One-year Stability of Objectively Measured Physical Activity in Young Brazilian Adults

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Background: To evaluate the 1-year stability of objectively measured physical activity among young adults living in South Brazil, as well as assessing the influences of temperature, humidity and precipitation on physical activity. Methods: A longitudinal study was conducted over 12 consecutive months (October 2012 to September 2013). Sixteen participants (8 men) used GT3X+ accelerometers 1 week per month for the entire year. Climate variables were obtained from an official climate information provider. Results: Physical activity was remarkably stable over the year—the proportion of the day spent in moderate-to-vigorous intensity physical activity (MVPA) was around 5% in every month. Average temperature ($p = -0.64; P = .007$), humidity ($p = -0.68; P = .004$) and rain ($p = -0.67; P = .004$) were inversely correlated to MVPA in the Summer. Rain was also inversely correlated to MVPA in the Spring ($p = -0.54; P = .03$). Conclusions: Objectively measured physical activity was stable over a 1-year period. Climate variables consistently influenced physical activity practice in the Summer, but not in the other seasons.

Keywords: accelerometer, seasonal variation, motor activity, climate, weather

The purpose of this study was to evaluate the 1-year stability of objectively measured physical activity among young adults living in Pelotas, Brazil. We also assessed the influence of temperature, humidity and precipitation on physical activity.

Methods

A longitudinal study was conducted over 12 consecutive months. We followed the participants from October 2012 to September 2013. Sixteen participants (8 males), aged 18 to 35 years, were selected by convenience, but representing different socioeconomic strata—half of the participants had family income up to BRL 3000 per month (equivalent to ~USD 1000), whereas the other half had a family income greater than that. To be eligible, participants had to live in Pelotas, Brazil and do not have traveling plans lasting for more than a month during the entire year of data collection.

Seasons were categorized according to official climate statistics. Summer runs from December to February. Autumn includes March, April, and May. Winter includes June, July, and August. Spring includes September, October, and November.

Physical activity during the 12 months was assessed using the GT3X+ ActiGraph monitor, placed on the hip at the right side, and set up with a 5-second epoch and a frequency of 30Hz. Participants received the accelerometer on Wednesdays, and data were analyzed from Thursday onwards. Individuals were advised to wear the accelerometer 24 hours per day for 6 consecutive days.

Accelerometry analyses were conducted using ActiLife version 6. More than 10 minutes of consecutive zero counts were considered nonwear period. A day was considered valid if at least 600 minutes of data were provided. Sleep time, detected automatically through the accelerometer’s algorithm, was excluded. Participants should provide at least 3 valid days per week to be included in the analyses. The Sasaki et al. cut points for different intensities were applied.

“Sedentary” was set from 0 to 99 counts per minutes (cpm), “light intensity” from 100 to 3207 cpm, “moderate intensity” from 3208 to 8564 cpm, “vigorous intensity” from 8565 to 11,592, and “very vigorous intensity” ≥ 11,593 cpm.

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Climate variables such as temperature, humidity and amount of rain in millimeters were obtained from an official climate information provider. These variables were collected from the official source of weather of Pelotas and mean values per month were calculated. Data were collected every month in periods matched with accelerometers using time by the participants.

Statistical analyses were performed in Stata 12. Mean counts per minute were described per month, as well as the percent time spent by participants in activities of different intensities. Analyses of variance and nonparametric Kruskal-Wallis test (when ANOVA’s assumptions were violated) were performed to compare physical activity variables according to months of measurement. Student’s t test was used to evaluate the association between physical activity and sex. We also evaluated the percent difference between each month’s average and the annual one. Spearman’s correlation coefficients were calculated to show the association between moderate-to-vigorous physical activity (MVPA) and climate variables.

The current study was approved by the Ethics Committee of the Physical Education School of the Federal University of Pelotas (IRB number: 054-2012). Written informed consent was obtained from all participants before data collection.

Results

The maximum number of possible data points to be obtained was 192 (16 individuals ×12 months). We were able to analyze 176 (91.7%) data points. Table 1 describes climate variables during the 12 months of data collection. The average temperature ranged from 10.2°C (SD 4.0) in August to 21.2°C (SD 8.4) in December. Humidity was, on average, above 60% in all months, with a peak in July (74.6%). December was the month with the highest amount of rainfall during a week (5.5 mm). The mean body mass index (BMI) of the sample was 24.3kg/m².

Figure 1 shows mean counts per minute spent by males and females in each month. Counts per minute were not statistically different between sexes in any month, except August, but males presented higher scores in 9 out of 12 months. In addition, there was no statistical difference among the months of measurement considering counts per minute (P = 9). The highest mean score was observed in October (511 cpm), whereas the lowest was observed in July (404 cpm).

Considering the annual average as the reference, variation coefficients varied from 2% (January) to –35% (October). Seven out of 12 months showed variation coefficient lower than 10%. Five months showed positive variation coefficients whereas 7 months presented negative variation coefficients.

Wear-time ranged from 966 (February) to 1102 (October) minutes per day, and the overall mean was 1008 minutes. Percent daily time spent in sedentary activities ranged from 66.5% in July to 70.2% in November. The lowest percentage of time spent in moderate-intensity physical activity was found in November (4.8%), whereas the highest was found in June (6.0%). Vigorous-intensity physical activity represented only 0.09% of daily time of the individuals in August. The highest percentage of time spent in vigorous-intensity physical activity (0.23%) was found in April (Figures 2 to 3). As shown in Figure 1, no statistical significance was found in the analyses considering time spent in physical activity intensities according to months (P-values ranging from 0.7 to 0.9).

Table 2 shows the correlation coefficients between percent time spent in MVPA and climate variables by season. Maximum temperatures were inversely correlated to MVPA during Summer months. Minimum temperatures were inversely correlated to MVPA during the Winter, but significant inverse correlation coefficients were found only in Summer months. We did not observe clear associations in Autumn and Spring. In the Summer, all climate variables were statistically inversely correlated to MVPA. The correlation coefficient between average temperature and MVPA was negative and of moderate magnitude (r = –0.64, P = .007). Rainfall also showed an inverse correlation coefficient with MVPA. In Spring, rainfall was the only climate variable statistically correlated to MVPA (r = –0.54; P = .030).

Discussion

Our monthly data collection lasted 1 year, so that we were able to evaluate the stability of physical activity and the effect of climate variables on activity levels among adults. In contrast to our hypothesis, high temperatures in the Summer were associated with low levels of MVPA. Humidity and rain were also predictors of low levels of MVPA during the Summer.

There are several possible explanations for the low daily time spent in MVPA in the Summer. First, most adults take vacation during this period of the year, because it coincides with children’s school recess. Second, the Carnival, one of the most traditional public parties in Brazil, takes place in February, during Summer. Third, the last half of December is when families get together to celebrate Christmas and the New Year’s Eve, which may lead to lower engagement in physical activity. This hypothesis is in agreement with previous studies on holiday weight gain.

Climate variables influenced physical activity differently across the seasons. While the temperature showed an inverse correlation with MVPA during the Summer, it was not related to physical activity in the other seasons. A previous systematic review described that extreme temperatures (low and high) negatively affect physical activity, since they jeopardize the practice of outdoor activities.

One should note that the lowest temperature registered in 2012 to 2013 during Winter in Pelotas (2.4°C) is not too extreme as the ones observed in other countries.

Rainfall was inversely related to MVPA in the Spring. A systematic review showed an inverse association between rainfall and steps/day in a sample of older adults. Our findings suggested that the Summer season did not positively influence physical activity, as suggested by other studies with adults. The same association observed between rainfall and MVPA in our sample was found in the study by Lewis and colleagues, carried out with samples of children from Australia and Canada. However, such association was found during Spring only. In addition, to corroborate with their findings, maximum temperature were inversely correlated with time spent in MVPA during Summer.

Physical activity was somehow stable throughout the year. The average count per minute in each month was mostly less than 10% different from the annual average. In the literature search, we located 1 study suggesting the same in the United States, but also others suggesting lower stability of physical activity over the year. There are few studies evaluating the stability of physical activity in such an intense way (monthly data collection) as we did.

A study conducted in South Carolina and Tennessee showed that during the Summer, steps count were higher than in any other season. Climate variables were not explored in this study. One of the possible explanations for the difference in the findings is that the infrastructure to practice physical activity is widely unlike in the US from that observed in Brazil. The other possible explanation is related to the domains in which physical activity is practiced. In low and middle-income countries, levels of occupational and transport physical activity are high; activities in these domains are less likely to vary over the year as compared with leisure-time physical activity.
### Table 1 Description of Climate Variables; Pelotas, Brazil

<table>
<thead>
<tr>
<th></th>
<th>Summer</th>
<th></th>
<th>Autumn</th>
<th></th>
<th>Winter</th>
<th></th>
<th>Spring</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>January</td>
<td>February</td>
<td>March</td>
<td>April</td>
<td>May</td>
<td>June</td>
<td>July</td>
<td>August</td>
</tr>
<tr>
<td>Maximum temperature (°C)</td>
<td>25.4 (10.0)</td>
<td>25.8 (10.1)</td>
<td>22.6 (9.0)</td>
<td>22.0 (8.8)</td>
<td>19.3 (8.3)</td>
<td>17.4 (6.8)</td>
<td>16.1 (6.6)</td>
<td>15.0 (6.3)</td>
</tr>
<tr>
<td>Minimum temperature (°C)</td>
<td>16.1 (6.3)</td>
<td>16.9 (6.7)</td>
<td>13.8 (5.7)</td>
<td>12.8 (5.1)</td>
<td>10.6 (4.7)</td>
<td>8.6 (3.5)</td>
<td>8.4 (4.0)</td>
<td>6.6 (3.1)</td>
</tr>
<tr>
<td>Average temperature (°C)</td>
<td>20.1 (7.9)</td>
<td>20.5 (8.1)</td>
<td>17.7 (7.1)</td>
<td>16.7 (6.6)</td>
<td>14.4 (6.3)</td>
<td>12.5 (4.9)</td>
<td>11.9 (5.1)</td>
<td>10.2 (4.4)</td>
</tr>
<tr>
<td>Humidity (%)</td>
<td>67.4 (26.4)</td>
<td>71.4 (28.1)</td>
<td>68.2 (26.6)</td>
<td>67.2 (26.6)</td>
<td>72.1 (28.3)</td>
<td>71.6 (28.5)</td>
<td>74.6 (29.3)</td>
<td>72.2 (28.2)</td>
</tr>
<tr>
<td>Rain (mm)</td>
<td>2.6 (2.5)</td>
<td>3.7 (2.6)</td>
<td>1.1 (1.5)</td>
<td>3.1 (2.7)</td>
<td>2.1 (1.4)</td>
<td>0.6 (0.7)</td>
<td>3.2 (3.1)</td>
<td>1.9 (1.8)</td>
</tr>
</tbody>
</table>

**Figure 1** — Average counts per minute in each month of the year in adults from Brazil.
Figure 2 — Proportion of the day spent in different physical activity intensities in each month; Pelotas, Brazil.

Figure 3 — Proportion of the day spent in moderate and vigorous physical activity intensities in each month—zoomed image; Pelotas, Brazil.
Table 2 Spearman’s Correlation Coefficient Between Percentages of Daily Time Spent in Moderate-to-Vigorous Physical Activity and Climate Variables

<table>
<thead>
<tr>
<th></th>
<th>Spring</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum temperature (°C)</td>
<td>0.37</td>
<td>-0.64</td>
<td>0.33</td>
<td>-0.34</td>
</tr>
<tr>
<td>P</td>
<td>.163</td>
<td>.008</td>
<td>.202</td>
<td>.192</td>
</tr>
<tr>
<td>Minimum temperature (°C)</td>
<td>0.13</td>
<td>-0.62</td>
<td>0.31</td>
<td>-0.28</td>
</tr>
<tr>
<td>P</td>
<td>.638</td>
<td>.010</td>
<td>.239</td>
<td>.291</td>
</tr>
<tr>
<td>Average temperature (°C)</td>
<td>0.34</td>
<td>-0.64</td>
<td>0.31</td>
<td>-0.33</td>
</tr>
<tr>
<td>P</td>
<td>.192</td>
<td>.007</td>
<td>.239</td>
<td>.218</td>
</tr>
<tr>
<td>Humidity (%)</td>
<td>-0.35</td>
<td>-0.68</td>
<td>0.31</td>
<td>-0.06</td>
</tr>
<tr>
<td>P</td>
<td>.180</td>
<td>.004</td>
<td>.249</td>
<td>.840</td>
</tr>
<tr>
<td>Rain (mm)</td>
<td>-0.54</td>
<td>-0.67</td>
<td>-0.28</td>
<td>0.12</td>
</tr>
<tr>
<td>P</td>
<td>.030</td>
<td>.004</td>
<td>.30</td>
<td>.657</td>
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</table>

Our study measured physical activity monthly throughout a year. A strength of our protocol was the use of accelerometry rather than self-report. Our protocol also has limitations—the sample is not representative of the adult population in the city. The sample size is also small, limiting our statistical power to study other associations.

In conclusion, physical activity in adults was stable over the year. Some climate variables affected physical activity practice, particularly during the Summer. Extrapolation of our findings to other populations needs to take into account the climate patterns of each location. Measuring physical activity once during the year may be a good approximation of routine physical activity levels in adults.

References