



School of Public Health,  
Dow University of Health  
Sciences

## Pedometer determined Physical Activity levels and Reliability of Pedometer data in Pakistani Adolescents

Shagufta Naseer

### Abstract

**Background:** Pedometer is the most convenient and economical objective tool which is progressively being used to assess physical activity in adolescents. The purpose of this study was to describe the overall and gender stratified physical activity levels and to determine minimal no. of reliable days for collecting pedometer data among Pakistani adolescents.

**Methods:** Descriptive cross-sectional study was conducted in four schools of Karachi during 2017. A total of 265 adolescents (age 13-16 years) wore unsealed Ymax Digi Walker SW-200 pedometer for a duration of 7 days including both weekends and weekdays. Data were analyzed using SPSS version 21. Independent t test and ANOVA were used for gender based stratified physical activity levels whereas, Cronbach's alpha and Intra class correlation coefficient (ICC) were used to ascertain the reliability of pedometer data.

**Results:** The average recorded step counts per day were 10,010 (SD:  $\pm$  4926). However, boys took 12,513 (SD:  $\pm$  5365) steps / day than girls 7,809 (SD:  $\pm$  3168) and higher steps were recorded from Thursday to Saturday. The reliability of pedometer monitoring increases with increase in number of days. The maximum pedometer reliability  $\alpha = 0.91$  was observed for 7 days.

**Conclusion:** This study concludes that adolescents are more physical active, with slightly higher reported activity among boys compared to girls. It also proposes that at least 7 days pedometer data should be collected for the reliable estimation of adolescent's physical activity. The resulting data provides key information regarding pedometer-determined physical activity which may be useful for formulating strategies and other interventions to increase level of adolescents physical activity

**Keywords:** Physical activity, adolescent, pedometer, Pakistan

### Introduction

The emerging public health issue among adolescence population is Physical inactivity (1). Physical Activity (PA) is the body movement which is produced by skeletal muscle on expenditure of energy (2, 3). It is evident that PA

during childhood and adolescence plays an important role in maximizing growth and development (4). This phase is considered as the most critical phase of skeletal mineralization (5). In children of growing age, increase in daily PA results in increased bone mineral

accrual and reduces the risk of fractures in later life (5). Those who are physically inactive may have elevated risk for chronic ailments such as cardiovascular diseases (CVD), particularly ischemic heart disease (6, 7), hypertension (8), hyperlipidemia (8), diabetes (9), atherosclerosis (8), osteoporosis (10) and obesity (11).

Moreover, obesity during childhood and adolescence may precede hyperinsulinemia and type II diabetes which can be prevented by increasing overall vigorous activities (8). In adolescents and older adults, PA is also beneficial in reducing anxiety and depression (12). PA is positively associated with self-esteem and academic performance in adolescents (13). On assessing the relationship between PA levels of parents and their young children, it was reported that children of active parents were found five times more active than children of inactive parents (14). During childhood, the social support from the friends aid in the early development of healthy habits of PA, which can also be observed throughout life (15). Additionally, lack of PA was one of the contributing factor of hypovitaminosis D among the young adults of Pakistan (16). In contemporary to this, it was noticed that online social networking might also hinder with the PA of students (17).

It is apparent that adolescents are more active than adults (18). Hence, it is difficult to measure their patterns of physical activity. Several studies had reported level of PA among adolescents by using self-reported questionnaires (19-23). The limitation observed in the use of self-reporting subjective assessment tools is recall bias for the frequency, duration and intensity of PA and misunderstanding of questions by the respondent (24-26).

Pedometer is an electronic device which measures vertical body movements as no. of steps taken. Due to its low cost and unobtrusiveness, it is considered as ideal tool for the assessment of PA in a large sample. Recently, the use of pedometers has been increased in assessment of daily physical activity (27-29). Pedometers are simple, small, cost effective, unobtrusive electronic devices which can be worn around waist (1, 18, 30). It measures steps counts in account of vertical body movement and expressed as steps/day. The reason which make pedometer superior over other objective assessment tools (i.e. accelerometer, indirect calorimetry, doubly labeled water) is its cost effectiveness, easy monitoring via visible display of step counts and self - interpretability.

Since the use of pedometer has been rapidly increasing, Tudor - Locke et al had conducted various studies in which the referenced cut off criteria for healthy children, adolescents and adult were established (31-33). Based on the cut off recommendation used in former studies, 10,000 steps has been considered as a guide for the assessment of adolescent PA (34).

The aim of this study was to assess the overall and gender stratified physical activity levels among Pakistani adolescents (Age: 13 to 16 years, Grade 7 to 10) and to establish preliminary standards for comparison in determining appropriate physical activity levels of adolescents based on pedometer counts. Secondly, to determine the minimal number of reliable days for collecting pedometer data among Pakistani adolescents.

## Methodology

The study was conducted in 4 schools of Karachi after taken the approval from Institutional Review Board of Dow University of Health Sciences (Ref: IRB-680/DUHS/Approval/2016/170) and School administrations. In each school (A, B, C, D) the total number of students who met inclusion criteria of this study were 265, 318, 289 and 225 respectively. Informed consent was sent to the parents or guardians and after their permission, 66 participants were recruited randomly from each school. The sample consisted of 265 students ranging in age from 13 to 16 years.

Ymax Digi Walker SW-200 pedometer was used throughout this study because of its slim body, higher accuracy and reliability as reported in the previous studies (18, 35-39). Prior to the conduct of this study, the functionality and reliability of each pedometer was checked by performing a step count test. All of them pedometers were found to be within 5% accuracy. The referenced cut-off criteria for pedometer step counts were used in this study (40). Adolescents who achieved <10,000 steps on all days of the week were considered physically inactive, those who achieved 10,000 steps on at least half of the days of the were moderately physical active and those who achieved 10,000 steps on all days of the week were physical active

Data were collected during the spring season between February to April 2017. Each week, participants from two to three classes were recruited in order to manage the process of data collection. The Ymax Digi Walker

SW-200 pedometers were given for a period of 7 days including both weekdays and weekend. The pedometer data collection cycle lasted a week from Monday to Monday. The first period was selected for data collection in order to record the whole day activities. Unsealed pedometer was used during this study, as no significant difference in reactivity between sealed and unsealed pedometers were noted in previous studies (34, 36, 41, 42).

At the time of recruitment, the participants were instructed to wear it on the waist belt, parallel to the midline of thigh. They were asked to wear the pedometer from the time of awakening in the morning till the bedtime for the entire 7 days. Besides that, instructions for device safety were also given which include: resetting of device and detaching of device before going to bed or during water based activities (e.g swimming, showering). It was also emphasized to continue the normal routine activities during the study.

Training for recording each day's pedometer scores, and resetting of devices was given to sports teachers and the school doctor. The students were informed to report to their sports teacher or in doctor's room every morning from 8 to 8:15 a.m. for recording of pedometer step counts on their individual record sheet which was provided. Whereas, special instruction manual was sent to parents/ guardian to record the step counts for weekends. In order to reproduce the timings of weekday's steps recording, they were advised to record weekend steps as the foremost thing on Saturday and Sunday mornings.

The participants were also instructed not to wear pedometer for the rest of the day, if they forgot to wear it in the morning and record zero step on the record sheet. For the missing weekdays when the student forgot to wear the pedometer mean step counts were calculated. In case the student forgot to wear the pedometer on the weekend, it was given over for the next weekend in order to record the weekend step counts.

#### Statistical Analysis:

All the analysis was conducted in the Statistical Package for Social Sciences Software (SPSS) version 21. Descriptive statistics (Mean  $\pm$  SD, Range), frequencies and percentages for daily pedometer step counts were calculated for overall and gender stratified samples. Independent t-test and ANOVA analysis were used to test for differences in average pedometer step counts between genders and within days respectively.

Ascertaining the reliability of pedometer in order to estimate the PA, Cronbach's alpha and Intra class correlation coefficient (ICC), were calculated from Two Way ANOVA model (Days x Participants).

## Results

In total, 265 students consented to take part in this study. Out of these, 141(53%) were girls with a mean age of 14 years, whereas 124 (47%) were boys with mean age of 13 years. Among 265 participants, 227 (85.7%) participants provided pedometer data for all 5 weekdays (N = 26 (9.8%) for 4 days, 12 (4.5%) for 3 days). However, 100% response rate was recorded for the weekends. The descriptive statistics for pedometer step counts per day were shown in Table I.

The average recorded step counts per day were 10,010 (SD:  $\pm$  4926). However, boys took 12,513 (SD:  $\pm$  5365) steps / day than girls 7,809 (SD:  $\pm$  3168) and higher steps were recorded from Thursday to Saturday. Boys showed higher step counts on weekend (Saturday) in comparison to girls. Significant step count differential within days (p-value\* <0.001) and in between both genders (p-value\*\* <0.001) was observed.

On the basis of overall pedometer step counts, 74 (27.9%) adolescents were found inactive, 159 (60%) adolescents were moderately active and 32 (12%) adolescents were active. Among boys, 83 (66.9%) were found more active whereas higher inactivity was recorded in girls i.e. 57 (40%). The results revealed significant differences of pedometer step counts between males and females (p-value <0.001,  $\chi^2= 28.95$ ) (Table II).

The reliability of pedometer over 7 consecutive days was estimated. Beginning with the initial 2 days (Mon - Tue) and subsequently added 1 day at a time. The increase in reliability was observed with increase in number of days. The minimally acceptable criterion value for reliability as defined by Nunnally Bernstein was  $\alpha \geq 0.70$  (36). This study reported utmost reliability of  $\alpha = 0.91$  for entire 7 days of monitoring.

Analysis for the weekend and weekdays were also conducted separately. The reliability of pedometer step counts on weekdays ( $\alpha = 0.88$ ) was higher than weekends ( $\alpha = 0.79$ ). Furthermore, the pedometer reliability for all possible combinations of 2 to 7 days was assessed by performing Cronbach's alpha and Intra class Correlation Coefficient (ICC) analysis, the results of which were shown in Table III. The mean reliability coefficient ( $\alpha$ ) for 2 days was 0.73, whereas,

0.80, 0.84, 0.86, 0.89 were observed for any 3, 4, 5 and 6 days respectively. With increasing number of days in combinations, the mean reliability coefficient reached 0.91 for 7 days.

**Table I Estimated Daily Pedometer Step Counts (± Standard Error) According to Gender and Time of week (n = 265)**

Steps/day	Full sample (n=265)			Male (n=124)			Female (n=141)			p-value**
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	
Monday	9737	5855	990 - 35812	12028	6936	990 - 35812	7722	3692	1140 - 19211	<0.001
Tuesday	9759	5587	1107 - 30450	11820	6176	2510 - 30450	7947	4274	1107 - 21046	<0.001
Wednesday	9875	5712	1195 - 32000	12377	6547	1256 - 32000	7675	3667	1195 - 21991	<0.001
Thursday	10442	6516	1000 - 51189	13450	7580	1916 - 51189	7797	3811	1000 - 18579	<0.001
Friday	10219	5846	1036 - 35361	12406	6627	2050 - 35361	8295	4231	1036 - 24203	<0.001
Saturday	10150	6412	1018 - 38571	12769	7256	2108 - 38571	7846	4454	1018 - 22080	<0.001
Sunday	9887	6778	1092 - 40943	12738	7824	1800 - 40943	7380	4396	1092 - 23296	<0.001
p-value*	<0.001			<0.001			<0.001			
<b>Pedometer Average steps/day</b>	10010	4926	2427 - 27694	12513	5365	3708 - 27694	7809	3168	2427 - 18248	

p-value\* calculated within groups-ANOVA

p-value\*\* calculated between groups-Independent t-test

**Table II Overall and Gender Stratified Physical Activity Levels for sample of 265 Adolescents Based on Pedometer Step Counts**

Steps/day	Full sample	Male	Female	p - value
	n = 265 (%)	n = 124 (%)	n = 141 (%)	
Inactive	74 (27.9)	17 (13.7)	57 (40.4)	<0.001 (X <sup>2</sup> = 28.95)
Moderate active	159 (60.0)	83 (66.9)	76 (53.9)	
Active	32 (12.1)	24 (19.4)	8 (5.7)	

Note: For Pedometer Step Counts / day: **Inactive** = didn't achieve 10,000 steps on any single day of all days, **Moderate Active** = achieved 10,000 steps on at least half of the days, **Active** = achieved 10,000 steps on all days

**Table III Descriptive statistics for Reliability of Pedometer Across Combinations of 2 - 7 Days of Monitoring for Sample 265 Adolescents**

Combinatio n of days	Reliability Coefficient (α)		ICC	
	Mean	Range	Mean	Range
	2 Days	0.73	0.61 - 0.87	0.58
3 Days	0.80	0.77 - 0.87	0.58	0.53 - 0.69
4 Days	0.84	0.81 - 0.88	0.58	0.48 - 0.78
5 Days	0.86	0.86 - 0.88	0.58	0.56 - 0.61
6 Days	0.89	0.89	0.58	0.57 - 0.59
7 Days	0.91	0.91	0.59	0.59

ICC = Intra class Correlation Coefficient

## Discussion

The findings of current study show that majority of adolescents were moderately Physical Active. Boys on an average exhibited higher levels of PA than girls, whereas the level of PA was higher on weekdays as compared to weekends. Based on pedometer step counts, more than half (60%) of the participants in our study, were moderately active. In our study, boys exhibited higher average step counts per day than girls, which is consistent when compared to the findings of other published studies from different countries (27, 30, 33, 34, 43). The average reported steps for boys in our setting (12513 ± 5365) were found higher than New Zealand (10849 ± 381) whereas, reported steps for New Zealand girls were higher (9625 ± 289) than our findings (7809 ± 3168). Adolescents of similar ages from US scored 2000 less steps / day in comparison to our study (36). Yet similar average step counts were observed among European countries (38). Keeping in view that such comparison of PA does not substantially reflect the overall difference between countries because neither data set is representative. While comparing the activities of weekdays and weekend, significantly low activity was noticed among both genders on weekend (Sunday). This increase in weekdays step counts may be because of the opportunities to participate in sports, games or physical education program during school timings. Cuberek (38), Clemes SA (35), Basette Jr (44)

also had reported reduction of PA on Sunday. Evidence of significantly low PA on weekend was also reported among Indian adolescents (45). We feel that this decline in PA on Sundays is not random but reveals an inherent characteristic of fluctuations in real life behavior relating to PA. During weekdays, the routine of adolescents is challenging because of excessive activities at school, both mental and physical. Hence, weekend is considered as relaxation time and adolescents may not push themselves in activities. Secondly, due to law-and-order situation of our country, parents do not let their children to participate in outdoor activities such as cycling, playing cricket, football etc. Another striking factor contributing in reduction of PA is the advancements in the mode of entertainment and technology, due to which sedentary lifestyle is found more prevalent among adolescents of our setting (46, 47). The possible reason behind high number of step counts on weekdays is organized sports and vigorous PA during physical education (PE) classes and lunch time at school. Additionally, this research was administered during spring months of typical school year (February to April). During this season extra - curricular activities such as sports day, student week and annual function are also held in schools which can also be the possible reason of higher level of PA on weekdays.

The minimal acceptable criteria for pedometer reliability ( $\alpha \geq 0.70$ ) was defined by Nunnally and Bernstein (36). Our analysis indicated that 7 days of monitoring is required to attain reliability of  $\alpha = 0.91$  among adolescent age group. Previous studies reported the reliability of  $\alpha = 0.80$  for 5 days measurement in 10 to 14 years of age (36, 48). Five days accrued similar reliability in our study. Robert W. et al reported reliability of  $\alpha = 0.80$  for 3 days which was identical to the 3 days results of this study (37).

#### **Strengths and Limitation:**

To the best of our knowledge, the current study is the first conducted study in Pakistan which has assessed overall and gender stratified patterns of PA among adolescents by using objective assessment tool i.e. pedometer. The results of this study will be contributed in providing baseline data of PA among adolescents for future researches conducted in Pakistani settings.

This study has limitations. The data is from only four schools of Karachi, and the student's voluntary

participation may have affected the generalizability of the results of this study. Similarly, adolescents who are not enrolled at any school were not included in this study, so the findings are only representing PA behavior of school going adolescents. For this study, data were collected during spring season so the amount of PA could be different in other seasons of the year simply due to weather variation. So the current study, due to its shorter duration, could not capture the changing PA behavior between different months. Similarly, the school used during this study had a large campus and playground which offered the opportunity to participate in moderate PA.

## **Conclusion**

To the best of our knowledge, this is the first published study which not only reveal the moderate patterns of physical activity but has established an average cut off points of 10,000 steps per day for Pakistani adolescents. Based on the findings of this study, the PA levels in both genders were not same, also there were differences in day-to-day activities as well as statistically significant variation between weekend and weekday activities.

It is also found that the use of unsealed pedometer is an easy and inexpensive mode of objective assessment of PA among adolescents. This study also showed that minimal 7 days of recording pedometer data for adolescents provide highly reliable estimates of physical activity when worn across weekdays and weekends.

#### **Conflict of Interest:**

There was no conflict of interest. It was a self-funded study and a total of 30 pedometers were used

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