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## Application of the GPS technology to assess time-location pattern of undergraduate students at a private medical university in Karachi, Pakistan: A pilot study

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### Abstract

To compare time-location pattern of undergraduate university students through GPS and diary method, and with level of physical activity, a cross-sectional survey was conducted from September 2012 - May 2013 involving 50 undergraduate students from Aga Khan University. Data were recorded through GPS, diary method, International Physical Activity Questionnaire (IPAQ-L) and accelerometer (ActiGraph). Median self-reported time spent in the indoor-inside the campus, indoor-outside the campus and outdoor environment was 405 (IQR:300-540), 720 (IQR:465-840) and 300 minutes (IQR:180-495) respectively, while 52% of the students were in moderate, 40% vigorous and 8% in mild categories of physical activity. Mean differences in location (GPS versus diary method) were statistically insignificant; indoor residential, -30.2, indoor other, -26.2, outdoor at rest, 45.9 and outdoor travelling, 10.5 minutes. We conclude that students spent most of their time indoors-outside of campus and majority were physically active, while also demonstrating the applicability of GPS and ActiGraph for such studies.

**Keywords:** Time-location pattern; GPS; Physical activity; Undergraduate students; Pakistan.

### Introduction

Time-location data have been collected in many human activity surveys and human exposure studies<sup>1</sup> while conventional time-location analysis relies on interviews or diaries.<sup>2</sup> However, these methods have many limitations whereas studies have demonstrated Global Positioning system (GPS) tracking time-location data to be far more accurate.<sup>3</sup> One of the most significant influences on young people's physical activity is the amount of time

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spent outdoors, which correlates with the physical activity.<sup>3</sup> The use of accelerometers to measure physical activity has been increasing during recent years<sup>4</sup> because of more accurate measurements.<sup>5</sup> Several studies have used accelerometer to assess the level of physical activity and it has been validated with the International Physical Activity Questionnaires (IPAQ).<sup>4,6</sup>

The aim of this study was to compare the time-location pattern of undergraduate university students through GPS and diary method; and to compare the time-location pattern with level of physical activity.

### Methods and Results

This pilot study that included was a cross sectional survey conducted from September 2012 to May 2013 at the Aga Khan University, Karachi,<sup>7</sup> Pakistan. We selected 25 undergraduate students (not residing in hostels) each from MBBS and BScN programmes at AKU. The IPAQ - long form (IPAQ-L) was used to record the physical activity level.<sup>6</sup> We also enquired about socio-demographic information and provided time activity record form to each participant. Study participants were expected to carry a GPS receiver (ASEN GPS 742)<sup>8</sup> with

**Table-1:** Time activity location patterns among undergraduate students in Karachi, Pakistan (n=48).

| Characteristics                      | Percentage (%) of time in 24 hours |
|--------------------------------------|------------------------------------|
| <b>Location (GPS)*</b>               |                                    |
| Indoor                               | 22.3%                              |
| Outdoor                              | 77.7%                              |
| <b>Indoor<sup>1</sup></b>            |                                    |
| Residential indoor                   | 15.04%                             |
| Other indoor                         | 84.9%                              |
| <b>Outdoor<sup>2*</sup></b>          |                                    |
| Outdoor transit (speed <2m/s)        | 74.4%                              |
| Outdoor walking / rest (speed ≥2m/s) | 13.6%                              |

1. Indoor= < 9SAT,

2. Outdoor > 9SAT, \*Missing data: 5.6%

3. Residential indoor = <40m distance

4. Other indoor= ? 40 m distance

\* Missing data: 12% due to misclassification.

**Table-2:** Comparison of the time-location pattern of undergraduate university students through global positioning system (GPS) receivers and diary method (n=48).

| Characteristics    | Mean difference (minutes) | 95%CI        | p-value |
|--------------------|---------------------------|--------------|---------|
| Indoor residential | -30.20                    | -130.5, 70.1 | 0.54    |
| Indoor other       | -26.25                    | -138.5, 86.0 | 0.64    |
| Outdoor at rest    | 45.92                     | -3.3, 95.1   | 0.06    |
| Outdoor travelling | 10.5                      | -38.0, 60.5  | 0.66    |

Indoor Diary method = time in minutes at residential and other indoor.

Outdoor Diary method time in minutes at transit and travel outdoor.

them for 24 hours continuously. The GPS data were classified into four microenvironments (residential indoors, other indoors, transit, and walking outdoors); the selection criteria included used number of satellites (used-NSAT), speed, and distance from residence.

Physical activity was measured every 10 seconds using the ActiGraph GT3X5. Level of physical activities in bouts/mins (minutes) were classified into sedentary [0 to 100], light [101 to 760], lifestyle [761 to 1951], moderate [1952 to 5724] vigorous [5725 to 9498], and very vigorous [9499 and higher].<sup>5</sup> Both the GPS and accelerometer data were collapsed to provide minute by minute data. All GPS data were combined into a single set and imported into ArcGIS 9.2 (ESRI, California).

Data were entered into Epidata 3.1 and statistical analyses were conducted using the SPSS statistical software package version 19 (SPSS Inc., Chicago, IL, USA), P values <0.05 were considered significant.

Approval was taken from the ethics review committee of Aga Khan University, Karachi. This was originally planned as a multi-country study involving 8 countries; however, due to various challenges at other centers, the study could only be completed at the Pakistan center.

Results show that the mean age of the study participants was  $20.7 \pm 1.41$  years and 24 (48%) were males and 26 (52%) females while approximately 5 (10%) were current smokers. Most of the participants had normal BMI 45 (90%) while 5 (10%) were overweight. Total physical activity level (MET/minutes/week) determined through IPAQ-L found: 26 (52%) of the students performed moderate activity, while 20 (40%) performed vigorous activity and 4 (8%) performed mild activity. The 24-hour record of physical activity through ActiGraph (counts/minutes) categorized most of the students as performing vigorous activity 39 (83%) while 8 (17%) of the students performed moderate activity.

In 24 hours, 22.3% of the time of the students was spent indoor while 77% was spent outdoor. This was calculated by adding the total number of minutes spent by all the

students indoors divided by the total number of minutes in 24 hours contributed by all students (Table-1). The diary method found that students spent most of their time sleeping (465.9 minutes). No statistically significant differences were found when we compared the time location pattern among students using GPS and diary method (Table-2). The diary method tended to overestimate time spent indoors and underestimate the time spent outdoors.

## Discussion and Conclusion

The GPS findings show that, participants spent most of the time outdoor. However, comparison between levels of physical activity and time location pattern through GPS indicates no difference among level of physical activity with indoor and outdoor categories, which is not consistent with some other studies which found that physical activity was 2-3-fold higher outdoors than indoors.<sup>3</sup> Current literature suggests that the use of GPS can be augmented with the accelerometer for measurement of time location pattern and level of physical activity.<sup>8,9</sup> A possible explanation of a lack of difference could be the fact that time spent indoors may also include sports and other activities at the gym; while time spent outdoors mostly covers time while commuting.<sup>9</sup> Furthermore, our results indicate that men spend more time outdoors as compared to women with time location pattern and level of physical activity; however, the differences were not statistically significant. Other studies have reported that increase in leisure time physical activity is most obvious in males as compared to females (n=549).<sup>10</sup>

We found that results of time location through GPS were comparable to those reported in the travel diary which is consistent with a study from Korea.<sup>8</sup> A study (n=31) comparing diary method (reported by parents) and GPS tracking to illustrate time-location pattern among children found that, diary method underestimated the time children spent at home by around 17%.<sup>3</sup> Our study provides evidence that time-activity pattern determined through GPS were comparable to the diary method in each of the four microenvironments. A similar pattern was

observed in the Korean study.<sup>8</sup>

This is amongst few studies in South Asia to compare time location pattern through GPS with diary method and level of physical activity through ActiGraph devices among students. Validated tools were used and there was good participant compliance. There were few limitations of this study; first, this study included a small sample size which limits generalizability. However, we believe that this study was primarily meant to be a pilot study, trying to determine feasibility of GPS for tracking time-location patterns in the South Asian context, and in that scope the sample size was adequate. Furthermore, one 24-hour reading for each student may be heavily influenced by the day of the week; number of classes/no classes on the day of study; time of year i. e. winter, versus summer; proximity of exams/assignments influencing students' physical movement/activity pattern, etc. The study was conducted in Karachi where there are many high-rise buildings therefore, the loss of data due to blocking of the GPS satellite signals was frequent. It is common for GPS signals to be somewhat unreliable when indoors, so there could have been misclassification. We provided two separate devices, GPS and accelerometer, to each participant which may have led to inconvenience; however, all our participants reported appropriate compliance.

In conclusion, this study determined that undergraduate university students spend most of their time indoors-outside of campus and majority were physically active. The interaction of a person with the environment and level of physical activity may best be explored by using GPS and ActiGraph tools.

### Acknowledgement

We are thankful to Dr. Imran Nisar for his guidance and provision of accelerometer for this research work; and the registrar's office at AKU for access to students.

**Disclaimer:** Findings from this study have also been presented in the '18th Annual Postgraduate Medical Education (PGME) Conference', held at the Aga Khan University, Karachi, Pakistan, in 2013.

**Funding:** None.

**Competing Interest:** The authors declare that they have no conflict of interest.

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