# Accelerometer-Determined Steps per Day in US Children and Youth

CATRINE TUDOR-LOCKE, WILLIAM D. JOHNSON, and PETER T. KATZMARZYK

*Pennington Biomedical Research Center, Baton Rouge, LA*

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**ABSTRACT**

TUDOR-LOCKE, C., W. D. JOHNSON, and P. T. KATZMARZYK. Accelerometer-Determined Steps per Day in US Children and Youth. *Med. Sci. Sports Exerc.*, Vol. 42, No. 12, pp. 2244–2250, 2010. **Purpose**: The 2005–2006 National Health and Nutrition Examination Survey collected accelerometer-defined step data in addition to activity counts. The accelerometer used (ActiGraph AM-7164) is known to detect more low-force steps than research-quality pedometers. This study extends similar research focused on adults in National Health and Nutrition Examination Survey. Its purpose is to provide the descriptive epidemiology of accelerometer-determined steps per day in US children (6–11 yr) and youth (12–19 yr), with and without censoring steps detected at <500 activity counts per minute, in an attempt to interpret these data against existing pedometer-based scales. **Methods**: The analysis sample represents 2610 children and youth who had at least one valid day (i.e., at least 10 h) of monitoring. Means (SE) for steps per day were computed using all detected steps (i.e., uncensored) and again after disregarding those steps below 500 activity counts per minute (i.e., censored). **Results**: US children average approximately 13,000 (boys) and 12,000 (girls) uncensored accelerometer-determined steps per day. Comparable values for male and female youth are 11,000 and 9000 uncensored accelerometer-determined steps per day, respectively. Censoring low-force steps reduces uncensored values by approximately 2600 steps per day overall, shifts distributions to the left, and shows that almost 42% of US male children and almost 21% of female children are sedentary as interpreted against expected values for steps per day in childhood using a pedometer-based scale. **Conclusions**: Regardless of censoring or not, across age, the US data show a peak value at 6 yr followed by generally consistent declines in steps per day values throughout childhood and into youth. **Key Words:** WALKING, EXERCISE, PHYSICAL ACTIVITY, SURVEILLANCE

Objective monitoring of physical activity using accelerometers and pedometers has greatly enhanced researchers' and practitioners' abilities to capture the unique movement behavior patterns of children and youth. In particular, accelerometers like those recently adopted by the US National Health and Nutrition Examination Survey (NHANES) provide activity count outputs that can be distilled to classify time spent in a range of intensities (i.e., from sedentary to vigorous intensity) (6) and can ultimately be used to ascertain achievement of intensity-based public health physical activity recommendations (26). Using the 2003–2004 NHANES accelerometer data, Troiano et al. (16) reported that 42% of children aged 6–11 yr obtained the recommended 60 $\mathrm{min \cdot d^{-1}}$ of moderate-to-vigorous physical activity; only 8% of youth (aged 12–19 yr) achieved this level. Using the same data, Matthews et al. (11) reported that US children spent approximately 6 $\mathrm{h \cdot d^{-1}}$ in sedentary behavior and youth spent 7.5–8 $\mathrm{h \cdot d^{-1}}$.

The accelerometer model (the ActiGraph AM-7164, formerly distributed as CSA/MTI AM-7164, and manufactured by ActiGraph, Ft. Walton Beach, FL) used in NHANES also has a step counter function that provides another objective indicator of physical activity. Step data were not released in the 2003–2004 NHANES, but they were available for the 2005–2006 cycle. Steps per day is considered a simple indicator of physical activity volume that is growing in acceptance by both researchers and practitioners (3,13). For example, normative values for steps per day on the basis of assembled pedometer studies and related dose–response questions (i.e., "how many steps are enough?") originally focused on adults (19), but, more recently, they have moved to include younger populations (21,24).

We have previously published the accelerometer-determined steps per day data of US adults (≥20 yr) on the basis of the 2005–2006 NHANES (22). The raw data suggested that US adults took approximately 10,000 steps per day, which is improbable considering other pedometer studies of free-living physical activity in the United States (20,28). Further, because 10,000 steps per day is used to identify active adults (19,21), these results run contrary to previous NHANES analyses that indicate that <5% of adults achieve public health guidelines (16).

The ActiGraph is known to be more sensitive to lower force accelerations (e.g., slow walking) in adults compared

Address for correspondence: Catrine Tudor-Locke, Ph.D., FACSM, Walking Behavior Laboratory, Pennington Biomedical Research Center, Baton Rouge, LA 70808; E-mail: Tudor-Locke@pbrc.edu.
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with widely accepted and commonly used research-quality pedometers (10,18). The ActiGraph has also detected approximately 800–1000 more steps during a single school day compared with two types of pedometers worn concurrently by 10-yr-old children (12). Because questions concerning "how many steps are enough" are based on the output of such pedometers, we determined that it was necessary to censor steps detected at lower relative activity counts per minute if the results were to be compared with other pedometer-based studies and ultimately interpreted against existing pedometer-based scales.

After considering several candidate cut points described earlier (22), we settled on censoring those steps detected below 500 activity counts per minute. A sensitivity analysis comparing the effects of alternative censoring cut points (ranging from 400 to 600 activity counts per minute in 50-count increments) for the adult analysis has been published (23). Using these cut points, the average values in the total adult sample were 7140, 6934, 6540, 6256, and 5983 steps per day, respectively. Interpreting overlapping confidence intervals (CI), there were no significant differences in steps per day values obtained using 450, 500, or 550 activity counts per minute as a censoring cut point. However, the total sample averages that were obtained using 400 and 600 as the cut points were significantly different from the average obtained using 500 activity counts per minute as the cut point; the maximum difference observed using either of these two cut points was approximately 600 steps per day compared with the original cut point. Ultimately, the results using the 500 activity counts per minute cut point indicated that US adults, on average, take approximately 6500 steps per day, in line with at least two US samples assessed by research-quality pedometers: Colorado (≈6800 steps per day) (28) and South Carolina (≈5900 steps per day) (20). By deciding to use the same censoring threshold as used for the adult data in this present exploration of young people's data, we are able to extend the previous analysis and provide a basis for comparison across the life course. Therefore, the purpose of this present analysis of the 2005–2006 NHANES physical activity monitoring (PAM) data was to provide the descriptive epidemiology of accelerometer-determined steps per day in US children (6–11 yr) and youth (12–19 yr), with and without censoring steps.

## METHODS

**NHANES 2005–2006.** NHANES is the primary source of objectively collected health data in the United States. Data are collected year-round (under a complex, multistage probability design to represent a nationally representative sample of the civilian, noninstitutionalized US population) and released in 2-yr increments. Households are identified, and a trained interviewer visits the home to administer an initial interview. Once completed, participants are invited to a mobile examination center to receive a health examination.

Although the PAM component was added to NHANES in 2003, the accelerometer data released for the 2003–2004 cycle focused on activity counts and did not include step data. Therefore, 2005–2006 represents the first NHANES release of minute-by-minute accelerometer-determined steps data in addition to activity counts. PAM participants were recruited during mobile examination center visits if they were ≥6 yr and had no walking impairments or other types of limitations that prevented wearing the accelerometer as required. The accelerometers were initialized to concurrently record both activity counts and steps in 1-min time intervals (epochs). Participants were asked to wear the accelerometer (on the right side of the hip using an elasticized fabric belt) continuously for 7 d, removing them only for water-based activities and at bedtime. Participants were compensated $40 when accelerometers were returned by mail using a prepaid envelope.

PAM data files contain manifold records of chronologically ordered and detailed minute-by-minute activity count and step data for each day worn by each participant. Before public release, NHANES staff review, process, and edit these data for outliers and unreasonable values. Examples of data flagging have been previously reported (22) but include accumulations of unreasonable activity count and step values. The National Center for Health Statistics ethics review board approved all NHANES protocols, and all participants were asked to give informed consent. Parental/guardian consent was obtained for minors. The Pennington Biomedical Research Center's institutional review board approved of this analysis.

**Data treatment.** This analysis is focused on NHANES children and youth respondents with National Center for Health Statistics–designated reliable accelerometer data. A SAS macro provided by the National Cancer Institute at http://riskfactor.cancer.gov/tools/nhanes_pam/ was used to compute time worn (hours or minutes). A valid day was defined as ≥10 h of wear in keeping with previous analyses that included this range of children and youth (11,16). Previous analyses have also required at least four valid days of monitoring (16); however, we have shown that mean steps per day vary with valid days worn in adults, illuminating measurement bias (22). Therefore, before determining the number of days of monitoring considered for parameter estimates herein, we also analyzed the PAM youth data to ascertain a similar potential for bias. Comparable to the adult data (22), evidence depicting a graded measurement bias was apparent with each additional day of data collected. Specifically, children and youth with fewer than four valid days of monitoring ($n$ = 728) took significantly fewer (10,102 ± 218 vs 11,853 ± 137, $P$ < 0.0001) steps per day than those who had four or more valid days of monitoring ($n$ = 1882). To be clear, the most active children and youth tended to wear the accelerometer for more days than the least active children and youth. We determined that the overall sample mean would be inflated by approximately 1700 steps per day if we neglected the data of those who

TABLE 1. Sensitivity analysis for alternative censoring cut points for NHANES children and youth accelerometer-determined step data.

| Alternative Activity Counts per Minute Censoring Cut Points | Resulting Mean Steps per Day | 95% CI |
|---|---|---|
| Children (6–11 yr) | | |
| 400 | 10,596 | 10,321–10,870 |
| 450 | 10,316 | 10,043–10,590 |
| 500 | 10,039 | 9766–10,311 |
| 550 | 9769 | 9497–10,040 |
| 600 | 9501 | 9229–9772 |
| Youth (12–19 yr) | | |
| 400 | 8251 | 7915–8586 |
| 450 | 8001 | 7672–8330 |
| 500 | 7760 | 7436–8084 |
| 550 | 7526 | 7207–7844 |
| 600 | 7300 | 6987–7613 |



wore the accelerometer fewer than four valid days. We therefore decided to base this descriptive analysis on the 2610 PAM children and youth participants who had at least one valid day of monitoring. A single valid day of NHANES accelerometer monitoring data has also been used by Matthews et al. (11).

Steps detected each minute were summed during each 1440-min day. Each minute was also associated with activity count data, and these were used to identify those steps taken below 500 activity counts per minute. Daily steps were summed and divided by the number of days the accelerometer was worn to derive average steps per day, both uncensored (based on raw data) and censored (based on ignoring those steps taken below the designated cut point of 500 activity counts per minute). The sensitivity analysis conducted in this young NHANES sample is shown in Table 1 and considers mean steps per day produced when using alternative censoring cut points. Similar to the previously published adult sensitivity analysis (23), significance was inferred from nonoverlapping CI. For children, there were no significant differences in mean steps per day determined by cutting at 450, 550, or 650 activity counts per minute compared with censoring steps <500 activity counts per minute; the only significant difference was found on censoring at 400 activity counts per minute, and the difference in the overall mean for steps taken was <500 steps per day. For youth, none of the alternative cut points considered produced means for steps per day that were significantly different from those computed using the 500 activity counts per minute cut point.

Because previous NHANES accelerometer studies have used the 6- to 11-yr-old age range to define children (16), we adopted the same range herein. However, a pedometer-determined physical activity hierarchy (anchored on body mass index–referenced cut points [25]) has been proposed for 6- to 12-yr-old children (21). We used this to determine the percentage of children in the 2005–2006 samples who were in each-step-per-day category (using both uncensored and censored steps per day). The cut points are sex-specific, and for boys, they are 1) <10,000; 2) 10,000–12,499; 3) 12,500–14,999; 4) 15,000–17,499; and 5) ≥17,500 steps per day (21). The corresponding values for girls are 1) <7000; 2) 7000–9499; 3) 9500–11,999; 4) 12,000–14,499; and 5) ≥14,500 steps per day. For both sexes, the escalating categories are congruent with "sedentary," "low active," "somewhat active," "active," and "highly active" labels used to define adult pedometer-defined step per day echelons (19,21). Unfortunately, there are no similar cut points

TABLE 2. Sex- and age-specific means, SEM, and 95% CI for steps per day were computed using both uncensored and censored steps per day.

| Age (yr) | *n* | Uncensored Mean | SEM | CI | Censored < 500 Mean | SEM | CI |
|---|---|---|---|---|---|---|---|
| Male | | | | | | | |
| 6 | 74 | 14,392 | 393 | (13,555.7–15,229.4) | 11,795 | 395 | (10,953.6–12,635.8) |
| 7 | 75 | 13,531 | 362 | (12,758.4–14,303.2) | 11,096 | 345 | (10,360.3–11,831.5) |
| 8 | 69 | 13,296 | 215 | (12,838.4–13,754) | 10,603 | 228 | (10,117.2–11,089.2) |
| 9 | 74 | 13,211 | 735 | (11,643.7–14,778.7) | 10,720 | 620 | (9398.5–12,041.3) |
| 10 | 83 | 12,391 | 731 | (10,832.5–13,949.8) | 9759 | 673 | (8325–11,193.8) |
| 11 | 67 | 12,067 | 771 | (10,423.8–13,710.1) | 9655 | 695 | (8173.7–11,136.8) |
| 12 | 119 | 12,015 | 444 | (11,069.5–12,961.3) | 9434 | 399 | (8585.1–10,283.9) |
| 13 | 112 | 12,788 | 509 | (11,703.1–13,872.7) | 10,257 | 437 | (9325.4–11,187.8) |
| 14 | 101 | 11,589 | 518 | (10,486.2–12,692.2) | 9133 | 494 | (8079.7–10,186.8) |
| 15 | 102 | 11,123 | 480 | (10,100–12,146.7) | 8610 | 400 | (7757–9462.5) |
| 16 | 113 | 10,668 | 487 | (9630.8–11,704.8) | 8159 | 429 | (7244.8–9073.3) |
| 17 | 99 | 10,639 | 385 | (9819.3–11,458.3) | 7811 | 374 | (7013.8–8608.2) |
| 18 | 100 | 10,805 | 509 | (9719.9–11,889.9) | 7808 | 540 | (6657.7–8957.4) |
| 19 | 93 | 11,660 | 651 | (10,273.3–13,047.7) | 8878 | 575 | (7652–10,104.2) |
| Female | | | | | | | |
| 6 | 80 | 13,095 | 451 | (12,134.7–14,055.1) | 10,399 | 396 | (9553.6–11,243.6) |
| 7 | 62 | 12,358 | 469 | (11,357.8–13,358) | 9632 | 448 | (8677.6–10,586.1) |
| 8 | 77 | 12,610 | 494 | (11,558.4–13,662.1) | 9923 | 454 | (8955.3–10,890.2) |
| 9 | 92 | 12,615 | 767 | (10,989.2–14,240.2) | 9714 | 736 | (8155–11,273.7) |
| 10 | 85 | 11,775 | 474 | (10,764.7–12,784.8) | 8966 | 454 | (7997.9–9934.7) |
| 11 | 77 | 11,385 | 414 | (10,503–12,267.2) | 8614 | 393 | (7776.8–9451.2) |
| 12 | 101 | 9590 | 355 | (8834.1–10,346.9) | 7062 | 253 | (6523.7–7600.9) |
| 13 | 114 | 9589 | 367 | (8807.8–10,370) | 7000 | 392 | (6164–7836.5) |
| 14 | 110 | 9629 | 285 | (9022.6–10,235.7) | 6989 | 238 | (6480.6–7497) |
| 15 | 115 | 9784 | 311 | (9121.2–10,447) | 7341 | 279 | (6747.2–7934.9) |
| 16 | 109 | 9376 | 391 | (8543–10,208.6) | 6866 | 302 | (6221.4–7510.6) |
| 17 | 107 | 8643 | 383 | (7827.8–9458.9) | 5972 | 378 | (5166.5–6777) |
| 18 | 116 | 8225 | 446 | (7274.7–9175.1) | 5710 | 461 | (4728.3–6692.6) |
| 19 | 84 | 9231 | 507 | (8150.5–10,311.7) | 6359 | 504 | (5284.7–7433) |

at this time for youth, so a similar categorization was not undertaken here for youth (aged 12–19 yr).

**Analysis.** All analyses were conducted with SAS System for Windows (Version 9.1; SAS Institute, Cary, NC). Specific procedures for sample survey data were used to account for the complex NHANES sampling design, and sample weights were applied so that findings could be generalized to the greater US child and youth populations. We calculated sex- and age-specific means, SE, and 95% CI for both uncensored and censored steps per day, separately for children and youth. Using the child-specific step-defined activity levels described above, we report the percent of children in each category, considering both uncensored and censored steps, and the effects of censoring on 1) those classified in the lowest step–defined activity categories (i.e., "sedentary") and 2) the modal category (i.e., the category with the greatest percentage of children). A similar analysis was not undertaken for youth for the reasons cited above.

## RESULTS

Table 2 contains sex- and age-specific sample sizes and means, SE, and 95% CI for steps per day using both uncensored and censored steps per day. Censoring low-force steps reduces raw values by 2634 ± 30.6 steps per day overall, ranging from the lowest mean difference (2412 steps per day) observed in 11-yr-old boys to the highest (2997 steps per day) in 18-yr-old boys. Still, the decreasing trend observed across age for mean steps per day is preserved regardless of whether censoring is used. Values for boys are also higher (censored values ranging in difference from 680 in 8-yr-olds to 3257 steps per day for 13-yr-olds) than those for girls at all ages.

Figures 1 and 2 display the percent of children who were categorized at each of the sex- and age-specific step-defined activity levels detailed in the Methods section, based on both uncensored and censored steps. As anticipated, the effect of censoring is to shift distributions to the left. For boys aged 6–11 yr (Fig. 1), this results in an increase in those classified as sedentary (from 16.8% to 41.8%); the modal category then moves from somewhat active to sedentary for this subgroup. For girls aged 6–11 yr (Fig. 2), where different cut points are used for interpretation (21,25), those classified as being sedentary increased from 2.7% to 21.2%, and the modal category becomes somewhat active, having shifted from active.

## DISCUSSION

The results indicate that US boys and girls aged 6–11 yr average approximately 13,000 and 12,000 uncensored accelerometer-determined steps per day, respectively. Interpreted directly against sex-specific scales designed to rank pedometer-determined physical activity, this suggests that US boys are somewhat active and girls are active. Male and female youth (aged 12–19 yr) average approximately 11,000 and 9000 uncensored accelerometer-determined steps per day, respectively. As stated above, no youth-specific scaling exists at this time, limiting our ability to interpret these values in a similar manner to the children.

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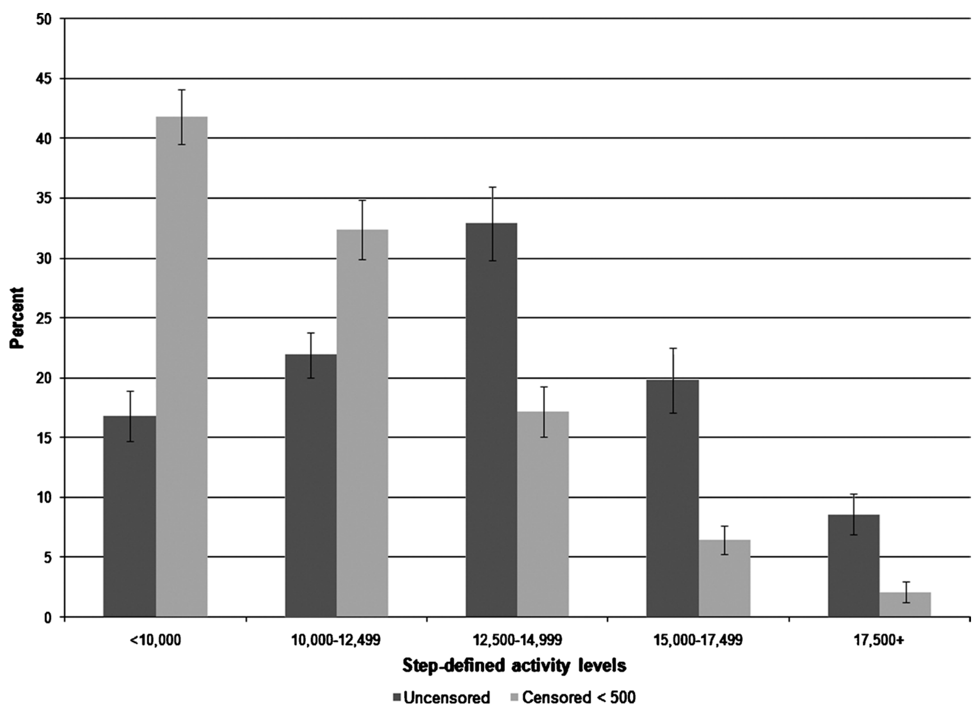


**FIGURE 1—NHANES 2005–2006 PAM participants categorized according to step-defined activity levels for male children aged 6–11 yr, considering both uncensored and censored steps: 1) <10,000 "sedentary"; 2) 10,000–12,499 "low active"; 3) 12,500–14,000 "somewhat active"; 4) 15,000–17,499 "active"; and 5) ≥17,500 steps per day "highly active."**

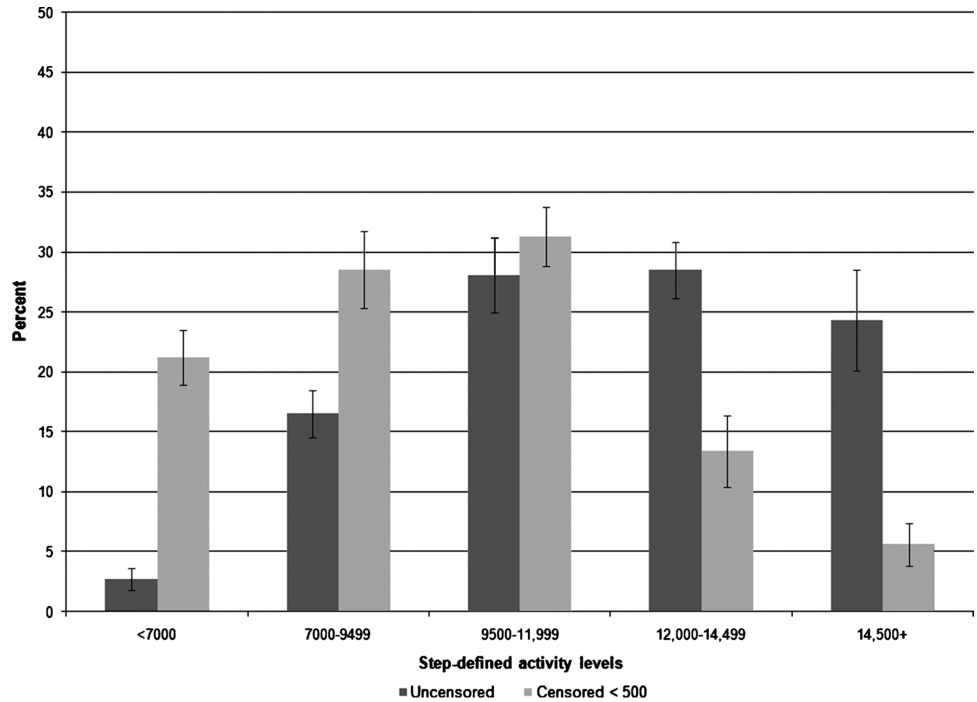


**FIGURE 2—NHANES 2005–2006 PAM participants categorized according to step-defined activity levels for female children aged 6–11 yr, considering both uncensored and censored steps: 1) <7000 "sedentary"; 2) 7000–9499 "low active"; 3) 9500–11,999 "somewhat active"; 4) 12,000–14,999 "active"; and 5) ≥14,500 steps per day "highly active."**



At least for the children, these findings are surprisingly good, considering the United States has one of the highest proportions of overweight and obesity in young people in the world (8). However, because the accelerometer used in the NHANES is known to detect more low-force accelerations (18) than accepted research-quality pedometers, making it also more sensitive to detecting erroneous steps (10), we undertook a similar data adjustment process herein used previously to make the NHANES adult accelerometer data more compatible with that expected from pedometers (22). A full discussion of the issues and merits of this approach to censoring low-force accelerations is addressed elsewhere (22). The censoring process reduces the raw values by approximately 2600 steps (not too different from an approximate 3000-step reduction in the adult data [22]) and shifts the distribution to the left.

Recently, Beets et al. (2) compiled sample-weighted pedometer data from 43 studies of young people conducted in 13 countries. The assembled data show that boys and girls from the Western Pacific (Australia and New Zealand) and Europe (Sweden, United Kingdom, Belgium, Czech Republic, France, Greece, and Switzerland) take significantly more steps than those from the United States. However, compared with a figure displaying overall estimates of steps per day generated from those studies that collected both weekday and weekend data (similar to NHANES protocol), the NHANES's uncensored steps for NHANES males are generally higher in early childhood years up until 10 yr, then lower than this overall estimate until 18 yr where it is again higher. For girls, the NHANES's uncensored steps are higher, on average, than overall pedometer estimate values of steps per day until approximately 11 yr and then remain lower at every age. To emphasize, the uncensored NHANES data suggest that US children are relatively more active, especially at younger ages, than overall pedometer-determined estimates assembled from 13 different countries (including the United States) suggest. This is difficult to reconcile, considering the overall findings of this multiple-country review. Although not a proof of validity, the censoring process lowers the mean steps per day values at every age; however, the pattern of a steady decrease in steps per day across ages is unaffected.

Perhaps more directly comparable, we have recently published the results of a pedometer-based surveillance study of 11,669 Canadian children and youth (aged 5–19 yr) (4). Focusing on the same age group covered in the NHANES data, from approximately 13,000 steps per day at 6 yr, Canadian boys show an increase in pedometer-determined physical activity that peaks around 14,000 steps at 9–10 yr, subsequently decreasing through youth to values of approximately 11,000 by 18 yr. In comparison, the US boys begin from a peak at age 6 yr of approximately 14,000 accelerometer-determined uncensored steps per day (12,000 censored) and, except for a single slight increase at 13 yr (evident in both the uncensored and the censored data), decrease steadily through youth until approximately 11,000 uncensored steps per day (9500 censored steps per day) at 18 yr.

The Canadian girls increase slightly from approximately 12,000 steps per day at 6 yr to approximately 12,500 steps per day at 7 yr. A subsequent decline most evident after

11 yr progresses until approximately 9500 steps per day at 18 yr. In comparison, the American girls (like their male counterparts) steadily decline from a peak value of approximately 13,000 uncensored steps per day (10,000 censored steps per day) at 6 yr and then decrease through the rest of childhood and into youth until approximately 8000 uncensored steps per day (6000 censored steps per day) at 18 yr. In both the Canadian pedometer data and the American accelerometer data (both uncensored and censored), there is a slight increase in steps per day at 19 yr evident for both boys and girls, possibly reflecting the transition to adulthood and independence.

Overall, Canadian boys took 12,259 steps per day and girls took 10,906 steps per day captured by a Yamax pedometer (4). If they had worn an ActiGraph accelerometer, we would expect these values to be higher because it is known to detect more low-force accelerations than the Yamax pedometer, including movements detected during slower walking (9) and riding in a car (10). Corresponding values for the uncensored American accelerometer–determined data are 12,143 and 10,606 steps per day (censored data: 9541 and 7940 steps per day). Given what we know about the measurement properties of these instruments, however, the apparent alignment of the Canadian pedometer data and the American uncensored accelerometer data is best described as coincidental. A direct comparison of adults answering the same questionnaire shows that inactivity in leisure time is more common, and markers of sedentarism are higher in the United States compared with Canada (7), so we would expect children's data to show similar between country differences. Regardless, both countries' objective data now serve as important reference data.

The analyses undertaken herein are not without limitations. First, because, like other motion sensors worn at the waist, the ActiGraph is designed to detect ambulatory activity (i.e., walking, running, etc.), it does not detect upper body movements or load carrying. It also requires removal for water activities. Second, because movement behaviors of children, in particular, are characterized as possessing brief bursts of intense movement interspersed with bouts of light and sedentary activity (27), the minute-long epoch used in the NHANES PAM protocol might mask sporadic steps that do not elicit sufficient activity counts to be considered toward adjusted daily totals. That being said, the number of steps lost because of censoring is lower in younger children than in older children (Table 2) and adults (22).

We have previously acknowledged that the process of censoring is based on an arbitrary cut point of 500 activity counts in a minute (22). The results compared favorably to other US samples collected using pedometers (20,28), and we ultimately subjected it to a sensitivity analysis for adults (23) and children (herein). Although we originally described this activity count-per-minute level as indicative of inactivity intensity (18), we did not specifically set out here or in the related adult analysis (22) to cut steps below any specified intensity *per se*. *Post hoc*, we attempted to describe this activity level by citing Barnett and Cerin (1) who showed that this cut point represents walking at 2.7 $\text{km}\cdot\text{h}^{-1}$ or 1.7 $\text{miles}\cdot\text{h}^{-1}$ in adults; we do not know what a comparable walking speed would be for children or youth, however. Individual calibration seems to improve the relationship between walking speed and activity counts per minute, but this is believed to be less important for population-based studies like this one (1). Further, because the sensitivity threshold of the typical research-grade pedometer (e.g., the Yamax pedometer models) is not adjustable (and, therefore, it will be the same in children through to adults) and because the aim herein was to extend the adult analysis and attempt to interpret the ActiGraph step output on a pedometer-based scale, it follows that any activity count cut point ultimately selected should be likewise static in nature. Further, we believe that by using the same cut point as used in adults also allows us to draw a more consistent picture of how similarly captured and represented steps alter over the life course. As we noted previously, the absolute number of steps lost to censoring is lower in children compared with that in adults. As a side note, Sardinha et al. (15) have used the 500 activity count cut point to identify "sedentary time" in 9- to 10-yr-old Portuguese children. Although Riddoch et al. (14) have reported that the median physical activity level of 11-yr-old children is only 580 activity counts per minute, this median is shaped in great part by a very large number of low values (presumably also including zero values) reflecting very low activity and inactivity accumulated throughout the day.

We did not apply traditional data analysis approaches that suggest that 4–5 d of monitoring are necessary to interpret young people's accelerometer data (17). Estimates in that original study were based on the number of days necessary to establish acceptable reliability for time in moderate- to vigorous-intensity activity (a relatively small proportion of the day's time budget) and were not a measure of total volume of activity reflected as steps per day. Before accepting any previously adopted notion of how many days were necessary to consider, we directly examined the data for evidence. As indicated previously, the most active children and youth tended to wear the accelerometer for more days, and the least active children and youth wore it for fewer days. Culling those at the lower end of monitoring compliance actually inflates step per day estimates by screening out the most sedentary individuals, as we have also shown before using the adult NHANES data (22). Craig et al. (5) have also shown that a single day of pedometer data is sufficient in describing population levels of activity. Acknowledging a final limitation, the ActiGraph AM7164 used in the 2005–2006 cycle of NHANES data is now obsolete. It was replaced by the GT1M model and that is now also obsolete, having been replaced most recently by the GT3X, which now offers movement detection on three axes and also contains an inclinometer to provide positional data. The manufacturers claim that the GT3X is "fully backward compatible" with earlier models; however, we await empirical evidence of this

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assertion. It remains also possible that pedometer models differ in measurement properties over time if appropriate quality controls are not in place and enforced.

As many as 42% of US male children and almost 21% of female children may be considered sedentary if censoring accelerometer-determined steps detected below 500 activity counts per minute produces a reasonable approximation of pedometer-determined steps, permitting interpretation of these data against existing pedometer-based scales. We must emphasize, however, that this was not a validity study, and much more research is necessary if we are to become more confident in our ability to translate the output of one instrument against that of another. Setting aside debate about scale-based interpretation and attempts to offer qualitative labels for quantitative values, it is readily apparent that these US data, regardless of whether censoring is used, display a peak steps per day value at 6 yr for both sexes and a subsequent steady decline in both boys and girls through the rest of childhood and into youth. We believe that these findings are of importance not only to researchers using this accelerometer but also to clinicians and other front-line practitioners, including schoolteachers who use pedometers more regularly with children and youth. Presenting results for both uncensored and censored data allows a full spectrum of users to select the more appropriate reference data for their purposes.

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