptions of urban, suburban, and rural). Most of these participants were either African American or Hispanic. The second data set included African American, Caucasian, and Hispanic participants age 8 to 11 years who attended 1 of 4 suburban schools or 1 of 2 rural schools. Only participants age 10 to 11 years were included in this secondary analysis because of being adequately represented in both data sets. Data in both studies were collected during September to April of the 2006–2007 and 2007–2008 school years.

Inclusion Criteria

To be included both studies 1) used a research grade pedometer (described in instruments section below), 2) monitored step counts for a minimum of 5 school or weekdays, and 3) followed similar data collection procedures (described in procedures section below). These inclusion criteria mirror what has been described as "empirically established methods" for youth pedometer data collection.[4] Data collection procedures were the same for each data set except one used sealed pedometers and the other used unsealed pedometers. Sealing pedometers refers to attaching a plastic tie around the exterior of the pedometer to prevent participants from meddling with the display panel, accidentally resetting the pedometer, or being able to see their step counts. In both conditions all participants knew they were wearing a device that measured their physical activity.

Previous research has shown that reactivity or the tendency to be more physically active when participants know their activity levels are being monitored is not an issue when using sealed or unsealed pedometers.[14–18] Matevey and colleagues studied this issue with adults. They found no significant difference between sealed and unsealed pedometers in steps/day in adults.[15] Vincent and Pangrazi found no reactivity when using sealed pedometers with elementary school children[18] and Ozdoba and colleagues used unsealed pedometers with elementary school children and also found no reactivity existed.[16] Still more researchers found no reactivity with unsealed pedometers in middle-school children,[17] and young adults.[14] In all of the above studies participants knew that their steps were being monitored with the pedometer whether the condition was sealed or unsealed. Given these conditions reactivity does not appear to be an issue whether the pedometer is sealed or not.

Participants

Participants attended 1 of 10 schools (4 urban, 4 suburban, 2 rural) representing 8 school districts located in a Southwestern state. Schools were classified by metropolitan status following criteria outlined in 2 previous studies: urban schools were located inside a Metropolitan Statistical Area (MSA) and inside the central city; suburban schools were located inside the MSA but outside the central city; and rural schools were located outside the MSA.[11,12] Table 1 describes general characteristics of each school. Table 2 describes the participants and the pedometer data obtained from each school. All participants gave written assent and parents/guardians of participants gave informed consent before data collection. A parent/guardian identified each participant's gender, age, and ethnicity. The University Institutional Review Board granted permission for data collection and analyses.

Table 1 General Characteristics of Participating Schools

School	A	B	C	D	E	F	G	H	I	J
Students	629	183	710	746	1131	418	655	561	640	437
Grades	PK–5	PK–8	K–6	PK–5	PK–8	PK–5	K–8	PK–8	PK–8	4–8
Metro class	Rural	Rural	Suburb	Suburb	Suburb	Suburb	Urban	Urban	Urban	Urban
% free & reduced lunch	27%	73%	90%	32%	37%	60%	80%	98%	82%	99%
Phys. ed.										
Min/week	40	150	60	60	50	60	45	45	45	45
Recess										
Min/day	40	40	55	55	55	55	40	40	40	40

Note. Data in this table came from the US Department of Education's National Center for Education Statistics (2007) or from each individual school. Free and reduced lunch is the percentage of students receiving state assistance for lunch at school—some students get lunch for free while others get reduced cost. The value listed represents the percentage of students receiving both free and reduced lunch.

Table 2 Description of Participants and Data Obtained from Each School

School	A	B	C	D	E	F	G	H	I	J
Participants (total, # girls)	61, 25	20, 8	75, 36	51, 29	57, 35	39, 25	91, 35	73, 28	82, 51	61, 37
African-Am (#)	3	1	3	6	4	7	27	0	42	30
Caucasian (#)	42	9	1	29	45	18	1	1	3	1
Hispanic (#)	16	10	71	16	8	14	33	72	37	30
Mean age	10.08	10.20	10.16	10.08	10.09	10.10	10.59	10.63	10.59	10.80
Days of monitoring	5	5	5	5	5	5	6	6	6	6
Pedometer brand	Y	Y	Y	Y	Y	Y	W	W	W	W
Days of data										
3	15	4	9	8	12	8	19	10	10	9
4	24	8	32	13	19	16	15	15	18	20
5	22	8	34	30	26	15	11	13	27	21
6	–	–	–	–	–	–	18	35	27	11

Note. Values for 'days of data' represent the number of participants who provided 3, 4, 5, or 6 days of pedometer data. Pedometer brands are classified as Y (Yamax) or W (Walk4Life).

Instruments

Participants wore either a Yamax Digiwalker SW-200 or a Walk4Life 2505 pedometer. Both pedometer brands are considered research grade and are valid and reliable estimates of youth physical activity in controlled and free-living conditions.[5,19–23] The Yamax Digi Walker SW-200 has been found valid and reliable in adults[21] and youth,[23] as has the Walk4Life 2505.[21,22] These 2 pedometer brands/models were also used in the Le Masurier et al secondary analysis cited above.[4]

Procedures

At each participating school, a trained research assistant provided a pedometer orientation to familiarize participants with how pedometers work and how to wear one properly. Each participant received a pedometer to handle, wear, and use. The research assistant guided participants in locating an accurate place on the waistband to wear the pedometer and conducting a 20-step count accuracy test. Each participant attached the pedometer above the right patella on the waistband, reset the pedometer, and walked 20 steps verbally counting the steps as she or he walked. After completing 20 steps, the participant would stop walking and open her or his pedometer to discover how many steps the pedometer counted. If a 20-count step test yielded results greater than ±1 steps, the participant was instructed to reset the pedometer and place it on the right hip and complete the 20-step count test again. Each participant was instructed to wear the pedometer either above the right knee or on the right hip—whichever placement yielded more accurate results.

Following the pedometer orientation, each participant was assigned a numbered pedometer. Participants wore their assigned pedometers for 2 to 4 school days or Physical Education classes before any data collection. These "practice days" were implemented to diminish potential novelty and reactivity effects before formal data collection began.

Data collection began on a Monday and continued for at least 4 consecutive school days. To ensure correct calibration of the pedometers, a research assistant performed a shake test the morning data collection began.[24] At a specified time (between 8 AM to 11 AM), participants would retrieve their assigned, numbered pedometers from their class pedometer box and attach it to the waistband of their pants or shorts. To ensure correct placement of the pedometer, a research assistant would visit each class to remind participants about where to wear the pedometer and offer assistance if needed. Participants wore the pedometer for the remainder of the school day and at home taking it off only to sleep, shower (bath), or swim. Before going to bed participants were to put the pedometer in a place where they would see it upon waking in the morning.

After waking in the morning, participants put the pedometer on and wore it back to school. At the same specified time that participants picked up their pedometer the previous day (providing for a 24 hour period of data collection) a researcher would collect the pedometers, record the data, and reset the display panel before giving them back to participants to wear for another day. If a participant reported removal of her or his pedometer for more than 1 hour (excluding sleeping, swimming, or showering) during the previous day, the data for that previous day was removed from the data set. This process was repeated for each day of data collection.

Data Analyses

A mean steps/day score was computed for each participant from the corresponding days of monitoring. Mean steps/day values were then used for subsequent analyses.

To be included in the analyses, each participant had to provide at least 3 days of pedometer data. Other large-scale youth pedometer studies have also followed the 3 day minimum requirement and have shown that 3 days is sufficient when estimating habitual physical activity patterns of children.[1,18] An intraclass correlation coefficient (ie, Cronbach's alpha score) for monitoring days 1 to 3 was conducted to ascertain steps/day reliability. A $2 \times 3 \times 3$ Factorial ANOVA (gender × ethnicity × metro status) was conducted to determine whether mean steps/day differences existed and if there were any significant interactions. Two separate one-way ANOVA tests were conducted for ethnicity (controlling for gender) and metro status (controlling for gender) with corresponding post hoc tests. Significance was established before analyses at $P \leq .05$ level. All statistical analyses were computed using SPSS version 16 (SPSS, Inc., Chicago, IL).

Results

Descriptive statistics for steps/day by gender, ethnicity, and metro status are presented in Table 3. Mean steps/day for boys and girls by ethnicity and by metro status are portrayed in Figures 1 and 2. Mean steps/day for urban, suburban, and rural girls and boys by ethnicity are displayed in Figure 3. Cronbach's alpha score for monitoring days 1 to 3 was 0.76. Results from the $2 \times 3 \times 3$ Factorial ANOVA demonstrated significant main effects by gender (F (1, 581) = 27.03, $P < .001$), ethnicity (F (2, 564) = 3.10, $P < .05$), and metro status (F (2, 564) = 4.94, $P < .01$) with no significant interactions. Post hoc tests for ethnicity and metro status indicated that Hispanic and Caucasian participants obtained significantly more steps/day than African American participants ($P < .05$) and that participants living in suburban and rural areas accumulated significantly more steps/day than participants living in an urban area ($P < .05$). Results from the one-way ANOVA tests indicated a significant main effect for girls by metro status (F (2, 306) = 12.07, $P < .001$). Post hoc tests revealed that girls living in an urban area obtained significantly fewer steps/day than girls living in suburban areas ($P < .001$). Despite not being significantly different, boys followed a similar pattern as girls where those living in an urban area accumulated fewer steps/day than those living in suburban areas.

Table 3 Descriptive Statistics for Steps/Day by Gender, Ethnicity, and Metro Status

	N	Mean ± SD
Gender		
Girls	309	10,409 ± 3136
Boys	273	12,853 ± 3831[a]
Ethnicity		
African American	125	10,709 ± 3386[b]
Caucasian	150	11,668 ± 3369
Hispanic	307	11,845 ± 3901
Metro status		
Urban	279	10,856 ± 3706[b]
Suburban	222	12,297 ± 3616
Rural	81	11,934 ± 3374

[a] Significantly different from girls at $P < .001$.

[b] Significantly different from other 2 groups at $P < .05$.

Discussion

This secondary analysis of 2 existing pedometer data sets describes and analyzes pedometer-determined steps/day of children age 10 to 11 years by ethnicity and metropolitan status. Although descriptive, the main findings of this study were 1) African American children, particularly girls, averaged fewer steps/day than their Caucasian and Hispanic counterparts and 2) children living in an urban area accumulated less steps/day than their suburban and rural counterparts.

Ethnic Differences

In national large-scale studies, Hispanic and African American youth have reported less physical activity participation than Caucasian youth.[6,8] According to the Youth Risk Behavior Survey the prevalence of youth grades 9 to 12 meeting current PA recommendations (ie, 60 minutes per day of PA, 5 or more times per week) was greater among Caucasian girls (30.2%) than Hispanic (26.5%) or African American (21.3%) girls. Prevalence of physical activity rates was also greater among Caucasian boys (46.9%) than Hispanic (39.0%) or African American (38.2%) boys. In addition, the prevalence of youth reporting no participation in moderate intensity or vigorous PA during the previous 7 days was greater among African American boys and girls (10.2%, 18.2%) than Hispanic (8.9%, 12.3%) or Caucasian (6.9%, 9.3%) boys and girls.[6] Other self-report studies with children substantiate these findings.[7–9]

In this study, Caucasian girls averaged approximately 400 and 1,200 more steps/day than Hispanic and African American girls, respectively (see Figure 1). Taken together, the results of this study and the self-report data cited above suggest a ethnic disparity in physical activity particularly among girls. At what age such differences begin to emerge is not clear. One study has shown marked differences as early as age 9 among African American and Caucasian girls.[9] Other research has identified adolescence as a time when females, particularly African Americans, demonstrate reduced and minimal physical activity participation.[7] Substantial differences in self-reported physical activity between Caucasian and African American adolescent females have been found in previous research studies.[7,9] One study revealed that by the age of 17, 56% of African American and 31% of Caucasian female participants reported no leisure time

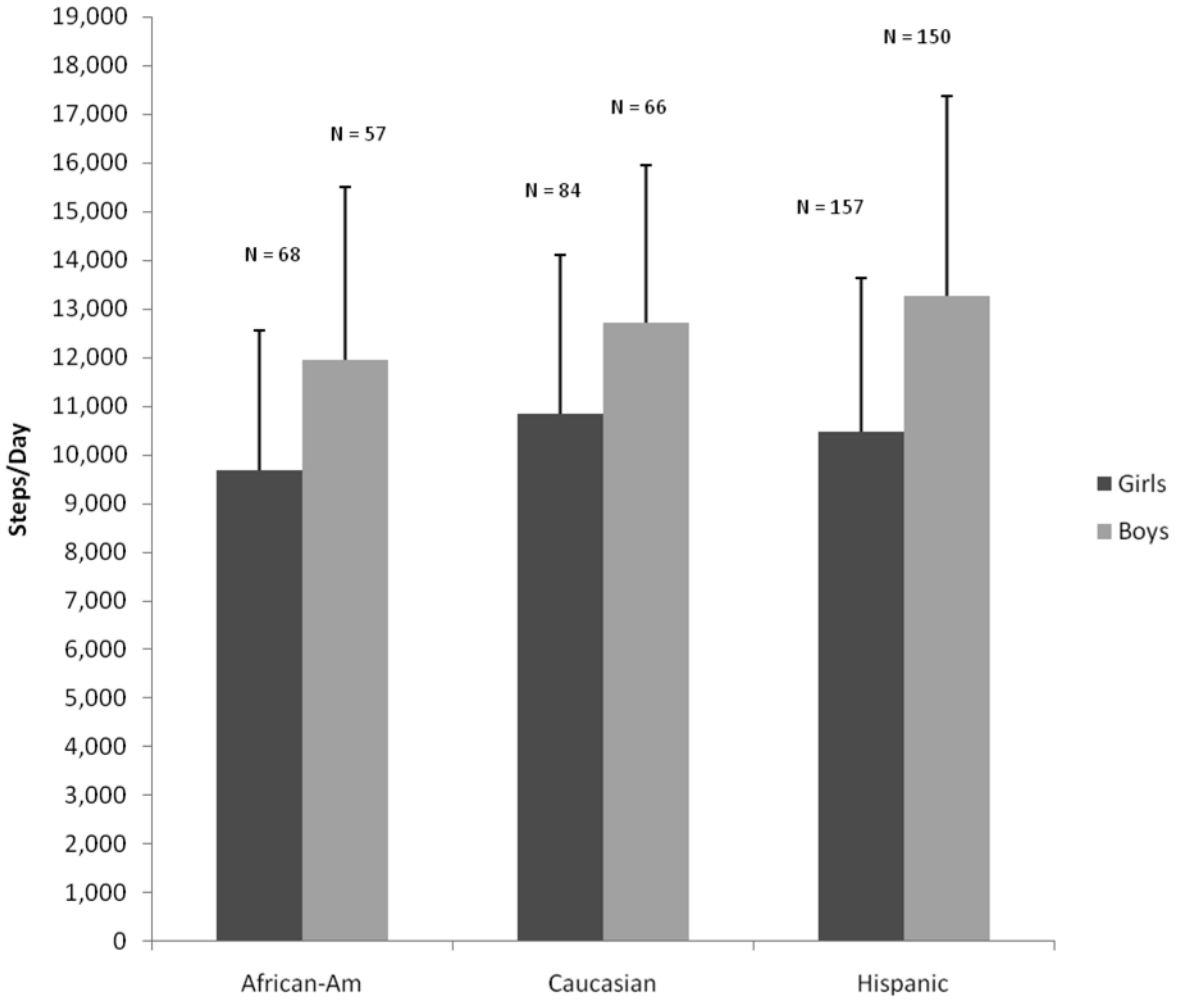

Figure 1 — Mean steps/day and standard deviations for girls and boys by ethnicity.

physical activity in the previous 7 days.[7] Despite such relatively high percentages of inactivity in both groups, African American girls appear to need the greatest amount of support to adopt physically active lifestyles. The current study provides objective physical activity data documenting how even African American girls age 10 to 11 years seem to lag behind their age-related Caucasian counterparts.

Although statistically significant differences were not found in this study among boys of various ethnicities, it is interesting to note that Hispanic boys averaged approximately 500 and 1,300 more steps/day than their Caucasian and African American counterparts, respectively (see Figure 1). Accelerometer data from a previous study showed Caucasian boys age 11 to 12 years were 5% more active than Hispanic boys age 11 to 12 years.[13] Reasons why Hispanic boys in this study obtained more steps/day than Caucasian boys is unclear; data regarding participants' involvement in after-school sports and extracurricular activities were not obtained and as a result prevented the research team from understanding where and when participants obtained step counts.

Although reasons for ethnic disparities in physical activity are, in no doubt, complex, possible reasons may relate to African American and Hispanic children and youth having fewer opportunities to play organized sport and having minimal or reduced access to physical activity facilities compared with their Caucasian counterparts.[25,26] For example the Youth Media Campaign Longitudinal Survey demonstrated that rates of participation in organized sports, among children age 9 to 13 years, differed extensively by race.[25] Also, Powell and colleagues found that zip codes located within the U.S. with higher proportions of African American and other minority residents were less likely to have commercial physical activity-related facilities such as physical fitness facilities, membership sports and recreation clubs, dance studios, and public golf courses.[26] Whatever the reasons

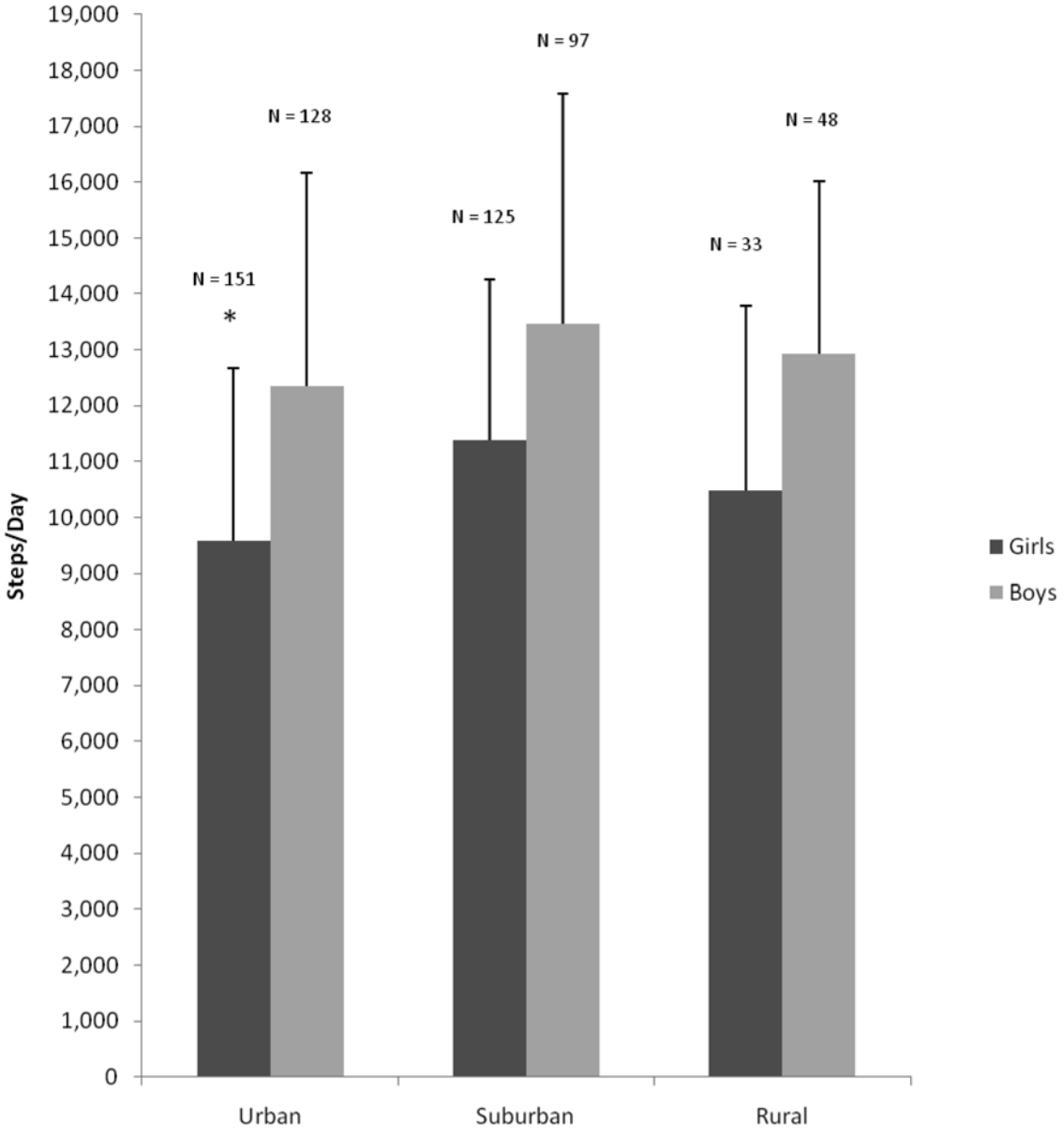

Figure 2 — Mean steps/day and standard deviations for girls and boys by metro status. *Significantly different from suburban girls at $P < .001$.

African American and Hispanic children and youth tend to obtain less physical activity than their age-related Caucasian counterparts.

Metro Status Differences

This is the first study to use an objective measurement tool to investigate physical activity of American children living in different metropolitan areas. Loucaides and colleagues conducted a pedometer study looking at the steps/day (measured for 4 weekdays in summer and 4 weekdays in winter) of 11- to 12-year-old urban and rural children living in Cyprus.[27] During winter, urban children (13,583) averaged more steps/day than rural children (12,436) whereas in summer, rural children (16,450) averaged more steps/day than urban children (14,531).[27]

Data have been published drawing attention to self-reported physical activity differences in children age 9 to 10 years[10,12] and youth age 13 to 17 years[11,12] living in urban, suburban, and rural areas in the U.S. Results from these studies have documented a lower prevalence of reported physical activity participation (ie, vigorous and moderate intensity) among urban than suburban and rural participants.[10–12] Among youth age 13 to 17 years, urban participants have also reported a higher prevalence of sedentary behaviors (ie, television watch-

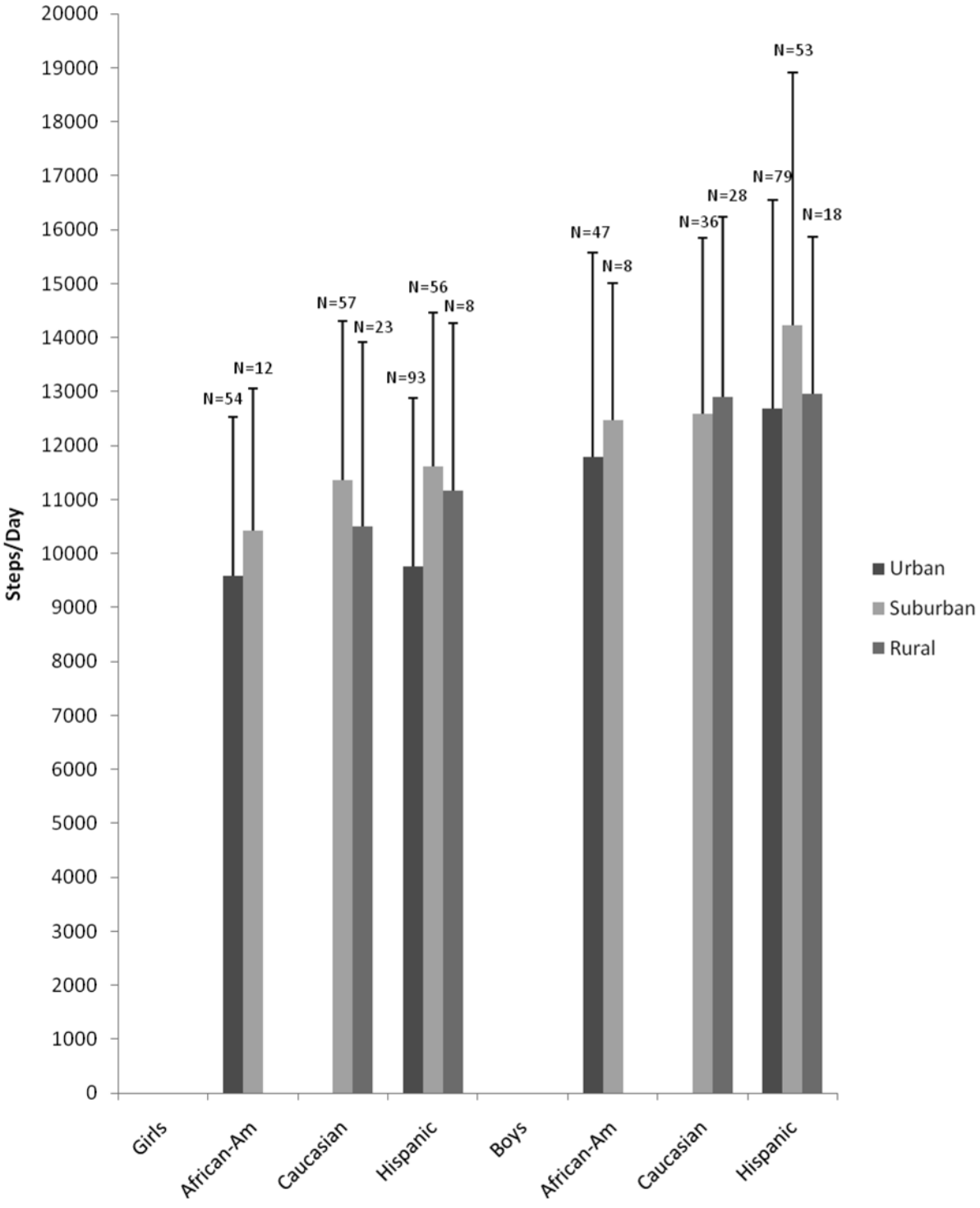

Figure 3 — Mean steps/day and standard deviations by gender, ethnicity, and metro status. *Note:* Mean steps/day values were not reported for rural African American girls and boys and urban Caucasian girls and boys because of limited participants.

ing, computer/video game use) than suburban and rural participants.[11] More recently, in Texas, 8th and 11th grade youth living in urban regions have reported a lower prevalence of physical activity behaviors than their grade-level counterparts living in suburban and rural areas.[12] Interestingly, among children and youth living in Texas, the physical activity disparity between urban and suburban/rural was greatest among 11th grade participants age 16

to 17 years compared with 8th or 4th grade participants age 13 to 14 and 9 to 10 years, respectively.[12]

Results from the current study support the findings cited above regarding lower physical activity among urban children compared with suburban and rural children. Specifically, urban girls accumulated approximately 1800 and 900 fewer steps/day than their suburban and rural counterparts, respectively (see Figure 2). In addition, urban boys obtained approximately 1100 and 600 less steps/day than their suburban and rural counterparts, respectively (see Figure 2). Previous research has shown that 1000 step counts generally equates to 10 minutes of activity time.[28] With this in mind, urban girls and boys in this study were getting 20 and 10 minutes less activity time per day than their suburban counterparts.

Reasons why urban children obtain less physical activity than their suburban and rural counterparts may be related to neighborhood safety concerns.[29–31] Weir and colleagues found that inner-city parents' anxiety regarding neighborhood safety was inversely associated with their children's (age 5 to 10 years) physical activity participation and was significantly greater than suburban parent's anxiety.[29] In another study, inner-city girls' outside of school physical activity was positively associated with their perception of a safe neighborhood.[30] On a national scale, in 2005, 10% of urban youth reported a fear of being attacked at school or on the way to or from school compared with 5% of suburban and rural youth.[31]

Previous research has also shown that opportunities to participate in physical education and interscholastic sports among children and youth are not as abundant in urban schools compared with suburban and rural schools.[11] For example, among 4th grade urban children (age 9 to 10 years) in Texas, 22% reported attending Physical Education ≥4 days per week compared with 40% and 47% of suburban and rural children, respectively.[12] In this study, suburban participants received 15 more minutes of structured Physical Education and 15 more minutes of unstructured recess per week than urban participants (see Table 1).

Descriptive results of this study leave behind a complicated question: Is ethnicity or degree of urbanization a stronger predictor of children's physical activity? Although results from this study do not pretend to provide definitive answers, it is interesting to note in this study that 1) African American girls and boys living in an urban area averaged less steps/day than African American girls and boys living in suburban areas and 2) Hispanic girls and boys living in an urban area averaged less steps/day than Hispanic girls and boys living in suburban and rural areas (see Figure 3). This finding corresponds to data published by Richmond and colleagues suggesting environment (geographical location) is a stronger predictor of youth physical activity than ethnicity.[32]

The following limitations should be considered when interpreting the results of this study. First, these data were collected on children age 10 to 11 years residing in 1 state in the southwestern U.S. Caution should be used in generalizing these results to children and youth of other ages and to those living in other areas of the U.S. Second, there are numerous ways to define metropolitan status which makes the selection of a definition perplexing and open to error. Nelson and colleagues cautioned researchers from using the standard metropolitan classifications (ie, urban, suburban, and rural) and to instead consider variables such as socioeconomic status, street connectivity, crime, road type, and the prevalence of physical activity recreation facilities when defining metropolitan areas.[33] Although such information cannot be ignored, the authors decided to define metropolitan status according to guidelines delineated in 2 previous studies with children and youth so as to enable comparison.[11,12] Third, participants living in the urban area wore the Walk4Life brand pedometer whereas participants living in suburban and rural areas wore the Yamax brand pedometer. Although research suggests both pedometers are valid and reliable measures of children's accumulated step counts, 1 study with adults has shown the Walk4Life brand pedometer to overestimate step counts compared with the Yamax brand.[21]

Conclusion

This is the first study to investigate pedometer-determined steps/day of children living in different metropolitan regions and of different ethnicities. Although descriptive, the following conclusions were drawn: 1) African American children, especially girls, were less active than their Caucasian and Hispanic counterparts and 2) urban children were less active than their suburban and rural counterparts. These results correspond to those found in self-report studies. To further understand the relationship between physical activity, ethnicity, and metropolitan status, future research studies should continue to explore characteristics of built environments so as to identify appropriate metropolitan categories. In addition, future research studies should combine objective measurement of physical activity with survey research projects investigating environmental issues.

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