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Assessment of Differing Definitions of Accelerometer Nonwear Time

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Keywords

motion sensors; physical activity; exercise

Measuring physical activity with objective measures, such as accelerometers, is becoming more common with researchers, as evidenced through the increasing number of research articles using accelerometers (R Troiano, 2005). Accelerometers measure acceleration multiple times within a given frequency and summarize this as a count over a pre-specified time period or epoch. The resultant count represents acceleration over the epoch length. Accelerometers are advantageous because they eliminate language or literacy difficulties, recall bias, and social desirability bias present with self-report measures of physical activity.

With the increasingly widespread use of accelerometers, standardization of how the data are collected, cleaned, and reported across studies would be useful. In 2005, Masse et al (Masse et al., 2005) identified five methodological issues regarding accelerometer data reduction, the process of reducing the data in order to derive summary measures. These included (1) identifying wearing time of the accelerometer, (2) defining minimal wear time for a valid day, (3) identifying spurious data, (4) computing summary variables and aggregating days of data, and (5) extracting bouts of activity. This paper focuses on the first issue, namely identifying nonwearing time of the accelerometer. Understanding whether the accelerometer is being worn is used to assess compliance and to determine if the participant's data will contribute to the resultant analyses. Defining wearing and nonwearing time also affects the derivation of summary physical activity measures based on this time, such as average counts per hour worn or minutes in sedentary, light, moderate, or vigorous activity (Corder, Brage, & Ekelund, 2007). How to define and assess nonwearing time of the accelerometer is not currently standardized across research studies.

Participants are typically instructed to wear the accelerometer during all waking hours and to remove the device for showering or swimming activities, although some devices are now waterproof. The challenge is that participants often take the accelerometer off for other personal reasons. When an accelerometer such as an ActiGraph or an Actical is not being worn, it will typically register as zero counts over the epoch. However, it is possible for a person to be still (such as sleeping or sitting without movement), while wearing the accelerometer, and also register zero counts over the epoch. This can occur for multiple

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minutes at a time and are likely more common among those who are very sedentary throughout the day. Some have recommended that participants keep a log sheet to help determine when the participant is not wearing the monitor (Esliger, Copeland, Barnes, & Tremblay, 2005; Trost, McIver, & Pate, 2005). The challenge with this approach is that the process of keeping a log introduces a self-reporting aspect of data collection and compliance can be hampered. For this reason the use of a log was included for the National Health and Nutrition Examination Survey (NHANES) pilot study and subsequently dropped for the deployment into the main study in 2003-04 (R Troiano, 2006; RP Troiano et al., 2008).

An alternative to a log kept by participants is to deduce the most reasonable nonwearing time based on the accelerometer data. This approach is more commonly used by researchers. Some recent studies of youth and adults utilizing the ActiGraph have, for example, used 10 minutes (Brage et al., 2004; Ekelund, Yngve, Brage, Westerterp, & Sjostrom, 2004; Riddoch et al., 2004), 15 minutes (Rousham, Clarke, & Gross, 2005), 20 minutes (Jilcott, Evenson, Laraia, & Ammerman, 2007; Savitz et al., 2006; Treuth et al., 2004), 30 minutes, or 60 minutes (Matthews et al., 2008; RP Troiano et al., 2008) to define the timespan of zeros on the accelerometer to indicate nonwearing time. Many other studies do not indicate how nonwearing time is defined. Dr. Masse and colleagues (Masse et al., 2005) explored the effect of differing definitions of nonwearing time on results, comparing 20 minutes and 60 minutes of consecutive zeros as an indicator of nonwearing time among a sample of 40 to 70 year old African American and Hispanic women. However, in the same analyses this study also varied other accelerometer data reduction decisions, making the interpretation of the influence of the varying of nonwear time only difficult.

The purpose of this study was to describe the effect of changing the definition of accelerometer nonwear time on an aggregated sample of participants, prior to using the data to analyze physical activity by individuals, and to assist others in replicating this process. To do this, we utilized data from the third Pregnancy, Infection, and Nutrition (PIN3) Postpartum Study, which collected accelerometer data on women at 3- and 12-months postpartum.

Methods

Study Description

The PIN3 Study is a prospective investigation of preterm delivery conducted at selected prenatal clinics in central North Carolina. Potential participants were identified by study staff through a review of all medical charts of new prenatal patients. Women were recruited at their second prenatal visit before 20 weeks of gestation and those who consented to participate in this study had study-specific data collected on them through pregnancy. Women who were less than 16 years of age, non-English speaking, not planning to continue care or deliver at the study site, or carrying multiple gestations were excluded. The PIN3 Postpartum Study builds on the PIN3 Study, extending data collection for a subset of study participants into the postpartum period. The study website (http://www.cpc.unc.edu/pin) provides greater detail on the protocols and measures. All data collection described herein was approved by the University of North Carolina - Chapel Hill Institutional Review Board and each participant provided their informed consent prior to participation in the studies.

Physical Activity Measurement

At 3- and 12-months postpartum, physical activity data were collected with a Manufacturing Technology Inc. (MTI) ActiGraph accelerometer (Pensacola, FL). The ActiGraph model #7164 is a small, light-weight uniaxial accelerometer that can be worn at the hip, ankle, or wrist. It measures accelerations in the range of 0.05 to 2 G’s with a band limited frequency of 0.25-2.5 Hertz (Trost et al., 2005). Validity of the monitor as an indicator for physical activity has been demonstrated among adults (Brage, Wedderkopp, Franks, Andersen, & Froberg, 2003; Freedson, Melanson, & Sirard, 1998; Hendelman, Miller, Baggett, Debold, & Freedson, 2000). The ActiGraph has also been shown to be a technically reliable instrument, able to detect differing levels of intensity (Brage, Brage, Wedderkopp, & Froberg, 2003; Brage, Wedderkopp et al., 2003; Esliger & Tremblay, 2006; McClain, Sisson, & Tudor-Locke, 2007; Metcalf, Curnow, Evans, Voss, & Wilkin, 2002; Welk, Schaben, & Morrow Jr., 2004).

From November 2004 to January 2007, women participating in the PIN3 Postpartum Study were asked to wear the accelerometer for one week at the conclusion of their 3- and 12-month home visits. If they agreed, women were fitted with the accelerometer to be worn on a belt or clip-on pouch over their right hip at the iliac crest. Written and verbal instructions, as well as a phone number to call with questions, were provided. Participants mailed the monitor back to the study offices at the conclusion of the 7 days. In thanks for their time, women received $30 at 3-months postpartum and $40 at 12-months postpartum. ActiGraph accelerometer data were collected with 1-minute epochs, and the monitors were regularly calibrated throughout the study using the calibration machine from MTI. To convert accelerometer counts to a measure of intensity, we utilized ActiGraph cutpoints for moderate-to-vigorous activity provided in two studies of adults: Freedson et al (Freedson et al., 1998) cutpoint of 1952 counts per minute and Swartz et al (Swartz et al., 2000) cutpoint of 573 counts per minute. We also classified inactivity at a count of less than or equal to 100 counts per minute (Matthews et al., 2008).

Statistical Analysis

SAS (Cary, NC) Version 9 was used to process the accelerometer data. The accelerometer data was first converted from accelerometer data files (DAT) to SAS data files with one epoch (1-minute) per observation. The SAS data files were then reduced to the 7-day period that the monitor was worn.

The creation of an accelerometer analysis file and the assessment of differing definitions of accelerometer nonwear time involved the following four steps.

1. The first step was to remove nonwearing time, which was defined as 20-, 40-, or 60-minutes of consecutive readings of zero counts.
2. The second step was to remove spurious data, defined as 1 epoch (1-minute) of isolated activity bordered before and after by strings of consecutive zero count readings. A graphical representation of the data revealed numerous 1-minute segments preceded by and followed by 20-, 40-, or 60-minutes of inactivity (zero counts). We elected to remove spurious data for two reasons. First, we did not consider the spurious data qualified as wear time since it is not likely to represent actual wearing of the monitor but rather movement of the monitor while not being worn. Second, the spurious data can influence the average number of times the monitor is worn per day, one of the statistics we evaluate when selecting which nonwear time definition to use. This 1-minute segment would indicate that after not wearing the monitor, the woman put the monitor on again and then within the minute took it off for an extended period of time, an unlikely scenario.
3. The third step involved restricting the data to adequate wear time. For this process, we removed days from the analysis that did not have at least 8 hours of wear time per day. The 8-hour wear time was chosen based on the time 70% or more of the women wore the monitor on weekdays (7.5 hours and 8.4 hours among 3- and 12-

month postpartum women respectively) and weekends (6.2 hours and 7.2 hours among 3- and 12-month postpartum women respectively).

4. The fourth step included assessment of the quality of the accelerometer analysis file. This was done with summary statistics and a graphical review of the data of the resultant outcomes as well as the number of times worn per day to help decide how best to use the data for further analyses.

For this study, we used 3 definitions of nonwearing time (20, 40 and 60 consecutive minutes of zero counts) for two sets of accelerometer data, one at 3-months postpartum and one at 12-months postpartum. We calculated the total times worn, the average number of times worn per day, and the percent of days (for each day contributed by the women) worn 4 or more times for the 3 definitions of nonwearing time with the accelerometer data (1) without spurious data removed and without a minimum wear time applied (i.e., through step 1), (2) with spurious data removed and without a minimum wear time applied (i.e., through step 2), and (3) with spurious data removed and with the minimum wear time of 8 hours applied (i.e., through step 3). Using the data through step 3, average counts and percent of minutes of moderate to vigorous physical activity (defined two ways) and percent of minutes of inactivity were also calculated for the 3 definitions of nonwearing time.

In order to visualize the data, we utilized SAS PROC TIMEPLOT. To prepare the data, wear time files were created three times, using the definitions of 20, 40, and 60 minutes of consecutive zeros to define nonwearing time. These wear time files with 1-minute/ observation were then reduced to wearing time segments, as defined by the periods of time not interrupted by one of the nonwearing periods. Each observation in this reduced dataset included a date, segment start time, segment stop time, length of the segment in minutes, and the average activity level of the segment in counts. Each time the monitor was put on counted as a segment. Using this procedure, each wear time segment was plotted on a separate line, along with the date, average count for the segment, start time, and end time. SAS PROC TIMEPLOT has a BY option that we used to plot each 1-week observation separately, one page per woman. The plot of each segment over a 24-hour day helped us visualize the wearing patterns.

Results

The sample was comprised of data from 182 women evaluated at 3-months postpartum and 204 women evaluated at 12-months postpartum, including the data of 80 women who wore the accelerometer at both visits. The results are described for each of the four steps in the creation and assessment of differing definitions of accelerometer nonwear time.

Step 1: Removing Nonwearing Time

The first step involved identifying consecutive strings of zeros in the accelerometry data. When 20-, 40-, or 60-minutes or more of zero counts were found, they were removed from the initial set of accelerometer data. This process removed minutes and hours of nonwearing time. At 3-months postpartum, the initial accelerometer data spanned 1274 days and182 participants over a one-week period and at 12-months postpartum, the data spanned 1428 days and 204 participants. The process of removing nonwearing time reduced the participants' number of days with wearing time by 48 days to 1226 days and by 42 days to 1386 days for women at the 3- and 12-month postpartum, respectively (Table 1). This was true regardless of the nonwearing time definition used (i.e., 20-, 40-, or 60-minutes of consecutive zeros). The actual total number of hours of wearing time varied with the nonwear time definition, with the shorter definitions of nonwear time (i.e., 20-minutes) resulting in fewer total hours of wearing time (Table 1).

Step 2: Removing Spurious Data

For the second step, we removed single epochs (1-minute) of non-zero readings that were bordered before and after by strings of consecutive zero count readings to define spurious data. For example, at 3-months postpartum, 694 minutes of spurious data were identified and removed using the 20-minute nonwear time definition (Table 1). As the nonwear time definition lengthened, we identified fewer spurious minutes since some number of the spurious minutes would now be incorporated in the extended wear time definition.

Step 3: Restricting the Data to Adequate Wear Time

The third step involved removing days with inadequate wear time, with adequate wear time for this study defined as at least 8 hours/day in a 24 hour period. For the 3-months postpartum participants, applying this definition removed 216 (18%), 200 (16%), and 191 (16%) of the days used for data analysis for subgroup datasets characterized by nonwearing definitions of 20-, 40-, or 60-minutes of consecutive zeros, respectively. However, since these were days that already demonstrated limited wear activity by participants, this only removed 5.8%, 5.2%, and 4.9% of the respective hours worn. For the 12-months postpartum participants, using this standard of deleting those days in which fewer than 8 hours of wear time was recorded, there were even fewer days and hours of wear time removed from the subsequent data analysis. On average, using the 20, 40, or 60-minutes definition of nonwear time, about 12% of the days and 3.5% of the wear hours were removed for further analysis. As the nonwear time definition lengthened, the number of days and hours with at least 8 hours of wear time increased (Table 1).

Step 4: Quality Assessment of the Accelerometer Analysis Files

The quality assessment involved exploring both descriptive data as well as graphical data of the resultant outcomes as well as the number of times the accelerometer was worn per day. We explored the resulting average counts as well as the number of minutes classified as moderate to vigorous and inactive. These three outcomes are often used in analyses using accelerometer data. As shown in Table 1, the longer the nonwearing time definition the lower the percent of minutes classified as moderate to vigorous defined using both Freedson et al (Freedson et al., 1998) and Swartz et al (Swartz et al., 2000) cutpoints, and the higher the percent of minutes classified as inactive, although the relative percent of these changes was small.

The study protocol requested that each woman wear the accelerometer from when she woke up in the morning until she went to bed at night, except to bathe or swim. If a woman wore the monitor without removing it from rising to going to bed, this would ideally result in one wear time segment per day. At 3-months postpartum, using the 20-minute nonwear time definition (step 1), 29.7% of all days women wore the accelerometer four or more times per day (Table 2). This value (percent of days women wore accelerometer four or more times per day) decreased to 19.9% by removing the spurious data (step 2) and decreased further to 18.5% when the minimum wear time of 8 hours per day was applied (step 3). Also using the 20-minute nonwear time criterion, the average number of times worn per day ranged from 2.4 to 3.0 times, depending on how the data was processed (using step 1, 2 or 3). For these same women, by increasing the nonwear definition to 60 minutes, for all three derivations of the accelerometer data (steps 1-3), both the percent worn 4 or more times per day and the average number of times worn per day dropped. Results showed similar trends with the 12-month postpartum sample.

As the definition of nonwearing time increased, the average activity count per minute decreased because more counts with zero (sequences of continuous zeros that did qualify as a nonwearing interval by definition) were included in the calculations, diluting the average activity score. There was no change in the number of minutes of moderate-to-vigorous activity because changing the wear time definition only added additional zero minutes into the tally. The calculation of the number of minutes above the moderate count threshold was therefore not changed by how many more zero minutes are added. However, the total count average must decline as the total is diluted. To exemplify, consider one hour from a selected data set with 5 minutes of activity that is bordered at both ends by physical activity, displaying 25 minutes of zero counts before the activity and 30 minutes of zero counts following the activity. By the shorter (20-minute) nonwear time definition, these two (25 minute and 30 minute) time segments of continuous nonwear would have been deleted from subsequent data analysis. In contrast, using the longest 60-minute nonwear definition would have forced both the 25 minute and 30 minute of consecutive zero counts of time to be counted as wear time since this hour did not comprise 60 consecutive zero minutes. Hence, the 55 zero minutes would have been included in the analysis, diminishing the average activity score.

Using the SAS TIMEPLOT procedure, we further explored the nonwear time definitions for each woman. Figure 1 show a single case selected to graphically demonstrate changes in wear time patterns between the 20- and 60-minute definitions. In Figure 1A, using the 20-minute definition, it appears that the woman put the monitor on 27 times over 7 days, on average about 4 times per day. In Figure 1B, using the 60 minute definition, it appeared that the woman wore the monitor once per day, wearing it to just after midnight on the first day. For this particular woman, changing the nonwearing time definition from 20 to 60 minutes resulted in an increase in the hours worn (93.1 to 104.5), an increase in the average hours per day worn (13.3 to 14.9), an increase in the percent of minutes of inactivity (55.6 to 60.4), and a decrease in the average counts for that day (377.7 to 336.4). Assuming the woman followed the requested protocol, the 60-minute definition made the most sense to use for later analyses.

The SAS TIMEPLOT procedure has a PAGE BY option that allowed the creation of these time series plots for all of the participants and when we compared these multiple series of plots, the difference in outcomes by choice of nonwear time definition was dramatic. For some women’s wear data there were no meaningful changes, but for other women the resultant changes were striking. By assuming that the women in the study made a reasonable effort to follow the study protocol, the descriptive data and plots led us to conclude that the 60-minute definition provided the most optimum set of accelerometer data to use for future analyses.

Discussion

These results highlight the meaningful effect of changing the definition of accelerometer nonwear time. When we initially examined our data, using a 20 minute consecutive count of zeros to define nonwearing time, and also with and without removal of spurious data and requiring at least 8 hours of wearing time, the resultant range from 2.2 to 3.0 average number of times worn per day for the 3-month and 12-month postpartum assessments seemed high (Table 2). The graphical representation of the data also revealed numerous segments of 1-minute lengths that were preceded by and followed by at least 60 minutes of inactivity. This may indicate that the monitor was being moved but not worn, but we have no way of verifying this. When we changed our nonwearing time definition to 60 minutes of consecutive zeros, and removed the isolated 1-minute epochs of activity, the total number of wearing time segments decreased and the total wearing time increased. Moreover, when considering the effect on potential outcomes, the average count decreased and the percent of minutes classified as moderate to vigorous decreased, while concurrently the percent of minutes classified as inactive increased. Having plotted and reviewed all records in the study, it was also clear that by changing the definition as described, a higher percentage of days showed the "staircase" effect graphically (i.e., fewer wear time segments per day such as in Figure 1b).

It is important to note the change in the average accelerometer counts, a proxy for physical activity, with the change in wearing time definitions. For example, the percent of the total number of minutes above the Swartz et al (Swartz et al., 2000) moderate-to-vigorous cutpoint declined from 17.3% to 16.4% at 3-months postpartum and 18.9% to 18.1% at 12-months postpartum. As the number of consecutive zeros used to define nonwear time increased, the mean accelerometer count for the sample declined (Table 2), as expected since more zeros were being included as wear-time data. For studies utilizing imputation methods for the accelerometer data (Catellier et al., 2005), it may change the number of participants considered to be out of compliance (i.e., did not wear the monitor for some minimal amount of time) for that day and thus would have their data imputed. The higher the number of consecutive zeros required to define nonwearing time, the less imputation would occur. This highlights the importance of describing these decisions in research papers and also working towards standardization across studies when feasible.

It should be noted that activity bouts of 8 to 10 minutes in length will not be affected by our definition of nonwearing time. For example, when we increase the nonwearing time definition from 20 to 40 to 60 minutes, we are adding sedentary time only as minutes of zero activity and when we remove spurious data of 1 to 2 minutes of isolated activity, we would not be changing any activity in bouts of at least 8 to 10 minutes. By definition, all activity in bouts of at least 8 to 10 minutes are truly active wear time and are not affected.

These data were analyzed aggregately rather than individually. For the analysis, which described the initial steps of cleaning the data, this seemed useful since the participants were similar (all were postpartum) and likely had similar wear time patterns. This assumption might not be true for a more heterogeneous sample. At the conclusion of our data cleaning, it was intended that the data could be used for a more traditional participant-by-participant analysis.

We are not aware of other research studies that have excluded very short periods of wear time (i.e., 1 minute epochs that we defined as spurious data). However, it did not seem reasonable that a woman would not wear the monitor for at least 20-, 40-, or 60-minutes, and then wear it for 1 minute, and then not wear it again for at least another 20-, 40-, or 60-minutes, respectively. Interestingly, our data did not have any spurious 2-minute segments, indicating that the choice of 1-minute may have been most appropriate for this sample.

The challenge to these analyses is that we do not have an objective way to determine whether or not the woman was actually wearing the monitor. To study this, we propose that direct observation would ideally be needed, although not very practical in nature. It is questionable whether log books would yield the precision needed to know when the monitor was being worn and also when the monitor was being moved precisely to the minute.

It would be useful to explore these analyses in other populations. It may be that even longer periods of nonzero time are appropriate for older adults, who may not be as active, whereas shorter periods of nonzero time may be more appropriate for children (Masse et al., 2005). It should also be noted that these analyses used the ActiGraph accelerometer. The appropriate definitions may vary depending on the accelerometer used. For example, in a study using the Tritrac, the authors defined nonwearing time if the vector magnitude did not reach 10 for 30 minutes in a row (Cradock et al., 2004).

In summary, these results highlight the meaningful effect of changing the definition of accelerometer nonwear time on the resulting total number of wearing time segments, average wearing time, average accelerometer counts, and resultant minutes in different intensity levels of physical activity. The procedure we describe herein can be replicated by others to further explore appropriate wearing time definitions for different populations. The interruptions of 1-minute epochs need to be verified and validated against observation of the participant or a well-kept log. Researchers are encouraged to describe in their research the definitions used to define nonwearing time and to consider the resulting effect of their choice on the analyses.

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A.
                                SAS PROC TIMEPLOT

------------------------------------------ id=5735 ------------------------------------------

date_stamp    avg_act    _start     _end    min                                            max
                                            0:00                                         23:59
                                            *-----------------------------------------------*
02/11/2006     233.00      9:46    14:24    |                   *----|---*                  |
02/11/2006     338.70     14:51    21:24    |                        |    *------------*    |
02/11/2006     152.80     22:00    23:22    |                        |                  *--*|
02/11/2006     434.30     23:57    23:59    |                        |                     @|
02/12/2006     644.30      0:00     0:07    |@                       |                      |
02/12/2006     445.50      9:54    12:01    |                   *----*                      |
02/12/2006     270.30     12:47    20:35    |                        |*--------------*      |
02/12/2006     171.00     21:36    23:57    |                        |                *---*|
02/13/2006     271.20      8:15     9:11    |                *-*     |                      |
02/13/2006     334.90      9:32    11:47    |                   *---*|                      |
02/13/2006     144.10     12:09    13:24    |                        *-*                    |
02/13/2006     281.00     13:49    23:50    |                        |  *------------------*|
02/14/2006     265.80      7:31    12:14    |               *--------*                      |
02/14/2006     320.50     12:41    18:06    |                        |*---------*           |
02/14/2006     411.60     18:44    22:01    |                        |            *-----*   |
02/15/2006     376.90      9:41    14:34    |                   *----|----*                 |
02/15/2006     197.50     15:01    16:18    |                        |    *--*              |
02/15/2006     252.50     16:42    22:35    |                        |        *----------*  |
02/15/2006     225.20     23:09    23:17    |                        |                    **|
02/16/2006     724.70      8:19    13:34    |                *-------|--*                   |
02/16/2006     559.30     14:00    18:31    |                        |  *--------*          |
02/16/2006     232.10     19:53    22:04    |                        |              *---*   |
02/16/2006     267.50     23:10    23:55    |                        |                    **|
02/17/2006    2769.70      7:19     9:00    |              *---*     |                      |
02/17/2006    1137.70      9:53    11:48    |                   *---*|                      |
02/17/2006     191.50     12:10    15:09    |                        *-----*                |
02/17/2006     179.80     15:41    23:59    |                        |      *--------------*|
                                            *-----------------------------------------------*
```

```
B.
                                SAS PROC TIMEPLOT

------------------------------------------ id=5735 ------------------------------------------

date_stamp    avg_act    _start     _end    min                                            max
                                            0:00                                         23:59
                                            *-----------------------------------------------*
02/11/2006     248.80      9:46    23:59    |                   *----|---------------------*|
02/12/2006     644.30      0:00     0:07    |@                       |                      |
02/12/2006     246.50      9:54    23:57    |                   *----|---------------------*|
02/13/2006     257.60      8:15    23:50    |                *-------|---------------------*|
02/14/2006     300.20      7:31    22:01    |               *--------|------------------*   |
02/15/2006     266.40      9:41    23:17    |                   *----|---------------------*|
02/16/2006     452.60      8:19    23:55    |                *-------|---------------------*|
02/17/2006     538.10      7:19    23:59    |              *---------|---------------------*|
                                            *-----------------------------------------------*
```

Figure 1.

3-Month Postpartum ActiGraph Wear Time Segments Based on Excluding 20 Minutes (Figure 1A) and 60 Minutes (Figure 1B) of Nonwearing Time

(note: horizontal lines were added and are not part of the SAS output)

Table 1

Descriptive statistics using 20-, 40-, and 60-minutes of continuous zeros to define nonwear time among the aggregated sample of 3-month and 12-month postpartum women

	3-Months Postpartum n=182			12-Months Postpartum n=204		
	Number of continuous zeros used to identify the nonwearing period			Number of continuous zeros used to identify the nonwearing period		
	20	40	60	20	40	60
Total number of days with any amount of wear time#	1226	1226	1226	1386	1386	1386
Total number of hours worn#	14,101	14,641	14,928	16,853	17,357	17,656
Total number of minutes of spurious data	694	423	326	610	373	266
Total number of days with at least 8 hours of wear time per day	1010	1026	1035	1207	1221	1229
Total number of hours when including only days with at least 8 hours of wear time per day	13,271	13,866	14,182	16,182	16,756	17,071
Percent of minutes above or below a count when including only days with at least 8 hours of wear time per day:						
>= 1952 counts per minute*	2.5	2.4	2.3	2.7	2.7	2.6
>= 573 counts per minute**	17.3	16.7	16.4	18.9	18.4	18.1
<= 100 counts per minute***	54.3	55.9	56.7	51.4	52.8	53.6

reported before spurious data was removed; all other values have the spurious data removed

* >=1952 cutpoint for moderate to vigorous physical activity (-Freedson et al., 1998)

** >=573 cutpoint for moderate to vigorous physical activity (Swartz et al., 2000)

*** <=100 cutpoint for sedentary behavior (Matthews et al., 2008)

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Table 2

Accelerometer data derived in three steps using 20-, 40-, and 60-minutes of continuous zeros to define nonwear time among the aggregated sample of 3-month and 12-month postpartum women

Derivation of accelerometer data	3-Months Postpartum n=182 — Number of continuous zeros used to identify the nonwearing period			12-Months Postpartum n=204 — Number of continuous zeros used to identify the nonwearing period		
	20	40	60	20	40	60
(step 1) Accelerometer data without spurious data removed and without a minimum wear time:						
Total times worn	3625	2466	2128	3667	2565	2227
Average number of times worn per day	3.0	2.0	1.7	2.6	1.9	1.6
Percent of days worn 4 or more times	29.7	11.4	6.5	23.8	8.2	4.1
Average counts (SD)	321(678)	309(668)	303(663)	348(705)	338(701)	332(697)
(step 2) Accelerometer data with spurious data removed and without a minimum wear time:						
Total times worn	2931	2043	1802	3057	2192	1961
Average number of times worn per day	2.4	1.7	1.5	2.2	1.6	1.4
Percent of days worn 4 or more times	19.9	5.8	2.1	16.6	3.9	2.1
Average counts (SD)	321(678)	309(668)	303(663)	348(705)	338(701)	332(697)
(step 3) Accelerometer data with spurious data removed and with a minimum wear time of 8 hours in a day:						
Total times worn	2396	1659	1466	2629	1878	1692
Average number of times worn per day	2.4	1.6	1.4	2.2	1.5	1.4
Percent of days worn 4 or more times	18.5	4.7	1.4	15.4	2.9	1.6
Average counts (SD)	321(676)	310(666)	304(662)	348(705)	338(699)	333(694)