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ASSESSING WALKING STEPS AND ITS RELATIONSHIP WITH NUTRITIONAL STATUS AMONG ADULTS IN KUALA TERENGGANU

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ABSTRACT

To date, 10,000 steps per day are extensively promoted as a target for achieving health-related benefits. Despite mounting evidence on the numerous health benefits provided by sufficient physical activities, little is known about physical activity levels in terms of walking steps of adults in Kuala Terengganu and the relationship between activity levels and nutritional status. Therefore, this study was aimed to assess daily walking steps taken as well as the relationship with nutritional status among 100 adults in Kuala Terengganu, Malaysia. Walking activity was assessed using an Omron HJ-005 pedometer, while nutritional status was assessed through BMI, waist circumference, blood pressure, fasting glucose and serum lipid concentration. On average, participants recorded 5796 (4186) steps per day, below the recommended target of 10,000 walking steps goal. There was no significant relationship found between number of walking steps and nutritional status. Remarkably, daily walking steps were found to be significantly correlated with the International Physical Activity Questionnaire (IPAQ), where $r = 0.26$, $p < 0.01$, indicating that pedometers are good indicators of physical activity levels. Nonetheless, an awareness program to increase the level of leisure-type physical activities such as walking is much encouraged in this population.

Key words: Walking steps, nutritional status, pedometers, physical activity

INTRODUCTION

Physical activity contributes positively to health, while sedentariness or inactivity has been contributing as a risk factor for mortality causing an estimated 6% of deaths globally (WHO, 2009). In Malaysia, recent data indicates that only 14% of adults perform adequate daily physical activity, while 74% of the adults spent majority of their daily time for sedentary activities (Poh *et al.,* 2010). Statistics also show that 33.3% (5.4 million) are pre-obese while 27.2% (4.4 million) are obese in Malaysia (National Health & Morbidity Survey, 2015). This has prompted the Malaysian government to initiate appropriate programs to reduce the prevalence of sedentary lifestyles among Malaysians. Therefore, in July 2009, the Ministry of Health Malaysia introduced the 10,000 Steps Program to encourage the public to embrace physical activity as their daily routine and to promote healthy lifestyle (Geok *et al.,* 2015).

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Research has demonstrated that attaining 10,000 steps per day is associated with various health benefits. Studies have shown that the daily use of pedometers together with a quantifiable walking measure brings about a significant increase in physical activity (Pal *et al.,* 2011). Walking 10,000 steps per day was originally promoted in Japan and appears to be a practical estimation of daily activity for healthy adults. Recent findings have suggested that individuals who take 10,000 daily walking steps have higher possibility to meet the existing physical activity guidelines publicized by the Center for Disease Control and Prevention (CDC), as well as the American College of Sports Medicine (ACSM), which recommended that a healthy individual should engage in at least 30 minutes of moderate-intensity exercise. Tudor-Locke and Bassett (2004) declared that 10,000 steps per day are comparable to about 8 kilometres or 5 miles, or an energy expenditure of 300 to 400 kcal per day.

In recent years, an increasing number of studies have examined the advantages of taking 10,000 steps per day. Many previous studies have revealed

that increased walking activity can improve cardiovascular health as well as lower the risks of coronary heart disease, hypertension, diabetes as well as obesity (Abdullah *et al.,* 2015). A 10,000 daily steps goal effectively increased the physical activity level as well as significant improvements in body weight and body mass index (Dunton & Schneider*,* 2006). One study done among hypertensive patients demonstrated that taking 10,000 steps per day or more for 12 weeks is generally helpful in reducing their blood pressure, sympathetic nerve activity and increasing exercise capacity. The health benefits of walking were further proven by Swartz *et al.* (2003). Their findings proposed that 8 weeks of accumulating daily physical activity, in the form of walking steps, was effective overall at improving glucose tolerance in formerly sedentary, overweight women at risk for developing type 2 diabetes. Furthermore, healthy Brazilian middle-aged men achieving more than 10,000 steps per day have better cardiometabolic conditions (Cocate *et al.,* 2014). In addition, higher levels of physical activity, including walking, have been found to be correlated with better cognitive function in addition to less cognitive decline (Weuve, 2004).

As the 10,000 daily step goal has been widely promoted, researchers are beginning to recognize that pedometers offer a better solution for a low cost and practical monitoring tool that are able to objectively quantify walking steps per day as well, as to motivate the engagement of adequate physical activity (Tudor-Locke, 2002).

Therefore, this study is aimed at measuring the physical activity level by assessing the number of steps, focusing on the relationship between the number of walking steps and nutritional status among the adults in Kuala Terengganu.

MATERIALS AND METHODS

This study involved a cross-sectional study design, including a total of 100 adults aged 18 to 55 years old in Kuala Terengganu for duration of two months from August to October 2016. Based on Cochran's sample size formula, given 95% confidence level, 0.1 precision level, expected proportion of sedentary population among Malaysian is 33.5% (National Health Morbidity Survey, 2015) and considering 15% drop out rate, a total of 100 respondents were obtained. Kuala Terengganu was chosen among eight administrative districts in Terengganu through cluster sampling. Cluster sampling is a type of sampling that continuing narrow the geographic areas until obtain an area which is desire for the study. The respondents were recruited through convenience sampling by face to face approach. It was assumed that the subjects are homogeneous, suggesting that there would be no difference in the study outcomes obtained from a random sample, a nearby sample, a co-operative sample, or a sample assembled in certain unapproachable part of the population.

The questionnaire consists of four sections, which are socio-demography, nutritional status measurement, physical activity level questionnaire, and 24 hour dietary recall. Section A is the socio-demographic section which includes age, gender, race, religion, marital status, education level and monthly household income which denote the characteristics of the study subjects. Section B is the nutritional status assessment part where the variable involved including body weight, body height, body mass index (BMI), body fat percentage, waist circumference, blood pressure, serum lipid concentration as well as blood glucose level. Body weight and body fat percentage of the respondents were measured using Tanita Bioelectical Impedence Analysis (BIA). Waist circumference was determined by locating the upper hip bone and placing a non-elastic tape in a horizontal plane around the abdomen at the level of the top of the iliac crest (Ritchie *et al*., 2005). Blood pressure was measured by using Omron Automatic Blood Pressure Monitor. Blood glucose level and lipid profile were measured by using Accutrend® blood glucose meter and PTS Panels Lipid Panel, respectively. Section C is the physical activity assessment part where daily walking steps and the physical activity questionnaire were used to find out the physical activity participation of the respondents. The physical activity questionnaire is the shortened version of International Physical Activity Questionnaire (IPAQ) which is available from the USDA website (https://snaped.fns.usda.gov/materials/international-physical-activity-questionnaire-ipaq). In this study, the data collected for IPAQ were minutes reported in vigorous, moderate, walking as well as sedentary activities for each week together with MET minutes per week. To calculate the total amount of time spent in each activity category particularly, the number of days involved per week was multiply with the minutes spent performing the activity in a day. On the other hand, the number of minutes expended in each activity category was used to multiply with the particular MET score for different activity category to evaluate the total weekly physical activity (MET-Min week^{-1}) (Oyeyemi *et al.,* 2011). For the last section, three days 24-hour dietary recall form was included. A three days 24-hour dietary recall (two weekdays and one weekend) were used to estimate the energy intake data of the respondents.

The research instrument used to assess walking steps was Omron HJ-005 pedometer. Omron HJ-005 pedometer is used as it is an accurate and reliable

measurement tool that can be employed to quantify physical activity as well as suitable to be employed as a self-monitoring motion sensor considering of its cost and technical requisite for its function. Respondents were instructed to self-monitor their physical activity for two days (including one weekday and one weekend). Respondents were asked to wear the pedometer from the time they woke up in the morning until they went to bed at night, excluding water-based activities (such as swimming) and bathing time. Respondents were asked to write day-end values for pedometer steps and to reset to zero every day. The respondents were instructed to carry out their normal lives without restriction.

Data was analysed using Statistical Package for the Social Sciences (SPSS) version 20.0. In all analyses, results were considered significant at $p < 0.05$. Normality determination using Kolmogorov-Smirnov test was carried out in data analysis. To indicate parametric data, the mean and standard deviation were used while the median, represented by percentiles, was used for non-parametric data. Descriptive statistics such as mean, median, frequency and percentage have been used to present the data including socio demographic data, nutritional status characteristics, physical activity classifications as well as the lifestyle characteristics. To assess the relationship between the daily walking steps and nutritional status including body mass index, body fat percentage, waist circumference, blood pressure, serum lipid and blood glucose level, Partial Pearson correlation were used, controlling for the effect of energy intake. As for the 24 hour dietary recall data, a Nutritionist Pro was used. Nutritionist Pro is a program that provides thorough nutrient analysis of diets which comes with an accurate, up-to-date food and nutrient data, including brand-name, fast foods, ethnic foods and enteral products. Using this program, the daily dietary intake of the respondent can be analysed.

RESULTS AND DISCUSSION

Socio-demographic of respondents

Table 1 shows most of the respondents were female, aged 26 to 30, were predominantly Malay and most of them had completed a Bachelor's Degree. A majority of the adults in Kuala Terengganu (64%) were aware of the 10,000 steps program introduced by the government while 36% of them did not know about the 10,000 steps goal. Extensive effort is needed to ensure more than 80% of the population in Malaysia remains aware and responsive to the 10,000 walking steps program launched by the government.

Table 1. Respondents' Socio-Demographic Profile

Characteristics	Number of respondents n (%)
Gender	
Male	29 (29)
Female	71 (71)
Age (Years)	
Less than 25	37 (37)
25 – 34	41 (41)
35 – 44	15 (15)
45 – 54	7 (7)
Race	
Malay	87 (87)
Chinese	13 (13)
Religion	
Muslim	88 (88)
Buddhist	10 (10)
Others	2 (2)
Marital status	
Single	55 (55)
Married	43 (43)
Widow	2 (2)
Educational level	
Secondary	26 (26)
Diploma	15 (15)
Bachelor degree	40 (40)
Others	19 (19)
Monthly household income	
Less than RM1000	42 (42)
RM1000 – RM1999	13 (13)
RM2000 – RM2999	14 (14)
RM3000 – RM3999	11 (11)
RM4000 – RM4999	6 (6)
RM5000 and above	14 (14)
Overweight family member	
Father	7 (7)
Mother	17 (17)
Siblings	16 (16)
Grandparents	1 (1)
None	59 (59)
10000 steps knowledge	
Yes	64 (64)
No	36 (36)
Occupational activity	
Sedentary	30 (30)
Active	70 (70)

Physical activity level of respondents

Total number of walking steps taken. The adults in Kuala Terengganu walked less on weekend days than weekdays. From Table 2, the number of walking steps taken on weekdays was 6256 (5528) steps while the number of walking steps taken on weekend days was 5053 (4465) steps. According to the occupational activity reported by the

respondents, a total of 70% of them claimed that their job schedules were active. This indicated that they might have to walk around at workplace or carry heavy burdens as well as perform physically strenuous work. Therefore, a high step count on weekdays was expected. Conversely, a lower step count during the weekend was most likely because the respondents preferred to spend more time indulging in sedentary or light leisure physical activities such as reading and watching television or movies at home. On average, the adults took 5796 steps per day. According to the physical activity standard established by Tudor-Locke and Basett (2004), taking 5000 to 7499 walking steps per day is considered as "low active". Therefore, the adults in Kuala Terengganu were categorized as "low active". Unlike the study conducted by Hazizi *et al.* (2012) which involved a total of 174 undergraduate students enrolled in Universiti Putra Malaysia, the physical activity recorded among undergraduate students was 7947 ± 2817 steps per day, classified as "somewhat active". Besides, another study performed by Abdullah *et al*. (2015) had shown comparable results whereby the 112 university employees aged 21-65 years from Universiti Kebangsaan Malaysia recorded an average of 7521 ± 3707 steps per day. However, all the subjects in these studies failed to achieve achieved the recommended target of 10,000 steps per day. Compared to 10,000 steps, only 57.9% of the total recommended daily walking steps were achieved in this study. These results were found to be in line with a report from Malaysian Adult Nutritional Survey (MANS) which stated that only 14% of adults successfully attained the desired amount of daily physical activity (Poh *et al.,* 2010). Malaysia is experiencing a major shift of job-related activities especially in urban areas toward computerization and automated equipment, which has contributed to a more sedentary working atmosphere and consequently a decline in their daily physical activity (Chan *et al.,* 2014). Furthermore, various studies have shown that an awareness of the significance of physical activity could be attributed to external and internal barriers (Justine *et al.,* 2013). Major barriers reported by people who were trying to engage in physical activity include lack of time, low self-efficacy, lack of access to convenient facilities, and lack of safe environment (Centers for Disease Control and Prevention, 2011). Therefore, the 10,000 steps daily step goal should be given more attention in order to achieve the physical activity recommendation guidelines.

Physical Activity Categories of Respondents. In 2004, Tudor-Locke and Basett had established a graduated step index for healthy adults. In this study, most subjects were said to be physically inactive. As seen from Table 3, a total of 35% adults performed limited activity, which indicated 2500 to 4999 daily walking steps, while 3% of them only engaged in basal activity, equivalent to less than 2500 steps. Remarkably, 15% of them did actually achieve 10,000 walking steps as recommended. These results can be explained by the study conducted by Chan *et al.* (2014) which stated that women participation in physical activity were generally lower than men. This might be due to the fact that women are more likely to engage in light and moderate intensity activities such as daily chores, gardening and grocery shopping whereas men tend to involve in vigorous-intensity activities including playing sports, running, and swimming. Since the respondents in this study were predominantly female, the findings are not surprising.

Relationship between daily walking steps and physical activity level

The physical activity level of the respondents was analysed and reported in terms of median MET-minutes. A Spearman correlation test was carried out to determine the association between the physical activities assessed by using pedometers and International Physical Activity Questionnaire (IPAQ). As shown in Table 4, the reported value was $r = 0.26$, $p < 0.01$, indicating daily walking steps were found to be slightly correspond to the real life

Table 2. Total Number of Walking Steps Taken

Number of walking steps	Median (IQR)
Weekday	6256 (5528)
Weekend	5053 (4465)
Average	5796 (4186)

Table 3. Physical Activity Classification of the Respondents

Physical activity categories (number of walking steps)	Number of respondents n (%)
Basal activity (less than 2500)	3(3)
Limited activity (2500 – 4999)	35(35)
Low active (5000 – 7999)	30(30)
Somewhat active (7500 – 9999)	17(17)
Active (10000 and above)	15(15)

Table 4. Relationship between Daily Walking Steps and Physical Activity Level

Variable	Physical Activity Level	
	Spearman Correlation (r)	p - value
Daily walking steps	0.26	0.01

* $p < 0.05$ indicated significant relationship

daily physical activity level. Therefore, it may be assumed that pedometer-determined physical activity levels deliver sufficient information to distinguish between levels of physical activity reported on the IPAQ, which verifies the pedometers data is reliable in physical activity assessment in large, free-living populations.

Nutritional status characteristics of respondents

Based on Table 5, generally, the nutritional status of adults in Kuala Terengganu was within the normal range according to the established guidelines. The median value obtained for BMI was somewhat overweight. The mean value for systolic and diastolic pressure was in a normal blood pressure range. In terms of the lipid profile characteristics, the adults in Kuala Terengganu had normal values for the different parameters including total cholesterol, high density lipoprotein cholesterol (HDL-c), low density lipoprotein cholesterol (LDL-c) and triglycerides.

Relationship between the number of daily walking steps and nutritional status

Body mass index. There was no significant relationship ($r = -0.10$, $p = 0.32$) between the daily walking steps and the body mass index (BMI) as shown in Table 6. This finding is comparable with studies carried out by Abdullah *et al*. (2015) and Pal *et al.* (2009). There were no significant differences found in between accumulated steps per day and BMI. However, ample evidence has shown that individuals who achieved the 10,000 steps per day target were more likely to have a healthier weight range and be classified as normal weight. For instance, Chan *et al.* (2003) specified that pedometer-determined steps per day were associated inversely with BMI among 106 generally sedentary workers in Canada ($r = 0.40$, $p < 0.0001$). The findings of this study may be affected by the fact that majority of the study subjects were being overweight or obese (63%) and generally sedentary or low active (68%). Moreover, Melanson *et al.* (2004) suggested that pedometer accuracy may also be compromised in obese individuals who tend to walk slower. Since most the participants of that study were overweight or obese, the steps counts were unable to detect accurately. Therefore, the relationship between daily walking steps and body mass index were found to have varied result as there was questionable accuracy.

Body fat percentage. On the subject of body fat percentage, there was no significant relationship between daily walking steps and the body fat percentage ($r = -0.08$, $p = 0.43$). However, the present results contradict those of a previous study in which a 10,000 steps per day exercise prescription resulted in 1.9% of body fat percentage reduction among 56 sedentary, overweight or obese adults (Dunton & Schneider., 2006). Despite the fact that numerous studies had demonstrated that daily walking steps is inversely associated with body fat percentage, this study was found to differ from previously published studies. This may be partly due to the fact that the instruments used in their studies were different. As most of the studies utilized the high accuracy air displacement plethysmography, it was expected to be more accurate and reliable, causing the relationship to be demonstrated successfully.

Waist circumference. A non-significant negative correlation was found between daily walking steps and waist circumference. The findings of the current study supported the study carried out by Backholer *et al.* (2012). According to them, there was no relationship between daily step count and the degree of change in waist circumference among 762 Australian adults. However, this result is inconsistent with the previous study which indicated

Table 5. Nutritional Status Characteristics of Respondents

Nutritional Status	Mean±SD or Median (IQR)
Weight (kg)	60.5 (20.9)
Height (cm)	159.32 ± 8.71
Body mass index (kg/m^2)	24.24 (7.79)
Body fat percentage (%)	25.65 ± 9.92
Waist circumference (cm)	78.94 (20.15)
Blood pressure	
Systolic pressure (mmHg)	109.96 ± 14.32
Diastolic pressure (mmHg)	72.00 ± 10.27
Serum lipid	
Total cholesterol (mmol/L)	4.94 ± 1.01
HDL-c (mmol/L)	1.45 (0.57)
LDL-c (mmol/L)	2.92 ± 0.90
Triglyceride (mmol/L)	1.03 (0.61)
Blood glucose (mmol/L)	5.8 (0.9)

Table 6. Relationship between daily walking steps and nutritional status

Variable	Daily walking steps	
	Partial Pearson Correlation (r)	p – value
Body Mass Index	-0.10	0.32
Body Fat Percentage	-0.08	0.43
Waist circumference	-0.11	0.29
Systolic Pressure	0.10	0.35
Diastolic Pressure	-0.08	0.46
Total cholesterol	0.11	0.29
HDL-cholesterol	0.13	0.19
LDL-cholesterol	0.04	0.71
Triglyceride	0.07	0.47
Blood glucose	0.01	0.88

that the number of daily walking steps significantly influenced that waist circumference among 93 postmenopausal women (Krumm *et al.,* 2006). According to Shepherd *et al.* (1999), waist circumference may have an absolute effect on pedometer accuracy. They proposed that large amount of abdominal adipose tissue may reduce the vertical accelerations of the trunk, contributing to a lesser step counts. Furthermore, accuracy among individuals with a higher amount of abdominal adipose tissue may be compromised due to the pedometer is often tilted away from the vertical plane, therefore increasing friction in the spring-suspended lever arm and causing all the steps could not be recorded accurately. With this, it is possible that the inaccuracy of the measurements cause the results to show discrepancies.

Blood pressure. In terms of blood pressure, the finding revealed that there was no significant association between daily walking steps and blood pressure. On the contrary, Kelley *et al.* (2001) reported that walking notably reduced both the systolic and diastolic blood pressure among adults in their meta-analysis. Besides that, various walking programs had demonstrated significant blood pressure lowering effects in 24 hypertensive individuals (Moreau *et al.,* 2001). Similarly to previous studies, Manjoo *et al.* (2010) also suggested that habitual walking decreases blood pressure among 201 individuals with type 2 diabetes. According to a systematic review conducted by Lee *et al.* (2010), walking has shown beneficial effects on lowering either systolic or diastolic blood pressure or both. However, the walking interventions which exhibited favourable outcome tended to have greater sample size, higher baseline blood pressure level, along with moderate to high intensity walking. As a result, this recent study failed to demonstrate the relationship between walking steps and blood pressure might due to the relatively small sample size and the subjects were normotensive, causing less capacity for relationship determination.

Serum lipid profile. The findings show no relationship between daily walking steps and lipid profile, including total cholesterol, high density lipoprotein cholesterol (HDL-c), low density lipoprotein cholesterol (LDL-c) and triglyceride. This association is supported by Duncan *et al.* (1991). Their study showed that there is not necessary for female to engage in vigorous physical activity to achieve significant improvements in their lipoprotein profile. Likewise, Tucker and Friedman (1990) stated that the relationship between walking and serum cholesterol are not warranted among 3621 adults. A study carried out by Tully *et al.* (2005) showed that no significant changes were found in lipid levels among the 21 subjects participating in a walking program. However, this was contradicted with a study conducted by Sugiura *et al.* (2002) which stated that increasing the number of daily walking steps can improve the serum lipids profile among 27 subjects. Kukkonen-Harjula *et al.* (1998) also found insignificant but consistently favourable changes regarding the risk of coronary heart disease occurred in serum lipoprotein fractions upon walking training among 117 healthy middle-aged adults. As the subjects in this study generally had an optimum mean baseline values, no noticeable improvements were to be expected as well as the short duration of the study period causing the relationship failed to be demonstrated.

Blood glucose level. Based on the results obtained, daily walking steps were not associated with blood glucose level. In contrast, Rosenqvist (2001) verified the relationship between walking and blood glucose level by pointing out low-intensity walking exercise was sufficient to produce a notable acute reduction of blood glucose levels among 39 elderly type 2 diabetes patients. However, the outcome of the current study can be supported by Morton *et al.* (2010), as they concluded that there was no change in fasting blood glucose level after walking training among 27 people with type 2 diabetes. Similarly, Belli *et al.* (2011) proposed that 12 weeks of supervised walking training did not leads to noteworthy changes in fasting blood glucose among 19 sedentary type 2 diabetic women, revealing there was no major relationship between walking steps and blood glucose level. The relationship between walking steps and blood glucose level failed to be demonstrated, perhaps due to the low intensity of activity. In addition, endogenous glucose production directly affects fasting glucose (Healy *et al.,* 2006). The walking steps taken by the respondents may not have been sufficient to alter endogenous glucose production. Therefore, there was no relationship to be found.

CONCLUSION

This is the first study aimed at determining the daily walking steps taken and investigating whether there was a correlation between the daily walking steps and nutritional status among the adult population in Kuala Terengganu. The findings from this study showed that the studied population was generally low active. Remarkably, the walking steps had positive weak correlation with the International Physical Activity Questionnaire ($r = 0.26$, $p < 0.01$). Thus, walking steps is said to be one of the good indicators to measure physical activity level. This study provides information regarding the physical activity level in terms of daily walking steps among adults in Kuala Terengganu. The association

between steps taken per day and nutritional status needs to be investigated further to confirm the relationship.

Several limitations must be noted in this current study. First, the cross-sectional nature of the study limits conclusions about causation. Furthermore, the subjects were not selected randomly from the population. This created a selection bias, as the populations agreeing to play a part may be different from the non-participating populations. Additionally, pedometers do have limitations, specifically for the measurement of sedentary behaviour. Self-reported pedometer-determined physical activity data cannot be considered a gold standard for objectively measured physical activity, since social desirability bias as well as questionable steps counts can occur. In addition, since the present study was conducted in a free-living environment where the subjects were given a pedometer to wear for 2 days without any supervision, respondents may have forgotten to wear their pedometer for steps count measurement and thus, manipulation of data may have occurred.

Further research is still warranted to assess the daily walking steps and its relationship with nutritional status. Given these limitations, a large, randomized controlled trial of men and women over a range of ages is required. A minimum of three days of physical activity monitoring is required, as any three days can provide adequate estimate of pedometer-determined steps per day (Tudor-Locke *et al.,* 2005). Furthermore, examining a specific exercise prescription in terms of walking steps or walking intervention might be a better approach for relationship determination.

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