Comparison of Older Adults’ Steps per Day Using an NL-1000 Pedometer and Two GT3X+ Accelerometer Filters

Tiago V. Barreira, Robert M. Brouillette, Heather C. Foil, Jeffrey N. Keller, and Catrine Tudor-Locke

The purpose of this study was to compare the steps/d derived from the ActiGraph GT3X+ using the manufacturer’s default filter (DF) and low-frequency-extension filter (LFX) with those from the NL-1000 pedometer in an older adult sample. Fifteen older adults (61–82 yr) wore a GT3X+ (24 hr/day) and an NL-1000 (waking hours) for 7 d. Day was the unit of analysis (n = 86 valid days) comparing (a) GT3X+ DF and NL-1000 steps/d and (b) GT3X+ LFX and NL-1000 steps/d. DF was highly correlated with NL-1000 (r = .80), but there was a significant mean difference (–769 steps/d). LFX and NL-1000 were highly correlated (r = .90), but there also was a significant mean difference (8,140 steps/d). Percent difference and absolute percent difference between DF and NL-1000 were –7.4% and 16.0%, respectively, and for LFX and NL-1000 both were 121.9%. Regardless of filter used, GT3X+ did not provide comparable pedometer estimates of steps/d in this older adult sample.

Keywords: step counts, physical activity, measurement, accelerometry, validity

Pedometers have been used to objectively capture ambulatory free-living physical activity as steps per day (Bassett, Schneider, & Huntington, 2004; Bassett, Wyatt, Thompson, Peters, & Hill, 2010). Although accelerometers are capable of detecting additional dimensions of physical activity, they have also been used to summarize ambulatory activity as steps per day (Colley et al., 2011; Tudor-Locke, Johnson, & Katzmarzyk, 2009, 2010). It has become apparent, however, that similarly named outputs do not necessarily translate well between instruments (Barreira et al., 2013; Cuberek, El Ansari, Fromel, Skalik, & Sigmund, 2010; Kinnunen et al., 2011), and while different generations of the same instrument have been shown to agree (John, Tyo, & Bassett, 2010), some researchers have reported differences (Kozey, Staudenmayer, Troiano, & Freedson, 2010; Rothney, Apker, Song, & Chen, 2008). This disagreement hampers the ability to compare between populations and studies. As a case in point, various generations of the ActiGraph accelerometer, which is the most widely used accelerometer, have been shown to be more sensitive (Le Masurier & Tudor-Locke, 2003; Tudor-Locke, Ainsworth,
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Thompson, & Matthews, 2002), similarly sensitive (Clemes, O’Connell, Rogan, & Griffiths, 2010; Ramirez-Marrero et al., 2008), and less sensitive (Colbert, Matthews, Havighurst, Kim, & Schoeller, 2010; Connolly, Coe, Kendrick, Bassett, & Thompson, 2011; Feito, Bassett, Thompson, & Tyo, 2012) in detecting steps taken compared with different research-quality pedometers. In addition, ActiGraph accelerometers have been shown to have inconsistent results compared with pedometers even in the same population (Barreira et al., 2013; Kinnunen et al., 2011) and when participants were stratified based on different pedometer-determined physical activity levels (Tudor-Locke & Bassett, 2004). In an effort to resolve these issues and accommodate a range of measurement needs, the manufacturers of this instrument recently provided users with a raw acceleration data format. With the introduction of the GT3X+ in the fall of 2010, ActiGraph also included the option to select different sensitivity filters (i.e., default filter [DF] and low-frequency-extension filter [LFX]) during data postprocessing. The LFX option was introduced after Rothney et al. (2008) pointed out that the ActiGraph 7164 and ActiGraph GT series (with digital band-pass filter) had different outputs at low frequencies. When enabled, the LFX expands the lower end of the filter cutoff, which in turn enables an increase in sensitivity to detect low-force movements. The opportunity to use a filter more sensitive to slower gaits may be especially relevant to older adult populations because of the demonstrated undercounting of actual steps taken using previous ActiGraph accelerometer models (Storti et al., 2008).

Since pedometers are more likely to be used for clinical and public health applications (Kang, Marshall, Barreira, & Lee, 2009; Tudor-Locke, Craig, Brown, et al., 2011), it becomes important to understand how the GT3X+ filters would perform relative to a practical yet accurate pedometer. This would inform our ability to translate GT3X+ output according to a pedometer scale. The impact of the different GT3X+ filters on conclusions about steps per day detected by the same instrument or compared with a pedometer (that is more likely to be used in clinical and practical applications) has not been published. Therefore, the purpose of this study was to compare the steps per day derived from the ActiGraph GT3X+ (ActiGraph, Pensacola, FL, USA) using both the manufacturer’s DF and the LFX with that derived from the NL-1000 pedometer (Lee’s Summit, MO, USA) in an older adult sample.

Materials and Methods

Participants

Participants (7 men, 73 ± 9 years of age, 26.1 ± 2.2 kg/m²; 8 women, 67 ± 4 years of age, 25.2 ± 2.6 kg/m²) were recruited from nondemented volunteers of ongoing research conducted by the Institute of Dementia Research and Prevention at the Pennington Biomedical Research Center. The procedures were approved by the institutional review board, and all participants provided informed written consent.

Participants’ height and weight were measured twice before they wore the objective monitors. Height was measured using a stadiometer, with the head held in the Frankfort plane while holding a deep breath. Weight was measured using a
digital scale with participants’ shoes removed. The average of the two measures was used in the analysis.

Objective Monitoring of Steps per Day

The GT3X+ has the ability to collect data in intervals up to 100 Hz. For this study it was initialized to record data in 80 Hz using ActiLife5 software version 5.5. The NL-1000 is a piezoelectric pedometer with a 7-day memory capable of recording steps and moderate to vigorous activity. The NL-1000 has a similar measurement mechanism as its predecessor, the NL-2000, which is known to be accurate (Connolly et al., 2011; Crouter, Schneider, & Bassett, 2005; Crouter, Schneider, Karabulut, & Bassett, 2003) and performs better than other commonly used waist-mounted devices (Feito et al., 2012). We considered the NL-1000 pedometer the reference instrument for this analysis. To be clear, we were interested in how the GT3X+ filters would perform relative to a practical yet accurate pedometer. In addition to having a 7-day memory, the NL-1000 has been shown to accurately measure steps at a range of speeds in different populations and to be superior to spring-lever pedometers during treadmill testing (Clemes et al., 2010; Connolly et al., 2011; McClain, Hart, Getz, & Tudor-Locke, 2010).

Participants were asked to wear a GT3X+ for 24 hr/day for 7 consecutive days to monitor physical activity and sedentary and sleeping behavior. In addition to wearing the GT3X+, participants were asked to wear the NL-1000 only during waking hours due to its inability to measure sleeping behavior. Otherwise, both instruments were only to be removed for showering/bathing or other water activities. The GT3X+ was worn on a belt and positioned at the hip, on top of the iliac crest and in line with the midaxillary line. The NL-1000 was worn on the same belt in a position immediately in front (anterior) of the GT3X+. Participants were also asked to log the times that they attached and removed the pedometer, as well as daily steps taken as recorded by the pedometer.

Data Treatment

Accelerometer data were downloaded using ActiLife5 software. Using the DF, data were then treated using standard decision rules imbedded in a National Cancer Institute–supplied SAS macro (http://riskfactor.cancer.gov/tools/nhanes_pam) to determine wear time and validity of the monitored day. Specifically, we defined accelerometer nonwear time as ≥60 min of consecutive zeros (allowing for interruptions as per the original macro) and a valid day of data as a recording of at least 10 hr of wear time. They were then processed two separate times, both times in 60-s epochs, once using the DF and once using the LFX.

Step data stored in the pedometer’s memory were recorded when the instruments were returned. If this was missing (in the case of a delayed return beyond the instrument’s memory), the participant-recorded data were accepted, which occurred for a total of 4 days, 2 participants with 2 missing days each. In pilot data where participants did not know the pedometer had a memory function, 10 people, age 57–78, 6 female, were asked to record their daily step counts for a total of 62 days, and those were compared with the step counts recorded from the pedometer memory. We found an almost perfect congruence \( r = .99 \) between these two sources of pedometer data in older adults (data not published).
Statistical Analyses

Descriptive data are presented as $M \pm SD$. Statistical analyses were conducted using day as the unit of measure and in a pairwise fashion comparing steps per day from (a) the GT3X+ DF and the NL-1000 and (b) the GT3X+ LFX and the NL-1000. Relationships within the two pairs were compared using Pearson correlation coefficients and Bland-Altman plots (Bland & Altman, 1999). In addition, mean differences between pairings were tested using $t$ tests for dependent samples, and the percent difference in instrument-detected steps per day was calculated as \((\text{NL-1000} – \text{GT3X+ filter})/\text{NL-1000} \times 100\). The absolute percent difference was computed in a similar fashion, but the negative values were transformed into positive values. Computing absolute percent difference communicates magnitudes of differences unaffected by the process of averaging negative and positive values together.

Days were also classified according to five step-defined activity categories (sedentary <5,000 steps/day, low active 5,000–7,499 steps/day, somewhat active 7,500–9,999 steps/day, active 10,000–12,500 steps/day, and highly active >12,500 steps/day; Tudor-Locke & Bassett, 2004) based on the number of steps per day recorded by the NL-1000 and the GT3X+ filters. Agreement between category classifications was computed. The percent difference and absolute percent difference between instruments for each of these categories were computed. For further comparison of steps per day obtained using the two different accelerometer filers, detected steps per minute were divided into eight cadence bands including 0 (considered nonmovement during wearing time), 1–19 (incidental movement), 20–39 (sporadic movement), 40–59 (purposeful steps), 60–79 (slow walking), 80–99 (medium walking), 100–119 (brisk walking), and 120+ steps/min (all faster human locomotor movements; Tudor-Locke, Camhi, et al., 2011). In addition, mean differences in steps per day accumulated at cadences representing at least moderate-intensity activity (100+ steps/min; Rowe et al., 2011; Tudor-Locke, Sisson, Collova, Lee, & Swan, 2005) were tested using paired $t$ tests. Time spent at these cadence bands was also computed. SAS version 9.2 was used for all analyses.

Results

The analysis sample comprised 86 valid days representing both the GT3X+ and the NL-1000 devices. The applied SAS macro detected an average wear time of 17.1 ± 2.2 hr/day for the GT3X+ using the DF and 18.3 ± 2.8 hr/day for the LFX, and participants reported wearing the NL-1000 for 14.7 ± 1.4 hr/day. The average steps per day for each device and/or filter are presented in Figure 1. Although the DF steps per day were highly correlated with the NL-1000 steps per day ($r = .80$, $p < .001$), there was a significant difference between the two, 769 steps/day $t(85) = –4.62$, $p < .001$, with the DF measuring fewer steps per day than the NL-1000. The Bland-Altman plot (Figure 2[a]) shows that the DF resulted in fewer steps per day relative to the NL-1000. It also shows a large spread in the agreement between the two instruments; there were six data points that fell outside the 95% limits of agreement. There was also a strong correlation between the LFX and the NL-1000 ($r = .90$, $p < .001$); however, the magnitude of the difference between the LFX and the NL-1000 was comparatively much larger, 8,140 steps/day $t(85) = 38.01$, $p < .001$, and the LFX counted more steps relative to the NL-1000. The related Bland-Altman plot (Figure 2[b]) shows that the LFX resulted in more
Figure 1 — Mean (SD) steps per day for the NL-1000 pedometer and the GT3X+ default filter (DF) and low-frequency-extension filter (LFX).
Figure 2(a) — Bland-Altman plot between the NL-1000 pedometer and the GT3X+ default filter (DF).
Figure 2(b) — Bland-Altman plot between the NL-1000 pedometer and the GT3X+ low-frequency-extension filter (LFX).
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steps per day (relative to the NL-1000), and again it was possible to see a large spread in the agreement between the two instruments; there were 3 data points that fell outside the 95% limits of agreement, which had a range of almost 10,000 steps. Percent difference and absolute percent difference between the DF steps per day and the NL-1000 steps per day were −7.4% and 16.0%, respectively. For the LFX steps per day and the NL-1000 steps per day the percent difference and absolute percent difference were the same (121.9%), demonstrating consistency in the direction of difference.

The number of days (of all possible valid days) classified in each steps-per-day-defined activity category using the NL-1000 were as follows: sedentary = 23 (27%), low active = 13 (15%), somewhat active 33 (38%), active = 10 (12%), and highly active = 7 (8%). The DF and NL-1000 agreed 65% of the time for steps-per-day-defined activity category classification (see Tables 1A–1C for details), while the NL-1000 and LFX and the DF and LFX only agreed at the highly active category for 8% and 6%, respectively.

The LFX and NL-1000 only agreed in the classification for the highly active category (8% of the classification). The LFX classified all other days in a higher activity category than did the NL-1000. Percent difference and absolute percent difference for the two GT3X+ filters by each NL-1000 steps-per-day-defined activity category are presented in Figure 3. Percent difference observed between the DF and the NL-1000 steps per day was negative, indicating a consistent undercounting by the DF. For the LFX, percent differences were all positive and equal to the corresponding absolute percent differences. The numbers of steps detected within each incremental cadence band using the two filters are presented in Figure 4[a]. The LFX detected more steps than the DF in each incremental cadence band. The DF detected 1,037 ± 1,398 steps/day at 100+ steps/min while the LFX applied to the same data detected 1,249 ± 1,530 steps/day above this threshold, t(85) = 6.6, p < .001. The times accumulated at different cadence bands measured by the two GT3X+ filters are depicted in Figure 4[b]. Time spent in nonmovement measured

| Table 1A Agreement and Disagreement Between NL-1000 Pedometer and GT3X+ Accelerometer Default Filter (DF) by Step-Defined Activity Category (SDAC) |
|---|---|---|---|---|---|
| DF SDAC | NL-1000 SDAC | Sedentary | Low active | Somewhat active | Active | Highly active | Total |
| Sedentary | 19 | 0 | 2 | 0 | 0 | 21 |
| Low active | 4 | 10 | 8 | 0 | 0 | 22 |
| Somewhat active | 0 | 3 | 22 | 6 | 2 | 33 |
| Active | 0 | 0 | 1 | 2 | 2 | 5 |
| Highly active | 0 | 0 | 0 | 2 | 3 | 5 |
| Total | 23 | 13 | 33 | 10 | 7 | 86 |

*Note. Activity categories are based on the following steps per day: sedentary <5,000, low active 5,000–7,499, somewhat active 7,500–9,999, active 10,000–12,500, and highly active ≥12,500. Bold denotes agreement between classifications. (Tudor-Locke & Bassett, 2004).*
Table 1B  Agreement and Disagreement Between NL-1000 Pedometer and GT3X+ Accelerometer Low-Frequency-Extension Filter (LFX) by Step-Defined Activity Category (SDAC)

<table>
<thead>
<tr>
<th>LFX SDAC</th>
<th>Sedentary</th>
<th>Low active</th>
<th>Somewhat active</th>
<th>Active</th>
<th>Highly active</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Low active</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Somewhat active</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Active</td>
<td>9</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Highly active</td>
<td>5</td>
<td>10</td>
<td>31</td>
<td>10</td>
<td>7</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>13</td>
<td>33</td>
<td>10</td>
<td>7</td>
<td>86</td>
</tr>
</tbody>
</table>

Note. Activity categories are based on the following steps per day: sedentary <5,000, low active 5,000–7,499, somewhat active 7,500–9,999, active 10,000–12,500, and highly active ≥ 12,500. Bold denotes agreement between classifications. (Tudor-Locke & Bassett, 2004).

Table 1C  Agreement and Disagreement Between GT3X+ Accelerometer Default Filter (DF) and Low-Frequency-Extension Filter (LFX) by Step-Defined Activity Category (SDAC)

<table>
<thead>
<tr>
<th>LFX SDAC</th>
<th>Sedentary</th>
<th>Low active</th>
<th>Somewhat active</th>
<th>Active</th>
<th>Highly active</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Low active</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Somewhat active</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Active</td>
<td>8</td>
<td>6</td>
<td>33</td>
<td>5</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Highly active</td>
<td>4</td>
<td>16</td>
<td>33</td>
<td>5</td>
<td>5</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>22</td>
<td>33</td>
<td>5</td>
<td>5</td>
<td>86</td>
</tr>
</tbody>
</table>

Note. Activity categories are based on the following steps per day: sedentary <5,000, low active 5,000–7,499, somewhat active 7,500–9,999, active 10,000–12,500, and highly active ≥12,500. Bold denotes agreement between classifications. (Tudor-Locke & Bassett, 2004).

by the DF was lower by approximately 200 min when measured by the LFX, while time spent at all other cadence bands was higher, with differences ranging from 100 min for incidental and sporadic movement to just a few minutes in the walking and higher cadence bands.

Discussion

The manufacturer of the ActiGraph accelerometer now offers two filters of different sensitivity for analyzing movement data, but their performance relative to pedometers that are more likely to be used in clinical and public health applications
is an unanswered question. The answer to this question is of practical importance to researchers and practitioners interested in translating the results of one device to the other. Therefore, we set out to compare steps per day obtained using these two accelerometer filters with steps per day measured by the NL-1000 pedometer in an older adult sample. The number of steps per day counted using the LFX almost doubled that obtained by the NL-1000 (delta = 8,140 steps/day). A close examination of the performance of the two filters across incremental cadence bands demonstrated that the LFX produced higher step counts within each cadence band and that the apparent heightened sensitivity was not confined to lower cadences only. Although the DF more closely approximated data obtained from the NL-1000
(delta = –769 steps/day), both accelerometer-filter estimates were significantly different from the reference instrument. While a 769-steps/day difference might not seem very large, the inconsistency of the difference (overcount on the low active days and undercount on more active days) makes it difficult to recommend a simple correction factor.

The GT3X+ version of the ActiGraph accelerometer was released in the fall of 2010. To our knowledge there have been no studies comparing free-living step

**Figure 4** — (a) Mean number of steps detected and (b) time spent within each incremental cadence band using the GT3X+ default filter (DF) and the GT3X+ low-frequency-extension filter (LFX).
counts obtained from this model with any type of pedometer. There are, however, a few studies that have compared previous generations of the ActiGraph accelerometer with pedometers under free-living conditions. In one of the first studies (Tudor-Locke et al., 2002), the ActiGraph model 7164 was compared with the Yamax SW-200 pedometer, and the ActiGraph was found to count more steps per day (delta = 1,845). In an older adult sample, Colbert et al. (2010) tested the difference between the NL-2000 pedometer and the GT1M model and found that the accelerometer detected fewer steps per day. In a recent study, using the most proximal version to the GT3X+, the GT3X was found to count fewer steps per day in the overall sample when compared with the Yamax pedometer (Barreira et al., 2013), but it counted more steps per day on the less active days. Only in the study with the oldest ActiGraph 7164 model (Tudor-Locke et al., 2002) were the results different from those observed in the current study using the DF.

It is known that both waist-mounted pedometers and accelerometers have reduced accuracy when individuals walk at slow speeds (Clemes et al., 2010; McClain et al., 2010), and selecting a more sensitive filter seems like a prudent solution to this problem. The addition of the LFX option to the latest ActiGraph model was intended to improve accuracy at these low levels of activity. This is considered to be most relevant for older adults, as studied herein, but the LFX actually produced steps-per-day estimates that were well above (almost double in fact) the values normally expected in this population (6,000–8,500 steps/day; Tudor-Locke, Craig, Aoyagi, et al., 2011), also compared with the values obtained with the concurrently worn NL-1000 and the DF of the same device. There are no other direct comparisons documenting such large discrepancies between pedometers and any other step measurement device as the differences we observed between the LFX and the NL-1000. This could be due to the extreme sensitivity of this filter to low-force accelerations, leading to misclassification of fidgeting movements and vibrations during nonmovement situations like riding in a car, which has also been demonstrated with previous generations of ActiGraph accelerometers (Le Masurier & Tudor-Locke, 2003). However, the difference was not confined to these lower level movements. The LFX also picked up more movement within high-intensity activity ranges as demonstrated by the differences observed (compared with the DF) at each incremental cadence band (delta = 1,083, 459, 172, and 40 steps for slow walking, medium walking, brisk walking, and all faster locomotion, respectively) including steps taken at 100+ steps/min (212 steps). This was unexpected as we had believed that the LFX would only affect measurement of low-intensity movements. The large differences between the LFX and the NL-1000 cannot be attributed to dissimilarities in the wear time due to the protocols used for the pedometer and accelerometer. If the wear protocol were the cause, the DF would also detect more steps per day than the pedometer, and this was not the case.

For these reasons it is safe to say that the LFX greatly overcounted the steps per day in this sample, at least in terms of a pedometer-based scale. Researchers should be aware of this issue and should be careful using and interpreting the LFX steps-per-day output as it appears to detect low-force movements and vibrations and misclassify them relative to a clinical or real-world measurement of steps. It also appears to be hypersensitive across the full range of acceleration to a point where
it may be double-counting some movements as steps. On the other hand, the DF
gave average values of steps per day within the expected range for the population
of this sample (6,000–8,500 steps/day; Tudor-Locke, Craig, Aoyagi, et al., 2011).
However, the difference in steps per day between the DF and the NL-1000 was still
too large (greater than 10%; Cibere et al., 2010; Tudor-Locke et al., 2006), and
there was too large a number of activity categories misclassified for those devices
to be used interchangeably or for the results from these devices to be directly
compared with much precision.

This study was carefully conducted, but it is not free of limitations. We recruited
only a small sample of volunteers and we did not perform direct observation of the
participants, and therefore we cannot determine which device accurately measured
steps per day. However, our intention was not to make inferences about population
behavior. Rather, our analysis sample comprised 86 valid days obtained from con-
currently worn detected instruments, and our inferences likewise focused on their
performance relative to the specific instrument more likely to be used in practical
applications. Results may not be representative of comparisons when data are
averaged over multiple days and day-to-day variability in over- and undercount-
ing is inevitably smoothed, at least to some degree. There were differences in the
estimated wear time derived from accelerometry and the participant-recorded wear
time for the pedometer. However, this difference between pedometer and acceler-
ometer wear time is somewhat expected. The time at which participants take off the
pedometer in preparation for going to bed and the time that they completely stop
moving (detected by a continuously worn accelerometer) and sustain nonmove-
ment (which would be classified as nonwear time with the accelerometer) is likely
to be different. In addition, a small movement during the night could cause large
amounts of time to be identified as wear time. The opposite is likely to happen in
the morning if the participant delays putting on the pedometer but movement has
been detected by the accelerometer. This movement before going to bed, during
sleep, and right when getting out of bed would likely consist of movement of low
intensity, which is supported by the fact that the DF recorded fewer steps per day
than the pedometer.

In summary, the ActiGraph GT3X+ has two different filters to process step
counts: a default offering that is presumably congruent with earlier versions and a
more sensitive option. The addition of the LFX was offered by manufacturers in an
target to correct previously documented problems associated with undercounting
of step counts observed during slow walking. However, under free-living condi-
tions, these results demonstrate that the LFX detects considerably more steps per
day (an average of 122% more) than a research-quality pedometer. To be clear,
this represents a doubling of estimated steps per day. On the other hand, the DF
counted fewer steps per day in this older adult sample but at a comparatively reduced
magnitude of difference. Unfortunately, a simple correction factor is elusive. In
conclusion, the result obtained from this older adult sample suggests that steps per
day measured by the GT3X+ in both filters cannot be compared with accuracy to
the steps per day measured by the NL-1000 pedometer.

Acknowledgments

We would like to acknowledge the efforts of Kimberly Kramer for data management.
References


