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Comparing GPS, Log, Survey, and Accelerometry to Measure Physical Activity

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Abstract

Objectives—Both self-report and objective measures have strengths and limitations for studying physical activity (PA) and travel. We explored how objectively measured global positioning system (GPS) and accelerometer data matches with travel logs and questionnaires in predicting trip duration and PA.

Methods—In a study of PA and travel among residents in Atlanta, GA conducted in 2008–2009, 99 participants wore GPS devices and accelerometers, and recorded all trips in a log for 5 consecutive days. Participants also completed a self-administered questionnaire on PA and travel behaviors.

Results—There was good agreement between GPS and log for assessment of trip duration, although log measures overestimated trip duration (concordance correlation coefficient 0.53 [0.47, 0.59]; Bland-Altman estimate 0.76 [0.16, 3.71] comparing GPS to log). Log measures underestimated light PA and overestimated moderate PA compared to accelerometry when greater than zero moderate PA was reported.

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Human Subjects Statement

Informed consent was received from all participants, all procedures were approved by the Emory University Institutional Review Board and data analysis procedures were approved by the University of Pennsylvania Institutional Review Board.

Conflict of Interest Statement

All authors of this article declare they have no conflicts of interest

Conclusions—It is often not feasible to deploy accelerometry or GPS devices in population research because these devices are expensive and require technical expertise and data processing. Questionnaires and logs provide inexpensive tools to assess PA and travel with reasonable concordance with objective measures. However, they have shortcomings in evaluating the presence and amount of light and moderate PA. Future questionnaires and logs should be developed to evaluate sensitivity to light and moderate PA.

Keywords

Global positioning systems; accelerometry; travel logs; physical activity questionnaire; geographic information systems

INTRODUCTION

Over the past decade, researchers have attempted to measure physical activity (PA) and travel patterns related to characteristics of individuals and the contexts in which they live.[1–3] Self-report measures have been used extensively; more recently, accelerometry and global positioning systems (GPS) have emerged. GPS data allows for the accurate assessment of participant location and speed, while accelerometry provides information on the amount and intensity of PA. The value of these approaches for quantifying PA and travel depends on their accuracy;[4] however, few studies have evaluated both GPS and accelerometry in concert with self-reported questionnaire and travel log data on PA.

Numerous questionnaires have been developed to determine typical PA intensity and duration, and these have been studied considerably to determine their criterion, concurrent, and intermethod validity.[4,5] Questionnaires are commonly used in large studies[4] due to their low cost and convenience for both researcher and subject.[6,7] Validity studies, however, suggest that respondents may inaccurately recall intensity and duration of PA.[8] Participants tend to over-report moderate PA when compared to objectively measured activity.[5,9,10]

Diaries/logs overcome inaccuracies in respondent recall by asking participants to record, concurrent with or within a day of activity, the type, duration, and intensity of PA and travel. Logs capture more detailed and frequent behavior reports than questionnaires, although studies have shown that logs over-report higher intensity activities.[11]

With recent technological advances, researchers increasingly employ objective instruments to measure PA and travel. Accelerometry, using sophisticated electronics to detect accelerations in planes of motion, is widely deployed to measure volume and intensity of PA.[12] Concerns with accelerometry include respondent burden, non-compliance with wearing the device,[13] and limitations in measuring upper body movement, load carrying exertion, changes in slope,[14] and activities occurring in water, lifting weights, or on bicycles.[15] Further, accelerometers evaluate PA over a particular time period, but this measured activity may not be representative of the typical habits of individuals studied. Some researchers believe accelerometry may not accurately measure PA energy expenditures in free-living situations.[14]

GPS devices capture the location of activity and travel. By processing these data, researchers can infer the type of activity, speed, and even mode of travel. Researchers have suggested that GPS, when added to accelerometry or logs, can improve the classification of PA and travel mode,[16] location of activity,[17] and route of travel.[18] However, signal noise and location devices are worn on the body can affect accuracy.[19] Further, GPS does not provide data in underground locations and in "urban canyons" where tall buildings block satellite signals.[20,21]

Accelerometry and GPS approaches require data processing and analysis to determine type and intensity of PA, as well as speed and mode of travel. Therefore, the objectivity of these measures may be compromised by assumptions in data processing. For instance, Ham et al.[22] found that differences in cut-point assumptions for accelerometry yield large differences in summary measures of PA. Additionally, accelerometry and GPS are relatively expensive, due to the cost of equipment and requirements for data processing and interpretation protocols.[23]

The aims of this study are (1) to compare objective GPS and accelerometry data with self-reported log and questionnaire data; (2) to identify systematic differences by method in moderate/vigorous PA and travel/transport duration; and (3) to assess the strengths and limitations of each method of data collection.

METHODS

Study Population

This analysis was conducted as part of the Atlantic Station Health Study (ASHS), a study of PA and travel among residents living in a development in Atlanta, Georgia.[24,25] Between February 2008 and January 2009, a convenience sample of 99 residents participated in the cross-sectional study of PA and travel. Full information on study eligibility criteria is available in Mumford et al.[25] During recruitment, staff reached 428 people by phone and screened 322 for eligibility. Of those screened, 117 (36.3%) were eligible to participate. Eighteen refused or withdrew, bringing the number of participants to 99 (84.6% of eligible). Informed consent was received from all participants, all procedures were approved by the Emory University Institutional Review Board and data analysis procedures were approved by the University of Pennsylvania Institutional Review Board.

Data Sources

Four self-report and objective data collection methods were used to measure travel and PA: questionnaire, travel/activity log, accelerometry, and GPS. Staff met and instructed participants to wear accelerometers and GPS devices and record all trips in the log for 5 consecutive days, including 2 weekend days and 3 weekdays. After data were successfully downloaded, participants received a $40 gift card.

Questionnaire—Participants completed a self-administered questionnaire on neighborhood preferences, attitudes, perceptions, PA, travel behaviors, health status, and demographics.[24,25] Questionnaire questions came from validated instruments such as the International Physical Activity Questionnaires (IPAQ).

Travel/Activity log—A combined travel/activity log was developed for this study, based on sun exposure/protection logs developed in previous research.[26] The log is place-based rather than trip or time-based, with participants reporting their travel/activity based on movement to another location rather than recording trips or documenting hourly activities. Participants recorded departure and arrival times, and mode of travel for each trip. A "trip" was defined as "any time a participant moved from one address to another," such as going from home to school. At each destination, participants recorded activities (eg, sleep, eat, work) and the type and duration of PA performed at each place. The log was designed so that information would be completed by selecting options from lists rather than responding to open-ended questions.

Accelerometry—The GT1M ActiGraph accelerometer was used to measure the amount and intensity of PA. The device captured activity intensity counts and step counts in one-minute epochs. Participants were instructed to wear the accelerometer around the waist at all times except when bathing, swimming, or sleeping.

GPS Data Loggers—The GlobalSat DG-100 was used to capture participants' location and speed at 3-second intervals. This device has been shown to be accurate within about 7.95 meters.[27] The device is the size of a mobile phone and was clipped on a waistband or carried in a purse or backpack. Participants carried the device whenever they traveled or moved outdoors.

Measures

PA measures included duration, intensity, location, and type of activity. Travel measures included number of trips, trip duration, trip distance, mode of travel, and destination or purpose of trips. The measures employed were:

Log PA Duration—The reported activity from the logs was assigned a metabolic equivalent (MET) value from the compendium of physical activities.[28] Log PA was computed as the sum of total daily minutes (including during travel) the participant engaged in each of a group of physical activities classified as light (<3 METs), moderate (3–6 METs), or vigorous (>6 METs) (summed as minutes of each activity per day per person).

Log Travel—Number of minutes the participant recorded for each trip (minutes per trip per person).

Log for Leisure and Transportation—Computed as logged number of minutes across moderate activities and vigorous activities for travel (based on mode) and for leisure (minutes per week).

Accelerometer PA duration—Light, moderate, and vigorous PA were computed as the sum of daily minutes in each activity within a group of physical activities classified as light, moderate, or vigorous (minutes per day per person).

GPS Travel—Number of minutes recorded for each trip taken (minutes per trip per person).

Questionnaire—Activity measures were summed based on responses to questions on normal minutes of walking or biking for transportation or leisure (minutes per week).

Data Processing

Following this process, GeoStats' Trip Identification and Analysis System (TIAS) was used to parse the GPS point data into individual trips.[29] Points falling outside the time of data collection were discarded, and trip destinations were determined based on stop times (for this study, stop times of 120 seconds or more were flagged as potential trip destinations). The GPS trip data were visually reviewed to screen out traffic delays, remove falsely identified stops, and to add stops that had dwell times of less than 120 seconds but exhibited clear stop characteristics.

If routine addresses visited by participants were provided (eg, home, work, or school), these addresses were geocoded and used to assist in the trip identification/confirmation process. Travel modes for each trip segment were assigned using a combination of the automated mode assignment algorithm of the TIAS program and analyst adjustments. The algorithm for mode assignment was based on the average and maximum speeds and speed variability recorded by GPS units. Assigned travel modes included walk, run, bike, vehicle and train.[29]

PA intensity from accelerometry was categorized based on National Health and Nutrition Examination Survey (NHANES) cut points of light (<2019 activity counts/minute), moderate (2020–5,998 activity counts/minute), and vigorous (>5,999 activity counts/minute).[30] Bouts of moderate or vigorous activity were recorded if they lasted for at least 10 consecutive minutes. Bouts of inactivity were recorded if there were ≥60 consecutive minutes with a PA level of zero. For the bout calculations, a 2-minute gap outside of the threshold was allowed.

Statistical Analysis

Univariate statistics were calculated for trip data (GPS and log) and PA data (log, questionnaire, and accelerometer). Differences between values were calculated for trips (GPS v log stratified by total, weekday, and weekend) and PA (accelerometer v log stratified by total, weekday, and weekend and by light, moderate, and vigorous PA). Comparisons were drawn for the 2 subjective measures (log v questionnaire stratified by moderate and vigorous and by leisure and transportation PA). To evaluate the agreement between measures, repeated measures concordance correlation coefficients (CCCs), which accounted for correlation of repeated measures within a participant, were calculated using the SAS macro as described in Carrasco et al.[31] Bland and Altman 95% limits of agreement were also calculated.[32] The distribution of trip and PA data were skewed, therefore all values (except the "Normal week duration" measures") were log-transformed to maintain the assumptions of normal distribution and constant variance needed for the calculation of concordance correlation estimates and limits of agreement. Agreement limits were back transformed and presented as limits of agreement for the ratio (not the difference) between 2 methods such that a ratio of 1 suggested 2 methods agree. Statistical analysis was performed using SAS (version 9.4) and Stata (version 13).

RESULTS

Participant characteristics, basic PA measures, and transportation modes from questionnaire data are presented in Table 1. Most participants were female (67%), over 34 years old (64%), earned above $60,000 annually (75%), and had completed college (77%). There were 1,155 person-trips with both GPS and log information. Log trip duration was missing for 4 person-trips and was set as zero for 12 person-trips, leaving a total of 1,139 trips for analysis.

Log and GPS

Across all days combined, weekdays only, and weekends only, trip duration was consistently higher for logs compared to GPS (Table 2). For all days combined, GPS trips had a median duration of 10.9 minutes while log trips had a median duration of 15.0 minutes. Sixty-seven percent of GPS trips were shorter than log trips; however, 81% of trips differed by less than 10 minutes. CCCs were 0.53 (95% Confidence Interval (CI) 0.47–0.59) and Bland and Altman estimates were 0.76 (95% CI 0.16, 3.71), indicating moderate statistically significant agreement between the 2 measures. Values were similar for weekday- and weekend-specific estimates; however agreement was higher for weekend values.

Log and Accelerometer

PA duration comparing accelerometry and log is shown in Table 3. For total days, log estimates of light PA were lower than accelerometer estimates (median absolute difference of 311 minutes) and there was no statistically significant relationship between the measures. For light PA, 10% of days showed <5 minutes of difference between the measures and correlations showed very poor agreement. For moderate PA, log and accelerometer measures had better agreement, with poor but statistically significant correlation between the measures. Logs showed 75% of days with no moderate activity, while accelerometer data showed 15% of days with no moderate activity. Of the 121 days when participants recorded some moderate PA on their log, 84% of days had higher log accelerometer measures of moderate PA (data not shown). Both measures indicated that participants did not engage in vigorous activity on most days. There was less than 5 minutes of difference on 85% of days and a moderate concordance correlation coefficient and a Bland-Altman estimate close to one but with a wide confidence interval. Log entries overestimated PA duration on 11% of the days; while accelerometry overestimated log measures on 8% of days. These PA patterns were consistent for weekday and weekend measures.

Log and Questionnaire

Table 4 shows comparisons between weekly PA using 2 subjective measures: log and questionnaire. PA was divided into moderate and vigorous and additionally by leisure and transportation activities. For moderate PA, participants reported higher levels of both leisure and transportation PA in the questionnaire. Leisure PA showed better agreement compared to transportation; however, 36% of days had <5 minutes of difference for transportation moderate PA compared to 28% for leisure. For vigorous PA, log measures of leisure activity were low with a mean of 39.2 minutes per week and 67% of participants recorded no leisure vigorous PA. Although the absolute difference between log and questionnaire measures was not great, the correlation between measures was poor and 94% of weeks had ≥5 minutes of difference between the 2 measures. For vigorous transportation PA, both measures were relatively low, with 94% of questionnaires and 97% of log weeks recording no vigorous transportation PA. The 2 measures showed moderately good agreement and 94% of weeks had <5 minutes difference between the measures.

DISCUSSION

This study examined the concordance of GPS and accelerometry data with self-reported log and questionnaire data to identify systematic differences in measured PA type and travel duration. Findings indicated that there was good agreement between GPS and log with respect to trip duration, although GPS measures tended to underestimate trip duration. Compared to accelerometry, log measures greatly underestimated light PA and overestimated moderate PA when moderate PA was recorded. Agreement was moderate between accelerometer and log measures for vigorous PA, although levels were low among participants in this study. Comparing log and questionnaires, correlations were modest for moderate PA, but vigorous leisure PA was overestimated in the questionnaire compared to log. Vigorous transportation PA levels were in agreement for the 2 subjective measures, but participants were unlikely to report this type of PA on either measure.

While GPS trip durations were consistently underestimated compared to log data, the magnitude of these differences was not great. This indicates that objective GPS data are a valid measure of trip duration when compared to recently-recalled log data. Log measures underestimated light PA minutes compared to accelerometry, likely because light PA was not consistently reported. Before concluding the methodologies are completely inconsistent, it is possible that the log could be altered to specifically ask about light PA activities. Accelerometry and log measures were in better agreement for moderate PA with log-reported levels slightly below accelerometer levels. However, when participants recorded any moderate activity on their log, they were likely to overestimate activity when compared to accelerometry. This demonstrates that participants were able to identify whether they conducted moderate PA, but overestimated the amount they engaged in. Participants recorded low levels of vigorous PA in this sample, but those levels were consistent across log and accelerometry. The 2 self-reported methods held acceptable agreement overall, although participants tended to over report vigorous PA on the questionnaire compared to log for leisure PA.

Findings in the Context of Relevant Literature

Parallel to these findings, other studies have shown that participants consistently over report vigorous PA and under report moderate or light PA when compared to objective data. Lee et al.[33] conducted a systematic review of validation studies and found that, across the 14 studies that compared accelerometry to IPAQ, correlation coefficients for total PA ranged from 0.09 to 0.39. Walking and vigorous activity strongly correlated with IPAQ scores compared to moderate activity. Dyrstad et al.[34] asked 1,751 adults to wear accelerometers for one week and to complete the IPAQ. Correlations between the measures varied between

0.20–0.46, and the authors concluded that participants self-report more vigorous PA and less sedentary time when compared to accelerometer measures.

Few studies have been able to estimate the agreement between GPS, accelerometry, and travel logs. Rodriguez et al. recorded travel data on 42 adolescent girls and found moderate to substantial agreement between GPS/accelerometry and self-reported daily (Kappa = 0.33–0.48) and weekly (Kappa = 0.41–0.64) walking trips.[35] No data were presented for trip duration. Kang et al. classified accelerometer data as walking or nonwalking using GPS or travel logs.[36] Consistent with our results, they observed that their GPS-based algorithm predicted 25.4 minutes of walking trips per person per day, while the travel diary predicted 21.6 minutes per person per day.

Low agreement and potential reporting biases for certain types of PA are not arguments against self-reported PA measures. Conversely, several studies have examined combinations of objective and subjective measures to create algorithms to more accurately assess PA. Iglesträm et al.[37] examined agreement between accelerometry and IPAQ among 39 individuals. They found the methods could be used interchangeably and that a combination of accelerometry and log provided a good description of PA. In a recent review of 24 studies using GPS to study PA, 17 studies had missing GPS data up to 92% of the time the device was worn, and therefore could not be used.[38] The authors emphasized that by combining self-reported data with accelerometer and GPS data, walking behavior could be evaluated despite the missing data.

Limitations and Strengths

This study had a number of limitations and strengths. This study was conducted with a convenience sample, and therefore generalizability of results is limited. The validity of comparisons is also a question. As previously stated, objective measures are not completely objective, as cut-points and other data processing decisions can impact findings. Additionally, questionnaire and log questions may assess different time periods. The specific demographics of the sample (eg, sex, education, or weight[15]), geography, season, or other factors may impact the generalizability of findings. Finally, low levels of vigorous PA in this sample limit the interpretation of findings for this specific activity. The strengths of this study include the use of multiple state-of-the art measures, high participation rates, and multiple days of measurements per participant.

Conclusions

In large population-based studies, it is often unfeasible and cost-prohibitive to deploy sophisticated accelerometry or GPS devices. Additionally, these devices require technical expertise and data processing to obtain consistent results. Questionnaires and logs provide inexpensive and easily implemented tools to assess PA; however, they have shortcomings in their sensitivity to capture whether light or moderate PA has occurred and quantifying levels of those types of PA. In light of these weaknesses, future questionnaires and logs should be developed and validated to evaluate sensitivity to light and moderate PA.

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Table 1

Participant Characteristics, Basic Physical Activity Measures, and Transportation Modes from Questionnaire Data (N =101)[a]

	Number (%) or Mean (SD)
Sex	
Women	68 (67%)
Aged over 34 years	65 (64%)
Race	
White	48 (47%)
Black	33 (33%)
Other	20 (20%)
Have Children	
Yes	8 (8%)
Income	
Above $60,000	76 (75%)
College/some graduate education	
Yes	78 (77%)
Walking for transportation	
Yes	84 (83%)
Days/week	4.5 (4.5)
Minutes/week	85.5 (140.5)
Walking for recreation	
Yes	54 (53%)
Days/week for walkers	3.0 (4.6)
Minutes/week for walkers	105.9 (204.0)
Moderate physical activity	
Yes	25 (25%)
Days/week for those with moderate PA	0.6 (1.2)
Minutes/week for those with moderate PA	34.5 (84.5)
Vigorous physical activity	
Yes	56 (55%)
Days/week for those with vigorous PA	1.9 (2.0)
Minutes/week for those with vigorous PA	109.1 (161.3)
Automobile travel	
Yes	88 (87%)
Days/week for those with automobile travel	4.7 (2.7)
Minutes/week for those with automobile travel	327.6 (435.0)

[a]Two participants did not wear GPS and accelerometer; subsequent analyses are completed on N =99

Table 2

Comparison of Trip Duration (in Minutes) from Log and GPS

	N (trips)	Mean±SD	Median	Min, Max	N (%) trips GPS<Log	N (%) trips <10 min difference	Concordance index [95% CI] (Natural log scale)[a]	Bland&Altman [95% Limits of agreement][b]
Total								
GPS	1139	13.9 ± 11.0	10.9	0.1, 90				
Log	1139	18.3 ± 20.2	15.0	0, 359				
Abs. Diff.	1139	7.5 ± 17.5	4.1	0, 358.4	773 (67%)	931 (81%)	0.53 [0.47, 0.59]	0.76 [0.16, 3.71]
Weekday								
GPS	742	13.8 ± 10.9	11.1	0.1, 76.9				
Log	742	18.5 ± 22.0	15.0	0, 359				
Abs. Diff.	742	8.0 ± 20.1	4.0	0, 358.4	505 (68%)	590 (80%)	0.50 [0.43, 0.55]	0.74 [0.14, 4.08]
Weekend								
GPS	409	14.1 ± 11.2	10.7	0.6, 90				
Log	409	17.9 ± 16.6	15.0	0, 165				
Abs. Diff.	409	6.6 ± 11.4	4.2	0.1,139.9	268 (66%)	341 (83%)	0.63 [0.56, 0.69]	0.79 [0.21, 3.04]

[a] Log of Zeros not defined, therefore zero minutes were included as zeros.

[b] Limits of agreement for the ratio after log values were back transformed.

Abs. Diff.=Absolute difference.

Table 3

Comparison of Physical Activity Duration (in Minutes) from Log and Accelerometer

Physical Activity	N (days)	Mean±SD	Median	Min, Max	N (%) days with zero	N (%) days Accel<Log	N (%)days <5 minute diff.	Concordance index [95% CI] (Natural log scale)	Bland&Altman [95% Limits of agreement][a]
Total									
Light									
Accel	470	299.7 ± 164.3	314	0, 595	45 (10%)				
Log	486	2.4 ± 21.0	0	0, 360	470 (97%)				
Abs. Diff.	461	297.0 ± 162.7	311	0, 595	44 (10%)	2 (0.4%)	47 (10%)	0.005 [−0.012, 0.023]	144.03 [3.44, 6029.40]
Moderate									
Accel	495	18.7 ± 24.6	12	0, 220	72 (15%)				
Log	486	16.4 ± 39.4	0	0, 360	365 (75%)				
Abs. Diff.	486	21.6 ± 31.9	12.5	0, 360	61 (13%)	102 (21%)	119 (24%)	0.150 [0.065, 0.233]	3.39 [0.07, 155.69]
Vigorous									
Accel	495	2.2 ± 8.0	0	0, 52	430 (87%)				
Log	486	5.8 ± 19.3	0	0, 135	433 (89%)				
Abs. Diff.	486	5.6 ± 17.7	0	0, 133	395 (81%)	52 (11%)	414 (85%)	0.401 [0.312, 0.483]	0.88 [0.09, 8.37]
Weekday									
Light									
Accel	287	312.2 ± 156.4	321	0, 586	25 (9%)				
Log	307	2.0 ± 13.2	0	0, 150	295 (96%)				
Abs. Diff.	287	310.5 ± 155.9	321	0, 586	25(9%)	1 (0.4)	25 (9%)	0.005 [−0.013, 0.022]	161.42 [4.63, 5626.77]
Moderate									
Accel	307	19.4 ± 22.7	14	0, 165	37 (12%)				
Log	307	14.5 ± 34.9	0	0, 280	236 (77%)				
Abs. Diff.	307	21.4 ± 27.8	14	0, 276	33 (11%)	60 (20%)	69 (22%)	0.132 [0.037, 0.225]	4.12 [0.10, 175.09]
Vigorous									
Accel	307	2.3 ± 8.2	0	0, 52	267 (87%)				
Log	307	5.3 ± 17.9	0	0, 135	275 (90%)				
Abs. Diff.	307	5.0 ± 16.1	0	0, 133	252 (82%)	31 (10%)	263 (86%)	0.446 [0.334, 0.546]	0.91 [0.11, 7.60]

Physical Activity	N (days)	Mean±SD	Median	Min, Max	N (%) days with zero	N (%) days Accel<Log	N (%)days <5 minute diff.	Concordance index [95% CI] (Natural log scale)	Bland&Altman [95% Limits of agreement][a]
Weekend									
Light									
Accel	174	276.7 ± 172.8	280	0, 595	19 (11%)				
Log	179	3.2 ± 30.1	0	0, 360	175 (98%)				
Abs. Diff.	174	275.2 ± 171.6	276.5	0, 595	19 (11%)	1 (0.6%)	22 (13%)	0.004 [−0.021, 0.028]	120.42 [2.20, 6594.31]
Moderate									
Accel	179	16.7 ± 27.2	8	0, 220	33 (18%)				
Log	179	19.7 ± 45.9	0	0, 360	129 (72%)				
Abs. Diff.	179	22.2 ± 37.9	11	0, 360	28 (16%)	42 (23%)	50 (28%)	0.211 [0.084, 0.332]	2.43 [0.05, 118.29]
Vigorous									
Accel	179	2.2 ± 7.8	0	0, 47	154 (86%)				
Log	179	6.8 ± 21.5	0	0, 120	158 (88%)				
Abs. Diff.	179	6.7 ± 20.1	0	0, 120	143 (80%)	21 (12%)	151(84%)	0.327 [0.180, 0.459]	0.83 [0.07, 9.77]

[a]Limits of agreement for the ratio after log values were back transformed.

Abs. Diff.=Absolute difference.

Table 4

Comparison of Weekly Physical Activity for Leisure and Transportation from Log and Questionnaire

Physical Activity	N (participants)	Mean±SD	Median	Min, Max	N (%) Persons with zero for the minutes per "normal week"	N (%) Persons with "normal week minutes days Questionnaire<Log	N (%) Persons with <5 minute weekly difference	Concordance index [95% CI]	Bland&Altman [95% Limits of agreement][a]
Moderate									
Leisure									
Log	99	113.2 ± 177.0	51.7	0, 1243	43 (43%)				
Questionnaire	99	172.3 ± 308.4	82.5	0, 2520	32 (34%)				
Abs. Diff.	99	128.7 ± 206.1	45.0	0, 1277	25 (26%)	25 (26%)	27 (28%)	0.540 [0.434, 0.654]	1.17 [0.24, 5.58]
Transportation									
Log	99	96.9 ± 119.3	60.4	0, 583	21 (21%)				
Questionnaire	99	104.9 ± 153.0	60	0, 1200	12 (12%)				
Abs. Diff.	99	99.9 ± 152.9	57.8	0, 1200	4 (4%)	11 (11%)	35 (36%)	0.459 [0.350, 0.568]	0.94 [0.08, 11.51]
Vigorous									
Leisure									
Log	99	39.2 ± 78.7	0	0, 350	66 (67%)				
Questionnaire	99	105.9 ± 146.1	60	0, 750	41 (42%)				
Abs. Diff.	99	82.9 ± 101.8	45.0	0, 470	35(36%)	46 (47%)	6 (6%)	0.113 [−0.078, 0.304]	2.12 [0.44, 10.24]
Transportation									
Log	99	4.3 ± 32.0	0	0, 307	95 (97%)				
Questionnaire	99	8.0 ± 35.4	0	0, 240	92 (94%)				
Abs. Diff.	99	6.6 ± 29.8	0.0	0, 200	92 (94%)	2 (2%)	92 (94%)	0.593 [0.465, 0.721]	1.41 [0.12, 16.76]

[a] Limits of agreement for the ratio after log values were back transformed.

Abs. Diff.=Absolute difference