



ORIGINAL PAPER

Jarosław Herbert ^{1(ABCDF)}, Piotr Matłoz ^{1(BC)}, Renata Grzywacz ^{2(FG)},
Patrycja Jaskierska ^{3(BG)}, Aleksander Sołek ^{3(EF)}

BMI as a factor influencing the number of steps among physical education students

¹Department of Health Science, Faculty of Physical Education, University of Rzeszów, Rzeszów, Poland

²Department of Cultural Foundations of Physical Education, Tourism and Recreation,
Faculty of Physical Education, University of Rzeszów, Rzeszów, Poland

³Student Research Society Travelers, Faculty of Physical Education, University of Rzeszów, Rzeszów, Poland

Abstract

Introduction. Organized physical activity (PA) is among factors that significantly influence the amount of realized PA.

Aim. The aim of this study was to collect and analyze the influence of BMI on the number of steps among women while undergoing obligatory sport camp as part of physical education studies and during study time at university.

Materials and methods. The studies included women (n=60) ranging from 19 to 25 years of age. Their weekly physical activity was monitored using an accelerometer ActiGraph. The significance of the differences between the results for two consecutive measurements are pointed out among the same people, but under different conditions there was assessed at-student test for the variables. Compliance of measurement was described using testing and Bland-Altman chart. For the level of statistical significance $p < 0.05$ was adopted.

Results. The requirements of the WHO on the minimum physical activity were met by almost all students. There is a lack of presence of a statistically significant relationship between BMI and the number of student steps, both in the case of measurement during study time ($R = -0.03$; $p = 0.815$) and at camp ($R = -0.02$; $p = 0.865$).

Conclusions. Women are characterized by high activity (number of steps). BMI does not affect the number of steps for studies. Students meet the requirements of WHO (10000 steps).

Keywords. physical activity, WGT3X-BT, accelerometer

Introduction

Physical activity (PA) is endorsed as health enhancing, and is known to prevent and reduce both musculoskeletal disorders and mortality.¹⁻³ Recent advancements in pedometers create the opportunity for use in providing more detailed information on physical activity patterns,

rather than simply recording a tally of steps/day, even though it is limited to ambulatory physical activity. Currently, empirical studies examining steps/day translation of the daily recommendation of 60 min MVPA in adolescents are divergent, ranging from 7,500 to 14,000 steps/day.⁴⁻⁶ Developments in technology to improve the objec-

Corresponding author: Jarosław Herbert, e-mail: jherbert@ur.edu.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 11.09.2018 | Accepted: 2.11.2018

Publication date: December 2018

tive PA measurement in humans through the use of objective measures such as pedometers and accelerometers have promise.⁷ Pedometers capture most of the variance in PA measured by accelerometers in adult populations.⁸ The pedometer has been and continues to be a popular instrument for physical activity assessment. Recently it has been suggested that 10,000 steps should be a daily step count cut-point used to assess optimal physical activity levels.⁴

Various governmental and professional organizations around the world have used the 10,000 daily step recommendation as an index of high physical activity level. This daily step-based recommendation has been endorsed by the World Health Organization, National Heart Association of Australia, US Centers for Disease Control and Prevention, and American Heart Association to improve overall health.⁹ The use of step data (usually as steps/day) is a simple means of reflecting habitual physical activity pattern, and this approach has become acceptable to many researchers and practitioners.¹⁰ Moreover, walking activity has been reported as a prevalent form of leisure-time physical activity and a functional task in the daily lives.²

Body mass index (BMI) is the metric currently in use for defining anthropometric height/weight characteristics in adults and for classifying (categorizing) them into groups. The common interpretation is that it represents an index of an individual's weight status. It also is widely used as a risk factor for the development of, or the prevalence of several health issues. In addition, it is widely used in determining public health policy.¹¹

Aim of the study

The aim of the study was to analyze the relationship between BMI and the number of steps taken by students of physical education during obligatory sport camp as part of their studies in the Faculty of Physical Education during a standard week of education in the course of winter semester.

The hypothesis is as follows: BMI affects the number of steps, the number of steps depends on the type of activities, and students meet the requirements of the WHO (min 10000 steps).

Material and methods

The study involved 60 female students in the Faculty of Physical Education, University of Rzeszów (Poland) who participated in sport camp and regularly attended obligatory courses during the semester. The criterion for inclusion in the project was: participation in all courses in one week with no medical contraindications. The study included healthy students who were enrolled, randomly selected at the University of Rzeszów, Poland during the 2017/2018 school year. The invitation to participate in the study was sent to 75 students. All participants were fully informed in writing and verbally

about the nature of the study. The consent of 75 students was obtained for participation in this study. Of those respondents, 15 were excluded from the study for the following reasons: removal of the accelerometer at any time of the study period, the device suffered mechanical error or operator error (incorrect epoch length, anthropometrics, and/or participant identification) ($n = 10$), and refusal to participate in study ($n = 5$). Ultimately, the study group consisted of 60 students.

Ethical clearance: Possible procedures were explained to students before signing the consent for participation in the study. Test procedures and protocols have been carried out in accordance with the Declaration of Helsinki.

The accelerometer ActiGraph WGT3X-BT (Pensacola, USA) was used in the testing. This is a three-axis accelerometer and one of the most commonly used devices to assess physical activity.¹² The accelerometer was placed on the waist using an elastic belt securely above the right hip bone for measuring the amount and frequency of participant movement. After a completed recording, a sensor connected to the computer via the mini USB transferred data. During the initialization, there was required information including the name of the entity, gender, height, weight, and race. Participants were instructed to have the accelerometer for seven consecutive days, 24 hours a day.

Data was collected in 60s epochs. Non-wear time was defined as 60 min of consecutive zeros allowing for 2 min of non-zero interruptions.²⁹ A wear time of ≥ 500 min/day was used as the criterion for a valid day, and ≥ 4 days were used as the criteria for a valid 7-day period of accumulated data.

ActiGraph data were analyzed using the software Actilife 6.0. Human characteristics (sex, age, were reported individually), moreover, weight and height of the body was measured. Body height was measured to the nearest 0.1 cm using a portable stadiometer Seca 213. The measurement was performed under standard conditions in an upright position, barefoot. Body mass was assessed to an accuracy of 0.1 kg using a body composition analyzer (BC-420, Tanita). Body mass index (BMI) was calculated as kg/m^2 . All measurements were performed in the early morning before setting up the accelerometer according to the guidelines of the manufacturer. BMI (kg/m^2) categories are as follows: underweight ($18.5 <$), normal weight ($18.5\text{--}22.9$), overweight ($23\text{--}24.9$), and obese ($25\text{--}29.9$) and class II obese (≥ 30.0).⁹

Activity log-in during the day during the sports camp (7 days) including camp program (7.20–8.00), gymnastics and runs (9.30–13.30), open water swimming/kayak/hiking (15.30–17.30), biking/boating/different sports in the sports hall (20.00–21.00), evening animation/runs/strengthening exercises. All physical activities were held an average of 8 hours per day in the month of July. Activity log-in during the day during the semester (7 days)

included activities at the University (7.00-20.45), theoretical and practical courses (volleyball, gymnastics, karate, dancing). Classes were held an average of 6-8 hours a day divided into 50% of theoretical and 50% of practical. The classes were held in October. The studies took place in July and October; the impact of the season should not affect the divergence of test results.

A statistical analysis of the collected data was conducted using the Statistica 13.1 program, StatSoft company. It used both parametric and nonparametric tests. The choice of parameterized test subject was the fulfillment of the basic assumptions such as compliance test schedule variables with normal schedule, were verified by the W Shapiro-Wilk test. For all the variables, descriptive statistics were calculated (mean, median, minimum, maximum, the first the third quartile and the standard deviation). The significance of the differences between the results for the two consecutive measurements in the same people, but under different conditions, was assessed with Student's t- test for dependent variables or alternatively no parametric test of order pairs Wilcoxon. To verify compliance of the measurement results obtained in measuring during studies with the results obtained in measuring during camp analysis Bland-Altman was performed.

Bland-Altman charts present lines of 95% compatibility ranges for the average difference between the measurements obtained during studies and camp and points with coordinates equal to results concerning differences of measurements obtained in two conditions. Good repeatability of the results is when 95% of the measurements are located between lines of conformity (acceptable percentage of outliers is 5%).

The correlation of two variables with distribution which does not satisfy the criterion for normality of the distribution is made by using the Spearman correlation. Compliance of the measurements taken during the study and during the camp was tested and was shown using test and Bland-Altman chart. For the level of statistical significance it was adopted $p < 0.05$.

Results

The average age of the students in measurement I (during studies) was 20.61 ± 1.45 years, and in measure-

ment II (camp) 20.46 ± 1.59 years. The difference between the I and II measurement was an average of 0.15 year. The students were situated in the range from 19 to 25 years. The age of the students in two consecutive measurements did not differ significantly.

The average height of the body of tested students in the measurement I and II was 170.42 ± 7.86 cm and contained in a range of values from 154 cm to 194 cm. Average body weight of the tested group in the measurement I (studies) was 62.53 ± 9.66 kg, and the measurement II (camp) 59.61 ± 6.04 kg. The difference between I and II measurement was an average of 2.92 kg. This difference was statistically significant ($p = 0.038$). Body weight of female students during camp was lower than during studies.

The average BMI of tested group in I measurement (studies) was 21.45 ± 2.32 kg/m², and in measurement II (camp) 20.62 ± 2.57 kg/m². The difference between I and II measurement was an average of 0.84 kg/m². This difference was statistically insignificant ($p=0.051$). BMI of students during camp was lower than during studies. The range for BMI in I measurement was from 16.47 to 27.47 kg/m², and in measurement II from 14.36 to 26.35 kg/m² (Table 1).

The average number of steps taken by the tested students during the day in measurement I (studies) was $11,444.66 \pm 4,246.03$, and in measurement II (camp) $16,377.76 \pm 5,562.55$. The difference between I and II measurement was an average of 4933.1. This difference was statistically significant ($p<0.001$). The number of taken steps a day by students during camp was higher than those taken during studies. The range for the number of steps in both I and II measurement was from 548.57 to 29,123.57 (Table 2).

Only one person in the course of the semester and 2 others tested during the camp did not meet the assumptions of WHO concerning the minimum number of steps to be performed daily for health maintenance. This difference was statistically insignificant ($p=0.592$).

A lack of the presence of a statistically significant correlation between BMI of tested students and the number of steps were shown, both in the case of measurement during studies ($R=-0.03$; $p=0.815$) and camp ($R=-0.02$; $p=0.865$). Statistical insignificance was found

Table 1. BMI of participants

BMI [kg/m ²]	Descriptive statistics								
	n	\bar{x}	Me	Min.	Max.	Q1	Q3	SD	d
studies (I)	60	21.45	21.45	16.47	27.47	19.71	22.47	2.32	0.84
camp (II)	60	20.62	20.94	14.36	26.35	18.61	22.27	2.57	
P	t=1.98 p=0.051								

n – number of observations; \bar{x} – arithmetic average; Me – mediana; Min – minimum; Max – maximum; Q1 – lower quartile; Q3 – upper quartile; SD – standard deviation; t – the Student's t-test result for dependent variables; p – level of significance of differences

Source: own study

Table 2. Number of steps /day

Number of steps	Descriptive statistics								
	[n]	n	\bar{x}	Me	Min.	Max.	Q1	Q3	SD
studies (I)	60	11444.66	10546.14	528.57	21877.57	9085.43	13084.14	4246.03	4933.1
camp (II)	60	16377.76	16478.00	548.57	29123.57	13684.43	19205.29	5562.55	
P	Z=4.79 p<0.001								

n – number of observations; \bar{x} – arithmetic average; Me – mediana; Min – minimum; Max - maximum; Q1 – lower quartile; Q3 – upper quartile; SD – standard deviation; Z – the test result of the order of par Wilcoxon; p – level of significance of differences
Source: own study

Table 3. The relationship between BMI and the number of steps at the time of the study and at camp

Variables	R	P
BMI and the number of steps at studies	-0.03	0.815
BMI and the number of steps at camp	-0.02	0.865
The difference between BMI and the difference in the number of steps	-0.03	0.817

R – the value of Spearman’s rank correlation; p – level of significance of differences
Source: own study

also in the relationship between the difference in the value of BMI and the difference in the number of steps obtained between the I and II measurement (R=-0.03; p=0.817).

Bland-Altman chart for collected data on BMI indicates that the measurement at camp (II) gives lower results than the measurement during studies - an average of 0.84 kg/m² (line for the average difference is 0.8367 lower than absolute compliance illustrated by the line of 0). The range of span compliance was 12.665 kg/m². In this range, there was about an 88.0% difference between pairs of measurements. Out of this range were 7 differences. This means that the coefficient of Bland and Altman was approximately 12.0%. Repeatability of measurement assessed by Bland and Altman method for BMI has not reached the criterion of the British Institute of Standardization; 95% of the differences between the results of measurement pairs was in the range of compliance for medium (Fig. 1).

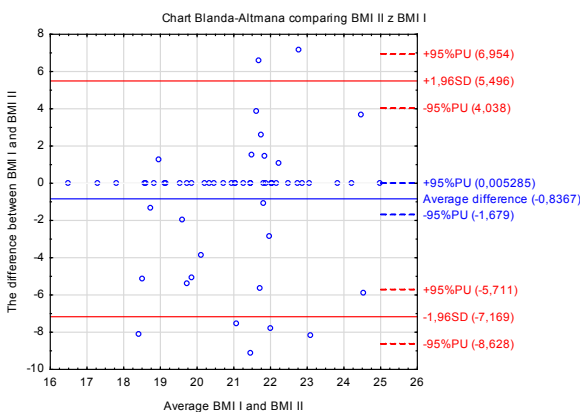


Fig. 1. Bland-Altman Diagram for BMI
Source: This study

Bland-Altman chart for collected data on the number of steps indicates that the measurement made at camp (II) gives higher scores than measurement during studies - an average of 4933 steps (line for the average difference is 4933 higher than absolute compliance illustrated by the line of 0). In this range, there was about a 93% difference between pairs of measurements. Out of this range were 4 differences. This means that the coefficient of Bland and Altman was approximately 7%.

Repeatability of measurement assessed by Bland and Altman method for number of steps has not reached the criterion of the British Institute of Standardization; 95% of the differences between the results of measurement pairs was in the range of compliance for medium (Fig. 2).

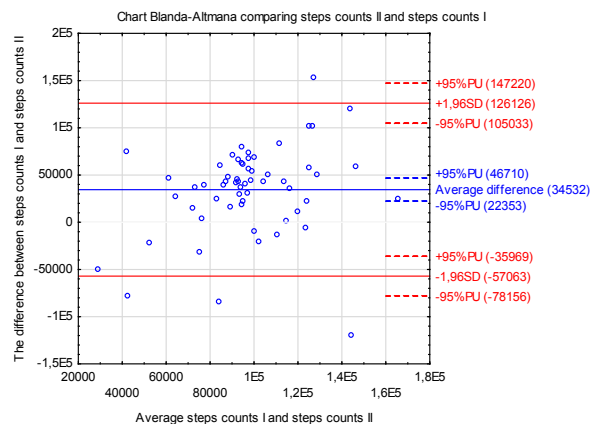


Fig. 2. Bland-Altman diagram for the number of steps
Source: This study

Discussion

The aim of this study was to collect and analysis of the influence of BMI on the number of steps among women during obligatory sport camp as part of physical educa-

tion studies and during study time at university. This is one of the few studies performed that compare the same group under different conditions (sports camp and a week of study).

There is lack of studies analyzing patterns of physical activity (number of steps) for students, particularly in Poland. Special periods in the life of a young person are undoubtedly studies. New surroundings and conditions of residence often involve taking more responsibility for creating their own lifestyle. This is connected with the new conditions of social life, the lifestyle and change of work rhythm. Research shows that the amount of number of steps made by Polish students meet WHO recommendations.¹³ It should be pointed out the fact that there are few studies on physical activity levels that depend on the Body Mass Index (BMI).¹⁴

Physical activity is estimated by subjective tools (questionnaires, surveys, interview) and objective (ActiGraph, a pedometer). In this study, an objective tool was used which allowed not only for determining the time spent, but also to measure and verify with the recommendations of the WHO's number of steps per day. Although self-reported data can provide useful insights into physical activity levels of populations or subgroups, these data have the tendency to over or underestimate true physical activity, energy expenditure, and rates of inactivity.^{15,16}

Few studies have attempted to measure the level of agreement between self-reported measures and steps/day data as a direct/objective measure of ambulatory physical activity.^{17,18} A popular public health message relating to pedometry is the 10,000 steps/day concept, which shows positive health outcomes in those achieving this target compared with those not achieving 10,000 steps/day. The values obtained here between an average of $11,444 \pm 4246.03$, and $16,377.76 \pm 5,562.55$ steps/day has generally been classified as very active.^{5,6,19} Research students ($n = 25$) from James Cook University in Cairns, Australia performed an average of $10,896.0 \pm 4,364.9$ steps, in turn, in similar studies, students ($n = 73$) performed an average of $9,096.7 \pm 3,955.3$ steps.^{20,21} Research from 23 countries found that among students from Central and Eastern Europe, only 32% of men and 18% of women meet the recommended frequency of leisure time in PA.²² Better results were found for students of universities from Australia, where 47% of men and 51% of women ($n = 103$) have reached 10,000 steps.²³ In turn, in Czech students, women performed 10,612 \pm 2,750 steps a day.²⁴ With the above information, the hypothesis that students meet the requirements of WHO (10000 steps) has been confirmed in the case of both groups, and in addition, it has been greatly exceeded.

Moreover, the results of our research indicate that BMI does not affect the number of steps for studies ($R = -0.03$; $p = 0.815$) and camp ($R = -0.02$; $p = 0.865$), and by far

the number of steps depends on the type and characteristics of the activities. These findings suggest that the more movement activities in the field, the greater the physical activity test, as in the studies, the number of female students from various fields of study was ($n = 323$) and only 2.5% did not make 10,000 steps a day.²⁵

By analyzing the results on the level of physical activity of students depending on body mass index (BMI), it was found that women are characterized by high activity (number of steps). Similarly, the student from South Africa on a valid body mass index (BMI) was shown to be more active than their peers underweight and overweight.²⁶ As physical activity is an important factor in weight control, a larger and more consistent body of evidence of significant negative associations between habitual physical activity and adiposity has been reported in cross-sectional studies using pedometry.^{27,28} Activities that were carried out on the training camp give the opportunity to participate in physical activity and should sustain the belief that physical movement and fresh air are factors in health promotion. Therefore, further research should outline the relationship between the physical active lifestyle and transition students into adulthood.

In conclusion, the physical environment can promote the regular involvement of students in physical activity and to assist them in adopting and maintaining an active lifestyle. Educators and health promoters must take into account a variety of factors (including natural surroundings) because they design effective interventions to promote physical activity among young people and encourage them to adopt and maintain physically active lifestyle.

Conclusion

Women are characterized by high activity (number of steps). BMI does not affect the number of steps in our studies. Students meet the requirements of WHO (10,000 steps). The results of this study provided us with a more accurate understanding of how important activity type is in predicting the physical activity of students. The results also indicated the direct contribution of specific variables (environmental) where all classes were held outdoors.

References

1. Steeves JA, Tudor-Locke C, Murphy RA, King GA, Fitzhugh EC, Harris TB. Classification of occupational activity categories using accelerometry: NHANES2003–2004. *Int J Behav Nutr Phys Act.* 2015;12(1):1–20.
2. Holtermann A, Hansen JV, Burr H, Sogaard K, Sjogaard G. The health paradox of occupational and leisure-time physical activity. *British Journal of Sports Medicine.* 2012;46(4):291–295.

3. Holtermann A, Marott JL, Gyntelberg F, et al. Does the benefit on survival from leisure time physical activity depend on physical activity at work? A prospective cohort study. *PLoS ONE*. 2013;8(1).
4. Colley R, Janssen I, & Tremblay M. Daily step target to measure adherence to physical activity guidelines in children. *Med Sci Sports Exerc*. 2012;44(5):977–982.
5. Adams M, Johnson W, Tudor-Locke C. A steps/day translation of the moderate-to-vigorous physical activity guideline for children and adolescents. *Int J Behav Nutr Phys Act*. 2013;10(49).
6. Fontana F, Da Silva M, Marston R, Finn K, Gallagher J. Step-count guidelines referenced on 60-minutes of moderate/ vigorous physical activity. *Motriz*. 2015; 21(1):92–99.
7. Helmerhorst HJ, Brage S, Warren J, Besson H, Ekelund U. A systematic review of reliability and objective criterion-related validity of physical activity questionnaires. *Int J Behav Nutr Phys Act*. 2012;9:103.
8. Tudor-Locke C, Ainsworth B, Thompson R, Matthews C. Comparison of pedometer and accelerometer measures of free-living physical activity. *Med Sci Sports Exerc*. 2002;34:2045–2051.
9. World Health Organization. WHO STEPS Surveillance Manual: The WHO STEP wise approach to chronic disease risk factor surveillance. Geneva, World Health Organization. 2005.
10. Bravata DM, Smith-Spangler C, Sundaram V. Using pedometers to increase physical activity and improve health: a systematic review. *JAMA*. 2007;298(19):2296–304.
11. Nuttall FG. Body Mass Index: Obesity, BMI, and Health: A Critical Review. *Nutrition Today*. 2015;50(3):117–128.
12. Crouter SE, Dellavalle DM, Haas JD, Frongillo EA, Bassett DR. Validity of ActiGraph 2-regression model, Matthews cut-points, and NHANES cut-points for assessing free-living physical activity. *J Phys Act Health*. 2013;10(4):504–514.
13. Arias-Palencia NM, Solera-Martínez M, Gracia-Marco L, et al. Levels and Patterns of Objectively Assessed Physical Activity and Compliance with Different Public Health Guidelines in University Students. *PLoS One*. 2015;10.
14. Rauner A, Mess F, Woll A. The Relationship between physical activity, physical fitness and overweight in adolescents: a systematic review of studies published in or after 2000. *BMC Pediatrics*. 2013;13:19.
15. Prince SA, Adamo KB, Hamel ME, Hardt J, Gorber SC, Tremblay MS. A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. *Int J Behav Nutr Phys Act*. 2008;5(1):56.
16. Biernat E, Piątkowska M. Overestimation of physical activity by long IPAQ in a Polish nationwide study. *Hygeia Public Health*. 2016; 51(1):87–95.
17. Miller R, Brown W. Meeting physical activity guidelines and average daily steps in a working population. *J Phys Act Health*. 2004;1(3):218–226.
18. Matton L, Wijndaele K, Duvigneaud N, Duquet W, Philippaerts R, Thomis M. Reliability and validity of the Flemish Physical Activity Computerized Questionnaire in adults. *Res Q Exerc Sport*. 2007;78(4):293–306.
19. Tudor-Locke C, Craig C, Beets M, et al. How many steps/day are enough? for children and adolescents. *Int J Behav Nutr Phys Act*. 2011;8:78.
20. Sushames A, Edwards A, Thompson F, Mcdermott R, Gebel K. Validity and Reliability of Fitbit Flex for Step Count, Moderate to Vigorous Physical Activity and Activity Energy Expenditure. *PLoS ONE*. 2016;11(9).
21. Clemente FM, Nikolaidis PT, Martins FML, Mendes RS. Physical Activity Patterns in University Students: Do They Follow the Public Health Guidelines? *PLoS ONE*. 2016;11(3).
22. Haase A, Steptoe A, Sallis JF, Wardle J. Leisure-time physical activity in university students from 23 countries: Associations with health beliefs, risk awareness, and national economic development. *Prev Med*. 2004;39(1):182–190.
23. Villanueva K, Giles-Corti B, McCormack G. Achieving 10,000 steps: A comparison of public transport users and drivers in a university setting. *Prev Med*. 2008;47(3):338–341.
24. Sigmundova D, Zaccal J, Sigmund E. The level of influence of organised physical activity on meeting the healthy criterion of 10,000 steps daily: Application of regression and formal concept analysis. *Acta Universitatis Palackianae Olomu-censis Gymnica*. 2010;40(4):15–24.
25. Sigmundová D, Chmelík F, Sigmund E, Feltlová D, Frömel K. Physical activity in the lifestyle of Czech university students: Meeting health recommendations. *Eur J Sport Sci*. 2015;13(6).
26. Cilliers J, Seneka LM, Kunneke E. The association between the body mass index of first-year female university students and their weight-related perceptions and practices, psychological health, physical activity and other physical health indicators. *Pub Health Nutr*. 2006;9(2):234–243.
27. Welk G, Blair S. Physical activity protects against the health risk of obesity. *Washington, DC. Presidents' Council on Physical Fitness and Sport Research Digest*. 2000;3:12.
28. Jimenez-Pavon D, Kelly J, Reilly J. Associations between objectively measure habitual physical activity and adiposity in children and adolescents: Systematic review. *Int J Pediatr Obesity*. 2009;1:1.
29. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Medicine & Science in Sports & Exercise*. 2008;40:181–188.