Medical Rehabilitation (Med Rehabil) 2016, 20 (4): 4-12 DOI: 10.5604/01.3001.0009.5479 eISSN 1896–3250 ISSN 1427–9622

Self-reported physical activity versus physical function capacity: alternatives for energy expenditure estimation

Deklarowany poziom aktywności fizycznej a wydolność funkcjonalna: alternatywy dla oceny wydatku energetycznego

Chidozie E. Mbada [1 (A,C,D,E,F)], Temitope A. Osifeso [1 (A,B, D, E, F)], Olubusola E. Johnson [1 (A,C,D,E,F)], Adaobi M. Okonji [2 (A,D,E,F)], Emmanuel A. Odeyemi [1 (A, D,E,F)]

[1] Department of Medical Rehabilitation, College of Health Sciences, Obafemi Awolowo University, Ile – Ife, Nigeria
[2] Department of Physiotherapy, Obafemi Awolowo University Teaching Hospitals Complex, Ile – Ife, Nigeria

Key words
physical activity, exercise capacity, energy expenditure, cardiovascular parameters, perceived exertion rate

Abstract
Introduction: The extent to which self-report activity measured by the International Physical Activity Questionnaire (IPAQ) can substitute performance-based functional capacity measured by the Six-Minute Walk Test (6MWT) remains inconclusive. This study assessed Physical Activity (PA) and Functional Exercise Capacity (FEC); and also determined the relationship between PA and FEC in apparently healthy young adults.
Materials and methods: A total of 342 (145 males and 197 females) undergraduates of Obafemi Awolowo University, Ile-Ile, Nigeria participated in the study. The IPAQ was used to assess PA, while FEC was assessed using the 6MWT, and expressed in terms of the Six-Minute Walk Distance (6MWD), Six-Minute Walk Work (6MWW), Maximum Oxygen Uptake (VO_2max) and Metabolic Equivalent (METS). Anthropometric and cardiovascular parameters were measured following standardized procedures. Data was analyzed using descriptive and inferential statistics. The alpha level was set at 0.05.
Results: The mean age of the participants was 22.0±2.87 years. The mean IPAQ score of all participants was 1471.4±1086.93. The percentage for low, moderate and high PA was 19% (65), 41.2% (141) and 39.8% (136), respectively. The mean 6MWD, 6MWW, VO_2max and METS were 639.47 ±66.6 m, 41805.0 ±8520.6 kg·m, 28.9 ±1.92 $mlO_2k^{-1}min^{-1}$, 4.05 ±0.32 mL/kg, respectively. There were significant positive correlations between PA and each of the 6MWD (r=0.268; p=0.001), 6MWW (r=0.219; p=0.001), VO_2max (r=0.268; p=0.001), METS (r=0.268; p=0.001). Measures of exercise capacity were not significantly correlated with the anthropometric variables (p>0.05).
Conclusion: Self-report of physical activity in healthy young adults does not adequately substitute the results of the Six-Minute Walk Test.

Słowa kluczowe
aktywność fizyczna, wydolność wysiłkowa, wydatek energetyczny, parametry układu sercowo-naczyniowego, skala odczuwania wysiłku

Streszczenie
Wstęp: Stopień, w jakim deklarowana aktywność fizyczna oceniania za pomocą Międzynarodowego Kwestionariusza Aktywności Fizycznej (IPAQ) może zastąpić opartą o wyniki wydolność funkcjonalną mierzoną testem 6-minutowego chodu (6MWT) pozostaje niejednoznaczny. W badaniu tym oceniano aktywność fizyczną (AF) i funkcjonalną wydolność wysiłkową (FEC); a także określono zależność pomiędzy PA i FEC u pozornie zdrowych, młodych dorosłych.
Materiał i metody: Badaniem objęto 342 studentów (145 mężczyzn i 197 kobiet) z Obafemi Awolowo University, Ile-Ile, Nigeria. IPAQ został wykorzystany do oceny AF, podczas gdy FEC oceniano za pomocą 6MWT i wyrażono w sześciominutowym dystansie chodu (6MWD), pracy wykonanej podczas sześciominutowego chodu (6MWW), maksymalnym minutowym pobo-

The individual division in this paper was as follows: a – research work project; B – data collection; C – statistical analysis; D – data interpretation; E – manuscript compilation; F – publication search

Received: 2nd Aug. 2016; accepted for publication: 30thNov. 2016

Please cite: Mbada Ch.E., Osifeso T.A., Johnson O.E., Okonji A.M., Odeyemi E.A. Self-reported physical activity versus physical function capacity: alternatives for energy expenditure estimation Med Rehabil 2016; 20(4): 4-12

Internet version (original): www.rehmed.pl

rze tlenu (VO_2max) i równoważniku metabolicznym (MET). Parametry antropometryczne i układu krążenia były mierzone zgodnie ze standardowymi procedurami. Dane analizowano przy użyciu wnioskowania statystycznego i opisowego. Poziom alfa został ustalony na poziomie 0,05.
Wyniki: Średni wiek uczestników wyniósł 22,0 ±2,87 lat. Średni wynik IPAQ wszystkich uczestników to 1471,4 ±1086,93. Procent dla niskiego, średniego i wysokiego poziomu AF to odpowiednio 19% (65), 41,2% (141) i 39,8% (136). Średni 6MWD, 6MWW, VO_2max i METS wyniosły odpowiednio 639.47 ±66,6 m, 41805.0±8520,6 kg·m, 28,9±1,92 $mlO_2k^{-1}min^{-1}$, 4,05±0,32 ml/kg. Istnieją znaczące dodatnie korelacje pomiędzy PA i każdym z 6MWD (r=0,268, p=0,001), 6MWW (r=0,219, p=0,001), VO_2max (r=0,268, p=0,001), METS (r=0,268; p=0,001). Miary wydolności wysiłkowej nie były istotnie skorelowane ze zmiennymi antropometrycznymi (p>0,05).
Wnioski: Deklarowany poziom aktywności fizycznej u zdrowych młodych dorosłych nie jest adekwatny do wyników testu sześciominutowego marszu.

INTRODUCTION

Physical Activity (PA) is defined as any bodily activity or movement produced by the skeletal muscles for whatever purposes, carried out throughout the day from active hobbies like dancing and walking to competitive exercises like running, cycling, swimming, etc.[1]. It is believed that PA does not need to be strenuous to be useful[2] as consistent PA of moderate or vigorous intensity at least three times per week or moderate intensity activity for 30 minutes at most is reported to be of substantial health benefits[3]. Traditionally, researchers in PA have been mostly concerned with quantifying activity[4]. However, there seems to be no consensus on the optimal epidemiological tool or method for assessing PA which may serve as an estimated energy expenditure of an individual[5]. Nonetheless, available methods of PA assessment along with its strengths and limitations can be broadly classified as subjective and objective. The subjective measures include activity diaries, interviewers and recall questionnaires, while the objective methods include measures such as a calorimeter, the doubly labelled water method, electronic motion sensors and other physiological indices such as heart rate[6].

Physical activity is commonly assessed on the basis of self-report using the International Physical Activity Questionnaire (IPAQ)[7-9]. IPAQ is considered as a standardised but subjective measure to estimate the habitual practice of PA with substantial data on its reliability and validity among various populations from different countries and socio-cultural contexts[7-9]. Studies have shown that habitual PA is an important determinant and also an indicator of exercise capacity in healthy individuals[10-12] and it is believed to be an estimate of energy expenditure of a person[13,14]. On the other hand, performance-based tests such as ergometry, treadmill, steps and timed-walk tests have been widely used to evaluate exercise capacity in healthy populations[15]. The Six-Minute Walk Test (6MWT) is one of the most commonly employed sub-maximal tests of exercise capacity in many studies[10,15,16] and has also been used as an estimate of energy expenditure[13,14,16-18]. However, discrepancies exist in literature as to what extent self-reporting can replace performance-based testing[19]. Unfortunately, there is an apparent dearth of studies relating self-report activity and performance-based measures of functional capacity. The objectives of this study were to assess PA level and functional exercise capacity; and also to determine the relationship between PA and exercise capacity in apparently healthy young adults. In addition, the study investigated the effect of the performance-based test on cardiovascular parameters and perceived exertion rate.

RESEARCH MATERIALS AND METHODS

A total of 342 (145males and 197 females) undergraduates of Obafemi Awolowo University, Ile-Ife, Nigeria, whose ages range between 18 and 35 years, participated in the study. The response rate for this study was 85.5% (i.e. 342/400). Exclusion criteria for the study included being younger than 18 years of age, having a positive history of musculoskeletal injuries, neurological, cardiovascular or cognitive impairment or other factors that may limit the ability to participate in the 6MWT, and previous involvement in exercise capacity assessment using the 6MWT. The mean age, weight, height and BMI of the participants in this study was 22±2.87 years, 65±11.04 kg, 1.65±0.07 m and 23.83 ±3.83 kg/m^2, respectively.

Participants were recruited using the multi-stage sampling technique. Nine faculties including Administration, Basic Medical Sciences, Clinical Sciences, Law, Pharmacy, Sciences, Social Sciences and Technology were randomly selected among the thirteen faculties of the university using the fishbowl technique. From the selected faculties, those that have only one degree awarding department were automatically included in the study, while two departments each were randomly selected from those faculties with more than one degree awarding department. The selected departments were Accounting, Biochemistry, Economics, Electrical Engineering, Law, Mechanical Engineering, Medicine, Medical Rehabilitation, Microbiology, Pharmacy, Psychology as well as Sociology and Anthropology.

The sample size for this study was calculated based on the formula by Araoye[20] (i.e. $n = Z^2pq/d^2$); where: n = the desired sample size (when the population is greater than 10,000); Z = the standard normal deviate usually set at 1.96 (or more simply at 2.0) which corresponds to the 95% confidence level; P = the proportion in the target population estimated to have a particular characteristic, if there is no reasonable estimate then use 50% (i.e. 0.50) q=1.0-p; d = degree of desired accuracy usually at 0.05 or occasionally at 0.02:

$$n = \frac{(1.96)^2(0.50)(0.50)}{(0.05)^2} = 384$$

The sample size for this study was approximated up to 400 to accommodate non-response and withdrawal from the study.

Ethical approval for the study was obtained from the Ethics and Research Committee of Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria. An informed consent form was used to elicit the willingness of the participants in the study. Anonymity of participants, as well as confidentiality of their personal information, were ensured by the use of number codes, and consent to publish the obtained information was granted by the participants.

The IPAQ Short-Form (SF) was used to assess the PA of the participants. Prior to the IPAQ-SF administration, the answering procedure was explained to the participants. The questionnaire assessed the level and specific types of PA undertaken during the last 7 days consisting of 10 questions with items (1), (2), (3) seeking information about vigorous intensity activity, (4), (5), (6) seeking information about moderate-intensity activity, (7), (8), (9) seeking information about leisure time activity while item (10) sought information on activity during sitting[21]. In addition to the IPAQ, there was a self-developed proforma used to elicit demographic questions.

Following standard procedures, height (m) and body weight (kg) were measured using a stadiometer (Seca Alpha brand, model 19066) and a bathroom scale (Mechanical Personal Scale), respectively. A digital sphygmomanometer (Omron-IM-HEM-7102-E(V)-01-08/08) was used to measure the blood pressure (mmHg) and pulse rate (bpm) of the participants, respectively.

The 6MWT was performed once by the participants according to standard protocol[15]. Participants were instructed to walk from one end to the other of a marked 30-metre hallway at their own pace, while attempting to cover as much ground as possible in the allotted six minutes. Two small traffic cones were used to mark the corridor every 3 metres according to American Thoracic Society standards. Participants were reminded of the time remaining for test completion every minute by the instructor in an even tone of voice. Standardized instructions and verbal encouragement such as 'You're doing well' or 'Keep up the good work' were strictly given to the participants every minute until the end of the test or reported exhaustion. Participants were also asked at the end of the test if they experienced any symptoms of dyspnea, chest pain, light-headedness or leg pain. This 6MWT was carried out at the Department of Medical Rehabilitation, OAU, Ile-Ife, Nigeria.

The 6MWD (m) was obtained by calculating the number of turns made by the participant and multiplying it by the 60-m distance of the walkway, and adding the additional extra distance covered after the turns. The modified Borg scale (0-10) and the Borg scale for dyspnoea (CR-10) were used to assess perceived rate of exertion and level of dyspnea, respectively, at the end of the walk[22]. Data were obtained on pre and post-6MWT cardiovascular parameters (blood pressure and pulse pressure).

Statistical analysis

Data were summarized using descriptive statistics of means, standard deviation and percentages. Descriptive and inferential statistics of the paired and unpaired t-test, One-Way ANOVA and Pearson's moment correlation analysis were used to analyze data. Testing of data normality was implemented by using the Shapiro-Wilk test to isolate outliers. The measures of variability around the mean values show that the distribution of data was normal. The Statistical Package for Social Sciences (SPSS), version 16.0 software package for Windows was used for all data analyses. Alpha level was set at 0.05.

Computations

IPAQ-SF continuous physical activity scores were expressed in METS-min/week, for each participant according to IPAQ scoring guidelines[23].

Formula for computation of MET -minutes/week

The selected MET (metabolic equivalent) values were derived from the study by Craig et al.[24] on the reliability of IPAQ in 2000-2001. Based on Ainsworth et al.[25], an average MET score was derived for each type of activity. For example, all types of walking were included and an average MET value for walking was created. The same procedure was undertaken for moderate-intensity activities and vigorous-intensity activities. The following values continue to be used for the analysis of IPAQ data: Walking = 3.3 METs, Moderate PA = 4.0 METs and Vigorous PA = 8.0 METs. Using these values, four continuous scores are defined:

1. Walking MET-minutes/week = 3.3 x walking minutes x walking days
2. Moderate MET-minutes/week = 4.0 x moderate-intensity activity minutes x moderate days
3. Vigorous MET-minutes/week = 8.0 x vigorous-intensity activity minutes x vigorous-intensity days
4. Total physical activity MET-minutes/week = sum of Walking + Moderate + Vigorous MET minutes/week scores.

BMI (Kgm^{-2}) = Weight (kg) ÷ Height (m^2)
RPP (bpm * mmHg) = Systolic Blood Pressure x Heart Rate [26].
6MWW (Kgm) = 6MWD x body weight [16].
VO_2max (mL/kg/minute) = [speed (mmin-1) x 0.1] + 3.5 [6].
METS (mL O_2 uptake/kg per min) = VO_2max ÷ 3.5 [27].
RPP – Rate Pressure Product
6MWW – 6-Minute Work Walk

RESULTS

Table 1 shows the general characteristics and baseline cardiovascular parameters of the participants. The re-

Table 1

General characteristics and baseline cardiovascular parameters of the participants

Variable	Male Mean ± *SD*	Female Mean ± *SD*	*t*-cal	*p*-value	All participants Mean ± *SD*
Age (yrs)	22.8±3.1	21.4±2.6	4.512	0.001*	22.0±2.9
Weight (kg)	69.3±11.3	62.3±9.9	6.015	0.001*	65.2 ±11.0
Height (m)	1.67±0.07	1.64±0.07	3.919	0.001*	1.65±0.07
BMI (kgm^{-2})	24.8±4.0	23.1±3.5	3.924	0.001*	23.8±3.8
SBP (mmHg)	113.6±9.1	115.1±11.1	1.305	0.193	114.4±10.3
DBP (mmHg)	80.1±10.6	78.1±10.4	1.752	0.081	78.94±10.5
HR (bpm)	75.6±10.1	75.9±9.9	0.212	0.832	75.69±10.0
RPP	8602.4±1454.0	8730.4±1443.0	0.808	0.420	8676.1±1447.2

HR – Heart Rate; SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; RPP=Rate Pressure Product; BMI – Body Mass Index; *SD* – Standard deviation, * – indicates significant difference at $p<0.05$

Table 2

Independent t-test comparison of walk test measures by gender and values for all participants

Variable	Male Mean ± *SD*	Female Mean ± *SD*	*t*-cal	*p*-value	All participants Mean ± *SD*
6MWD (m)	666.1 ±67.2	627.9±63.9	3.805	0.001*	639.47±66.63
6MWW (kg·m)	45369.0±8458.0	39182.0±7578.4	7.101	0.001*	41805±8520.65
Speed (m/s)	109.1 ±11.2	104.7±10.7	3.805	0.001*	106.58±11.10
VO_2max	29.1±2.06	28.7 ±1.80	2.031	0.043*	28.9±1.92
METS	4.1±0.3	4.0±0.3	3.805	0.001*	4.045±0.31

SD – Standard deviation; 6MWW – 6-Minute Work Walk, VO_2max – Maximum-oxygen uptake; METS – Metabolic Equivalent; * – Indicates significant difference at p<0.05

Table 3

Post-6MWT cardiovascular parameters, perceived rate of exertion and level of dyspnoea of the participants

Variable	Male Mean ± *SD*	Female Mean ± *SD*	*t*-cal	*p*-value	All participants Mean ± *SD*
SBP (mmHg)	122.2±7.9	122.86±7.8	0.741	0.459	122.6±7.8
DBP (mmHg)	87.3±10.8	85.46±10.3	1.560	0.120	86.2±10.5
HR (bpm)	83.9±10.4	84.20±10.0	0.238	0.812	84.1±10.2
RPP	10269.0±1491.9	10351.0±11.2	0.512	0.609	10316.0±1447.2
DYSP	0.6±0.7	0.9±0.7	3.618	0.001*	0.7±0.7
PRE	0.9±0.4	1.0±0.4	1.144	0.254	0.9±0.4

HR – Heart Rate; SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; RPP – Rate Pressure Product; DYSP – Dyspnoea; PRE (FA) – Perceived rate of exertion (Fatigue after); *SD* – Standard deviation, * – indicates significant difference at $p<0.05$

sult indicates that there were significant gender differences only in the general characteristics ($p<0.05$). The mean IPAQ score of all participants was 1471.4±1086.93. The frequency distribution for low, moderate and high PA among the participants was 19% (65), 41.2% (141) and 39.8%(136), respectively. The Chi-square test for comparison of low, moderate and high PA was $X^2 = 31.702$; $p=0.001$. Comparison of the walk test measures by gender and for all participants is presented in table 2.

The mean 6MWD, 6MWW, VO_2max and METS were 639.47±66.6 m, 41805.0±8520.6 kg·m, 28.9±1.92 $mlO_2k^{-1}min^{-1}$, 4.05±0.32 mL/kg, respectively. There was a significant difference in the 6MWD between male and female participants (666.1±67.2 m vs. 627.9±63.9 m; $p=0.001$). Similarly, there were significant gender differences in all the walk test measures ($p<0.05$). There was no significant correlation between PA and weight ($r=0.090$; $p=0.096$), height ($r=0.068$; $p=0.210$) pr body mass index ($r=0.054$; $p=0.322$). Likewise, there was no significant correlation between 6MWD and weight ($r=0.087$; $p=0.108$) or Body Mass Index ($r=0.019$; $p=0.721$), except for height ($r=0.115$; $p=0.019$).

The post-6MWT cardiovascular parameters, perceived rate of exertion and level of dyspnoea of the participants are presented in table 3. From the results, there were no significant gender differences in all the cardiovascular parameters and perceived rate of exertion ($p>0.05$) except in the level of dyspnoea ($t=3.6$; $p=0.001$). Table 4 shows the paired *t*-test compar-

Table 4

Paired t-test comparison of mean difference in post-and-pre 6MWT cardiovascular parameters for all participants according to gender

Variable	Post-6MWT M±*SD*	Pre-6MWT M ±*SD*	Mean diff	*t*-cal	*p*-value
All participants					
HR	84.0±10.2	75.7±10.0	8.4	32.4	0.001*
SBP	122.6±7.8	114.5±10.3	8.1	20.4	0.001*
DBP	86.2±10.5	78.9±10.5	7.3	23.5	0.001*
RPP	10316±1446.9	8676.0±1447.1	1640.2	37.5	0.001*
Male participants					
HR	83.9±10.4	75.6±10.1	8.4	19.0	0.001*
SBP	122.2±7.9	113.6±9.1	8.6	18.9	0.001*
DBP	87.3±10.8	80.1±10.6	7.2	17.1	0.001*
RPP	10269.0±1491.9	8602.4±1454.5	1666.6	24.5	0.001*
Female participants					
HR	84.2±10.0	75.8±10.0	8.4	26.8	0.001 *
SBP	122.9±7.8	115.1±11.1	7.8	12.9	0.001*
DBP	85.5±10.3	78.1±10.4	7.4	16.7	0.001*
RPP	10351.0±1451.2	8730.4±1443.1	1620.8	28.3	0.001*

HR – Heart rate; SBP - Systolic blood pressure; DBP – Diastolic blood pressure; RPP – Rate pressure product. * Indicates significant difference at $p<0.05$. Mean Difference – Post-6MWT value – Pre-6MWT value

Table 5

Pearson moment correlation analysis of the relationships between physical activity and each of the 6MWD, VO_2Max, METS, 6MWW tests

Variable	correlation co-efficient	p-value
All participants		
6MWD (m)	0.268	0.001*
VO_2max	0.268	0.001*
METS	0.268	0.001*
6MWW (kg·m)	0.219	0.003*
Male participants only		
6MWD (m)	0.366	0.001*
VO_2max	0.366	0.001*
METS	0.366	0.001*
6MWW (kg·m)	0.248	0.003*
Female participants only		
6MWD (m)	0.204	0.004*
VO_2max	0.204	0.004*
METS	0.204	0.004*
6MWW (kg·m)	0.196	0.006

6MWD – 6-Minute walk distance; VO_2max – Maximal volume of oxygen uptake; METS – Metabolic equivalent; 6MWW – 6-Minute Walk Work; * – Indicates significant difference at $p<0.05$

ison of mean difference in post-and-pre 6MWT cardiovascular parameters for all participants and by gender. The result indicated that there were significant cardiovascular responses to the 6MWT among the participants ($p<0.05$), similar results were also obtained during gender comparison.

Pearson product moment correlation analysis showed significant relationship between PA and each of the different performance-based exercise capacity measures (Table 5). However, the One-way ANOVA comparison of the post-6MWT cardiovascular parameters, perceived rate of exertion and level of dyspnoea of the participants based on PA levels showed no significant differences in the cardiovascular parameters, perceived rate of exertion and level of dyspnoea of the groups classified on the basis of PA level ($p>0.05$) (Table 6).

Table 6

One-way ANOVA comparison of the participants' post-6MWT cardiovascular parameters, perceived rate of exertion and level of dyspnoea based on physical activity levels

	Physical Activity level				
	Low	Moderate	High		
Variable	Mean ± *SD*	Mean ± *SD*	Mean ± *SD*	F-ratio	*p*-value
HR	84.04±9.8	83.95±10.5	84.25±10.0	0.029	0.971
SBP	121.77±7.5	123.4±7.5	122.12±8.3	1.402	0.248
DBP	86.29±9.8	86.0±10.6	86.41±10.7	0.051	0.950
DYSP	0.9±0.9	0.7± 0.7	0.1±0.2	1.332	0.265
PRE	1.1±1.5	0.9±0.4	0.9±0.4	3.2199	0.042*

HR – Heart rate; SBP – Systolic blood pressure; DBP=Diastolic blood pressure; DYSPA – Dyspnoea; PRE – Perceived rate of exertion; *SD* – Standard deviation; * – indicates significant difference at $p<0.05$

DISCUSSION

From the results of this study, a majority of the participants had s moderate PA level. This finding is at variance with some studies among young adults that reported high rates of physical inactivity[28-30] and considered improving the PA levels of youth as an important public health challenge[3]. A study by Haase et al.[31] on leisure-time PA in university students from 23 countries found that leisure-time PA is below recommended levels in a substantial proportion of students, and is related to cultural factors and the stage of national economic development. However, the high preponderance of moderate PA among the participants in this study can be linked to the active lifestyles of the students. An active lifestyle is largely encouraged by the environment peculiarities of the campus where students' residential areas, lectures theatres, shopping arenas, sports centre facilities are disperse, which consequently, encourages walking which is a light-intensity activity of daily life and a vital component of PA. In addition, the university setting offers social and physical environment opportunities for young adults to engage in PA by providing facilities such as sport fields and other accessible outdoor equipment. Therefore, understanding environmental factors that facilitate or restrict PA for young adults is believed to be vital in developing effective intervention strategies[32,33].

The mean 6MWD of participants in this study was 639.5 ±66.6 m. Literature on reference values for 6MWD in healthy individuals provides a wide range of values[10,12,17,34]. These values are reported to be influenced by factors such as the subjects' age and the degree of test familiarization provided[17]. Comparison of reference values across populations is believed to be difficult because of the variations in methods used in previous studies. However, the 6MWD in healthy adults has been reported to range from 400 m to 700 m[10]. The 6MWD obtained in this study is within the range reported in healthy individuals. A significant difference in the 6MWD between the male and female participants was observed in this study. The male participants had significantly higher 6MWD than their female counterparts (666.1±67.2 m vs. 627.9±63.9 m). The gender pattern for the 6MWD observed in this study is consistent with other reports among healthy subjects. Tsang[35] reported 645 m and 606 m for males and females respectively, while Gibbons et al.[17] found 800 m and 699 m for males and females, respectively. Other studies have associated lower 6MWD with the female gender[36-38]. The anatomical variation between males and females may be implicative of the difference in walk test performances. Generally, females have shorter legs and longer torsos than men, and consequently, shorter strides[37].

From this study, the mean value for 6MWW was 41805.0 ±8520.7 kg·m. The male participants had significantly higher 6MWW (45369.0 vs. 39182.0 kg·m) than their female counterparts. Similar to the findings of this study, a Brazilian study conducted among healthy subjects by Iwama et al.[39] found a significantly greater 6MWW in males than in females (46322 vs. 36356 kg·m). The 6MWW is a recent measure of exercise capacity. It is derived by multiplying 6MWD by body weight. The 6MWW has been hypothesized to be a better measure of exercise capacity. Chuang et al.[16] investigated the 6MWW using body weight-walking distance (i.e. body weight x walking distance) product as an alternative method for assessing exercise capacity for walking. The 6MWW accounts for body weight differences and thereby, estimates both work and energy expenditure expressed as the product of force and distance.

O_2max measurement is a reference parameter in the assessment of the cardiovascular system among healthy subjects and patients, and its prognostic value is well documented[40-42]. The mean predicted VO_2max found among participants in this study was 28.9±1.92 (ml $O_2kg^{-1}min^{-1}$), which is within the mean predicted VO_2 max found in literature for normal and sedentary healthy young adults ranging from 14-38.5 (ml $O_2kg^{-1}min^{-1}$)[43,44]. From this study, the VO_2max was higher among male participants than the female participants. It has been documented that females weigh less and have approximately 10% less muscle mass than men, which contributes to a lower absolute O_2max indicating that body mass plays a significant role in differences between males and females[45-47].

The mean MET for participants in this study was 4.05±0.32mL/kg, which was within the scope reported in literature for normal and sedentary healthy young adults ranging from 4-11 METS [40-44]. METS is defined as the oxygen consumed (millimetres) per kilogram of body weight per minute (ml/min/kg) during rest. It is equal to approximately 3.5mL/kg per minute[6]. It is commonly used to express the workload at various stages of exercise protocols[48].

From this study, the 6MWT evoked significant cardiovascular responses. Similarly, significant difference in SBP, DBP, RPP and HR post-6MWT were found when considered on the basis of gender. The results from this study are consistent with those of Basso et al.[49]m who reported a positive correlation between the 6MWT and cardiovascular parameters among healthy young adult controls but at variance with those of Miyai et al.[50], who reported no significant differences in SBP, DBP and HR pre- and post- submaximal exercise in healthy young adults. Cardiovascular response to exercise has been used in some studies as a major criterion in exercise prescription for both the patient and healthy young adult population[51-53]. Cardiovascular parameters have been shown in literature as important criteria for determining how one's cardiovascular system adapts to stress during PA[54,55]. Although, it is quite predictable that physical exercise evokes cardiovascular responses, however, whether the magnitude of the response is of clinical significance (for example, having a mean difference of 10 mmHg in blood pressure) is important. The results of this study show that the 6MWT evokes cardiovascular response that is statistically but not clinically significant among healthy population.

From this study, a significant relationship was observed between PA and exercise capacity. The different measures of performance-based exercise capacity including 6WWD, 6MWW, VO_2 max and METS demonstrated a significant direct but weak relationship with PA. Similar result patterns were obtained when the performance-based measures of exercise capacity were correlated with PA among male and female participants, respectively. A previous study among the young Greek population found that the 6MWD was significantly related to total PA score[56]. This study's findings are also corroborated by some other studies that found significant associations between exercise and self-reported PA levels in healthy subjects[10,34,57-59]. However, other studies found no significant relationships between PA and exercise capacity[18,60,61].

This study intends to relate self-report of PA with an actual performance of functional capacity. Originally, various studies revealed that timed-walk tests are submaximal non-laboratory estimates of PA in healthy subjects[10,62]. The 6MWT based on the distance covered is a submaximal form of exercise testing and is a powerful prognostic indicator of exercise capacity[63]. Although, more reliable and objective measures of PA, such as pedometers or accelerometers exist, the IPAQ, which is a self-report measure of PA is still commonly used in clinical and research settings[7-9]. Suwanachaiya et al.[64] stated that the discrepancies between the studies on the relationship of PA and 6MWD have not been clearly revealed. The correlation results from this study should be treated with caution. This is consequent to the fact that self-reported estimates of PA are subject to recall bias, mis-reporting, under-reporting or over-reporting. It has been shown that the IPAQ may over-report[65,66] or underestimate[67,68]. It is often believed that in self-report surveys, respondents may not have reported accurately, while others may have experienced more pressure to answer the questions in a socially desirable manner[69-71]. Similarly, physical performance testing is subject to the influence of motivation or standard words of encouragement[15,57,58,72]. If these challenges of both self-report and actual measures of exercise capacity are not minimized, relating both measures may be questionable. Further analyses in this study revealed that anthropometric characteristics had no significant correlations with PA and 6MWD (except for height and 6MWD), and may not have influenced the PA and 6MWD relationship.

CONCLUSION

The majority of participants had moderate physical activity levels. The exercise capacity of the participants was within normal range given in literature and was not influenced by anthropometric parameters. Physical activity level and performance-based exercise capacity had a significant but weak linear relationship. Therefore, self-reports of physical activity in healthy young adults do not adequately substitute the results of the Six-Minute Walk Test.

Conflict of Interest: None declared.

Acknowledgements

The authors wish to thank the African Population and Health Research Centre (APHRC), Nairobi, Kenya for providing technical support through the African Doctoral Dissertation Research Fellowship (ADDRF), Post-Doctoral Fellowship. ADDRF is funded by the International Development and Research Centre (IDRC), Canada.

References

1. Caspersen C.J., Powell K.E., Christenson G.M. Physical activity, exercise, and physical fitness. Public Health Rep 1985; 100: 125-131.
2. Centre for Disease Control (CDC). Compliance with physical activity recommendations by walking for exercise. Michigan, 1996 and 1998, 2000.
3. Adams P.F, Schoenborn C.A., Moss A.J., Warren C.W., Kann L. Health-risk behaviors among our nation's youth: United States, 1992. Vital Health Stat 1995; 10(192): 1-51.
4. Centre for Disease Control (CDC). Assessing Health Risks in America. The Behavioural Risk Factor Surveillance System (BRFSS) at a glance. Atlanta GA. Centre for Disease Control and Prevention. 1995.
5. Warrena J.M., Ekelund U., Bessond H., Mezzanif A., Geladas N., Vanheesh L.; for the Experts Panel. Assessment of physical activity – a review of methodologies with reference to epidemiological research: a report of the exercise physiology section of the European Association of Cardiovascular Prevention and Rehabilitation. Eur J Cardio Prev Rehabil 2010; 17: 127-139.
6. American College of Sports Medicine (ACSM). Principles of Exercise Prescription, William & Wilkins, 5.1995.

7. Macfarlane D.J., Lee C.C, Ho E.Y., Chan KL, Chan DT. Reliability and validity of the Chinese version of IPAQ (short, last 7 days). J Sci Med Sport 2007: 10(1): 45-51.
8. Mäder U., Martin B.W., Schutz Y., Marti B. Validity of four short physical activity questionnaires in middle-aged persons. Med Sci Sports and Exerc 2007; 38(7), 1255-1266.
9. Deng H.B., Macfarlane D.J, Thomas G.N., Lao XQ, Jiang CQ, Cheng KK, et al.. Reliability and validity of the IPAQ-Chinese: the Guangzhou Biobank Cohort study. Med Sci Sports Exerc 2008: 40(2): 303-307.
10. Enright P.L. and Sherrill D.L. Reference equation for the six minute walk test in healthy adults. Am J Respir Crit Care Med 1998; 158: 1384-1387.
11. Hulens M., Vansant G., Claessens A.L., Lysens R, Muls E. Predictors of 6-minute walk test results in lean, obese and morbidly obese women. Scand J Med Sci Sports 2003; 13: 98-105.
12. Troosters T., Gosselink R., Decramer M. Six minute walking distance in healthy elderly subjects. Eur Respir J 1999; 14: 270.
13. Paffenbarger Jr R.S., Hyde R.T., Wing A.L., Steinmetz C.H. A natural history of athleticism and cardiovascular health. JAMA 1984; 252(4): 491-495.
14. World Health Organization. Physical Activity. www.who.int/topics/physical_activity. Assessed 12/08/2013. 2011.
15. American Thoracic Society (ATS) Statement. Guidelines for the six-minute walk test. ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. Am J Respir Crit Care Med 2002; 166(1): 111.
16. Chuang M.L., Lin I.F., Wasserman K. The body weight-walking distance product as related to lung function, anaerobic threshold and peak VO_2 in COPD patients. Respir Med 2001; 95: 618-626.
17. Gibbons W., Fruchter N., Sloan S., Levy R.D. Reference values for a multiple repetition 6-minute walk test in healthy adults older than 20 years. J Cardiopul Rehabil 2001; 21: 87-93.
18. Khuangsirikul W., Jalayondeja W., Chuanchaiyakul R., Krittayaphong R., Chotinaiwattarakul C., Laksanabunsong P. Metabolic equivalent of exercise stress test explained by six-minute walk test in post coronary artery bypass graft and post percutaneous coronary intervention patients. J Med Assoc Thai 2014; 97(Suppl 7): S6-9.
19. Kuijer W., Gerrits E.H.J., Reneman E.F. Measuring physical performance via self-report in healthy young adults. J Occup Rehabil 2004; 14(1): 77-87.
20. Araoye M.O. Sample size estimation. Research methodology with statistics for Health and Social sciences. Ilorin. Nathadex Publishers. 2004.
21. International Physical Activity Questionnaire (IPAQ). International Physical Activity Questionnaire – Short, Last-7-Days Self-Administered. www.ipaq.ki.se/questionnaires. Accessed 14/10/2013.2002.
22. Borg G.A. Psychophysical bases of perceived exertion. Med Sci Sports Exerc 1982; 14: 377-381.
23. International Physical Activity Questionnaire (IPAQ). Guidelines for data processing and analysis of the International Physical Activity. www.ipaq.ki.se/scoring. Accessed 28/10/2013. 2005.
24. Craig C.L., Marshall A.J., Sjöström M., Bauman A.E., Booth M.L, Ainsworth B.E., et al. International Physical Activity Questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003; 35(8): 1381-1395.
25. Ainsworth B.E., Haskell W.L., Whitt M.C., Irwin M.L., Swartz A.M., Strath S.J., et al. Compendium of Physical Activities: an update of activity codes and MET intensities. Med Sci Sports Exerc 2000; 32(9): S498-S516.
26. Gobel F.L., Norstrom L.A., Nelson R.R., Jorgensen C.R., Wang Y. The Rate-Pressure Product as an Index of Myocardial Oxygen Consumption during Exercise in Patients with Angina Pectoris. Circulation 1978; 57: 549-556.
27. Lee C.J., Lee L.H., Wu C.L., Lee B.R., Chen M.L. Exercise Test Modalities. [IN:] Clinical Trials of Drugs and Biopharmaceuticals. CRC Press. Taylor and Francis Group. USA. 2005: 154.
28. Douglas K.A., Collins J.L., Warren C., Kann L., Gold R., Clayton S., et al. Results from the 1995 national college health risk behavior survey. J Am Coll Health 1997; 46(2): 55-66.
29. Li T.Y., Rana J.S., Manson J.E, Willett W.C., Stampfer M.J., Colditz G.A., Rexrode K.M., et al. Obesity as compared with physical activity in predicting risk of coronary heart disease in women. Circulation 2006; 13: 499-506.
30. Sibai A.M., Hwalla N., Adra N., Rahal B. Prevalence and covariates of obesity in Lebanon: findings from the first epidemiological study. Obes Re 2003; 11: 1353-1361.
31. Haase A., Steptoe A., Sallis J.F., 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.
32. Ferreira I., van der Horst K., Wendel-Vos W, Kremers S., van Lenthe F.J., Brug J. Environmental correlates of physical activity in youth – a review and update. Obes Rev 2006; 8(2): 129-154.
33. Wilson A.N, Dollman J. Social influences on physical activity in Anglo and Vietnamese-Australian adolescent males in a single sex school. J Sci Med Sport 2007; 10; 147-155.
34. Harada N.D., Chiu V., Stewart A.L. Mobility -related walk test. Arch Phys Med Rehabil 1999; 80: 837-841.
35. Tsang R.C.C. Reference value for 6-Minute walk test and hand-grip strength in healthy Hong Kong Chinese adults. Hong Kong Physiotherapy Journal (HKPJ) 2005; 23: 6-12.
36. Jay S.J. Reference equations for the six-minute walk in healthy adults. Am J Respir. Crit Care Med 2000; 161(4):1396-1396.
37. Enright P.L., McBurnie M.A., Bittner V., Tracy R.P., McNamara R., Arnold A., et al. Cardiovascular Health Study. The 6-min walk test: a quick measure of functional status in elderly adults. Chest 2003; 123(2): 387-398.
38. Lammers A.E., Hislop A.A., Flynn Y., Haworth S.G. The 6-minute walk test: normal values for children of 4–11 years of age. Arch Dis Child 2008; 93:464-468.
39. Iwama A.M., Andrade G.N., Shima P., Tanni S.E., Godoy I., Dourado V.Z. The six-minute walk test and body weight-walk distance product in healthy Brazilian subjects. Braz J Med Biol 2009; 42(11): 1080-1085.
40. Chung EK. Exercise Electrocardiography practical Approach. 2nd Ed. Baltimore. Williams and Wilkins 1983: 66-76.
41. Stelken A.M., Younis L.T., Jennisons H., Miller D.D., Miller L.W., Shaw L.J., et al. Prognostic value of cardiopulmonary exercise testing using percent achieved of predicted peak oxygen uptake for patients with ischemic and dilated cardiomyopathy. J Am Coll Cardiol 1996; 27(2): 345-352.
42. Szlachic J., Massic B.M., Kramer B.L., Topic N., Tubau J. Correlates and prognostic implication of exercise capacity in chronic congestive heart failure. Am J Cardiol 1985; 55(8): 1037-1042.
43. Ainsworth B.E., Haskell W.L., Leon A.S., Jacobs D.R. Jr, Montoye H.J., Sallis J.F., et al. Compendium of physical activities: classification of energy costs of human physical activities. Med Sci Sports Exerc 1993; 25(1): 71-80.
44. Prentice W.E. Fitness for college and Life. 5th ed. St. Louis. MO Mosby, 1994: 182-183.
45. T. Abe T., Kearns C.F., Fukunaga T. Sex differences in whole body skeletal muscle mass measured by magnetic resonance imaging and its distribution in young Japanese adults. Brit J Sports Med 2003; 37, 436-440.
46. Maud P.J. and Shultz B.B. Gender comparisons in anaerobic power and anaerobic capacity tests. Br J Sports Med 1986; 20(2): 51-54.
47. Perez-Gomez J.G.V., Rodriguez G.V., Ara I., Olmedillas H., Chavarren J., González-Henriquez J.J., et al. Role of muscle mass on sprint performance: gender differences? Eur J Appl Physiol 2008; 102(6): 685-694.
48. Pollock M.L,, Ayres J., Ward A. Cardiorespiratory fitness: response to differing intensities and duration and duration of Training. Arch Phys Med Rehabil 1977; 58: 467-473.
49. Basso R.P., Jamami M., Pessoa B.V., Labadessa I.G., Regueiro E.M., Di Lorenzo V.A. Assessment of exercise capacity among asthmatic and healthy adolescents. Rev Bras Fisioter 2010;14(3): 252-258.
50. Miyai N., Arita M., Miyashita K., Morioka I., Shiraishi T., Nishio I. Blood pressure response to heart rate during exercise test and risk of future hypertension. Hypertension 2002; 39(3); 761-766.
51. American College of Sports Medicine (ACSM). Resource manual for Guidelines for Exercise Testing and Prescription 1993; 2. ed. Philadelphia. Lea and Fabiger.
52. Banner N.R., Lloyd M.H., Hamilton R.D, Innes J.A., Guz A., Yacoub M.H. Cardiopulmonary response to dynamic exercise after heart and combined heart-lung transplantation. Br Heart J 1989; 61(3): 215-23.
53. Laughlin M.H. Cardiovascular response to exercise. Am J Physiol. 1999; 277(6 Pt 2): S244-259.
54. Astrand P.O, Rodahl K. Textbook of work physiology. New York. McGraw-Hill 1977: 617.
55. Astrand P.O, Rodahl K. Circulation, cardiac output and transportation of oxygen. Textbook of work physiology. 3rd ed. New York. McGraw-Hill 1986: 191-194.
56. Psichogiou A.G. Physical activity and functional capacity and normal-weight, overweight and obese Greek young adults. University of Chester MSc dissertation master's thesis). University of Chester, United Kingdom. Pobrano z: http://hdl.handle.net/10034/125147. 2010.
57. Guyatt G.H., Pugsley S.O., Sullivan M.J., Thompson P.J., Berman L., Jones N.L., et al. Effect of encouragement on walking test performance. Thorax 1984; 39(11): 818-822.
58. Guyatt G.H., Thompson P.J., Berman L.B, Sullivan M.J., Townsend M., Jones N.L., et al. How should we measure function in patients with chronic heart and lung disease? J Chronic Dis 1985; 38(6): 517-524.
59. Kennedy D., Stratford P.W., Pagura S.M.C, Walsh M., Woodhouse L.J. Comparison of gender and group differences in self-report and physical performance measures in total hip and knee arthroplasty candidates. J Arthroplasty 2002; 17(1):70-77.
60. Ben Saad H., Prefaut C., Tabka Z., Mtir A.H., Chemit M., Hassaoune R., et al. Six-minute walk distance in healthy North Africans older than 40 years: influence of parity. Respir Med 2009; 103: 74-84.
61. Poh M., Eastwood P.R., Cecins N.M., Ho K.T., Jenkins S.C. Six-minute walk distance in healthy Singaporean adults cannot be predicted using reference equations derived from Caucasian populations. Respirology 2006; 11: 211-216.
62. Reybrouck T. Clinical usefulness and limitation of six-minute walk test in patients with cardiovascular or pulmonary disease. Chest 2003; 123: 325-327.
63. Bittner V., Weiner D.H., Yusuf S., Rogers W.J., McIntyre K.M., Bangdiwala S.I., et al. Prediction of mortality and morbidity with a Six -minute walk test in patients with left ventricular dysfunction. SOLVD Investigators. JAMA1993; 270(14): 1702-1707.
64. Suwanachaiya S., Kulaputanaa O., Chaiwanichsirib B. Walk performance in Thai men and women: physical activity dependence. Asian Biomedicine 2010; 4(1): 87-93.

Medical Rehabilitation (Med Rehabil) 2016, 20 (4): 4-12 DOI: 10.5604/01.3001.0009.5479 eISSN 1896–3250 ISSN 1427–9622 © AWF Krakow

65. Fogelholm M., Malmberg J., Suni J., Santtila M., Kyröläinen H., Mäntysaari M., et al. International Physical Activity Questionnaire: Validity against fitness. Med Sci Sports Exerc 2006; 38(4): 753-760.
66. Zewnicki R., Auweele Z., De Bourdeaudhuij I. Addressing over-reporting on the International Physical Activity Questionnaire (IPAQ) telephone survey with a population sample. Public Health Nutr 2003; 6:299-305.
67. Hallal P.C and Victora C.G. Reliability and validity of the International Physical Activity Questionnaire (IPAQ). Letter to the Editor. Med Sci Sports Exer. 2004; 36:556
68. Kurtze N., Rangul V., Hustvedt B.E. Reliability and validity of the international physical activity questionnaire in the Nord-Trøndelag health study (HUNT) population of men. BMC Medical Research Methodology 2008; 8: 63 [http://www.biomedcentral.com/1471-2288/8/63/ - ins3.].
69. Raphael K. Recall bias: a proposal for assessment and control. Int J Epidemiol 1987; 16:167-70, 1987.
70. Hebert J.R. Social Desirability Bias in Dietary Self-Report May Compromise the Validity of Dietary Intake Measures. Int J Epidemiol 1995; 24: 389.
71. Motl R.W., McAuley E., DiStefano C. Is social desirability associated with self-reported physical activity? Prev Med 2005; 40: 735-739.
72. Demers C., McKelvie R.S., Negassa A., Yusuf A. Reliability, validity, and responsiveness of the six-minute walk test in patients with heart failure. Am Heart J 2001; 142(4): 698-703.

Address for correspondence

Chidozie E. Mbada BMR PhD (PT)
Department of Medical Rehabilitation
College of Health Sciences
Obafemi Awolowo University
Ile-Ife, Nigeria
E-mail: doziembada@yahoo.com
Phone number: +2348028252543