

THE ASSOCIATION BETWEEN ACCELEROMETER-DETERMINED PHYSICAL
ACTIVITY AND NUTRITIONAL STATUS AMONG USM STAFF

by

NAJIBAH NABILAH RADZI

Thesis submitted in partial fulfillment
of the requirements of the degree of
Bachelor of Health Sciences (Nutrition)

JUNE 2013

Hubungkait antara Aktiviti Fizikal yang ditentukan oleh Accelerometer dengan Status Pemakanan di Kalangan Staf USM

ABSTRAK

Tujuan kajian ini adalah untuk menentukan hubungan antara aktiviti fizikal yang ditentukan oleh accelerometer dengan status pemakanan di kalangan staf Universiti Sains Malaysia (USM). Seramai 41 staf (25 lelaki dan 16 perempuan) berbangsa Melayu mengambil bahagian dalam kajian ini. Berat badan, ketinggian, lilitan pinggang dan pinggul, dan komposisi badan diukur bagi setiap responden. Semua responden diminta untuk memakai accelerometer selama tujuh hari. Berdasarkan indeks jisim badan, majoriti (41.5%) daripada responden mempunyai berat badan berlebihan, manakala 17.1% adalah obes, 39% adalah normal dan hanya 2.4% adalah kekurangan berat badan. Berdasarkan ukuran lilitan pinggang, 39% daripada responden berisiko tinggi untuk mendapat obesiti abdomen. Majoriti responden (56.1%) telah diklasifikasikan mempunyai aktiviti fizikal yang kurang aktif dan seramai 26.8% daripada mereka adalah sedentari. Sementara itu, 14.6% adalah agak aktif dan hanya 2.4% yang mempunyai aktiviti fizikal yang aktif. Tiada hubungan yang signifikan dapat dilihat antara tahap aktiviti fizikal dengan BMI ($r = 0.23$, $p = 0.153$), lilitan pinggang ($r_s = 0.25$, $p = 0.119$), nisbah pinggang-pinggul ($r_s = 0.02$, $p = 0.906$), jumlah lemak badan ($r = 0.15$, $p = 0.360$) dan kedudukan lemak visceral ($r = 0.22$, $p = 0.168$). Sebagai kesimpulan, tiada hubungan yang signifikan antara tahap aktiviti fizikal yang ditentukan oleh accelerometer dengan status pemakanan di kalangan staf USM.


The Association between Accelerometer-determined Physical Activity and Nutritional Status among USM Staff

ABSTRACT

The aim for this study was to determine the association between accelerometer-determined physical activity and nutritional status among Universiti Sains Malaysia (USM) staff. A total of 41 Malay (25 males and 16 females) employees participated in this study. Body weight, height, waist and hip circumferences, and body composition were measured for each respondent. All respondents were asked to wear an accelerometer for seven days. Based on body mass index, majority (41.5%) of the respondents were overweight, while 17.1% were obese, 39% were normal and only 2.4% were underweight. According to waist circumference measurement, 39% of respondents were identified to have abdominal obesity. Majority of the respondents (56.1%) were classified to have low active physical activity and 26.8% of them were sedentary. Meanwhile, 14.6% were somewhat active and only 2.4% were having active physical activity. There were no significant association between physical activity level and BMI ($r=0.23$, $p=0.153$), waist circumference ($r_s=0.25$, $p=0.119$), waist-hip ratio ($r_s=0.02$, $p=0.906$), total body fat ($r=0.15$, $p=0.360$) and visceral fat rating ($r=0.22$, $p=0.168$). In conclusion, there is no significant association between accelerometer-determined physical activity level and nutritional status among USM staff.

DECLARATION

I hereby declare that the thesis is my original work except for the quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently submitted for any other degree or purposes in Universiti Sains Malaysia or at any other institutions.

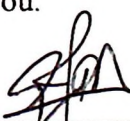


Najibah Nabilah Radzi

Date: 9/7/13

I certify that Ms Najibah Nabilah Radzi has carried out her study entitled “The Association between Accelerometer-Determined Physical Activity and Nutritional Status among USM Staff” as a final year research project in nutrition under my supervision. She has complied with the ethical standard and regulations in conducting her study and has completed writing her thesis. I am satisfied with her work and have no objection for the thesis to be examined by the appointed examiners by the School of Health Sciences, Universiti Sains Malaysia.

Thank you.



Dr. Hamid Jan Jan Mohamed
Senior Lecturer,
School of Health Sciences,
Health Campus,
Universiti Sains Malaysia,
16150 Kubang Kerian,
Kelantan

Date: 9/7/13

ACKNOWLEDGEMENT

I wish to thank, first and foremost, to the course coordinator, Prof. Wan Abdul Manan Wan Muda for the advice and guides in the process of preparing this thesis. I would like to address special gratitude to my supervisor, Dr. Hamid Jan Jan Mohamed, for the great opportunity to be his undergraduate student, for the continuous encouragement and knowledge that he had shared to me throughout all processes in this thesis writing. Without his useful comments, remarks and guidance, this thesis would not accomplish successfully. I would also like to thank for all the financial support for the sake to afford all cost required in this study.

It gives me great pleasure in acknowledging the help of my seniors who giving me fruitful ideas and guidance in completing this study. Special thanks to Ms Loy See Ling and Ms Marhazlina Mohamad for assisting me to complete this study from initial to final draft. Besides, I would like to thank to all USM staff who willing to be my respondents. Not forgotten to thank all the staff in Nutrition and Dietetic Laboratory for providing me with help throughout data collection process and facilities for anthropometry tools.

Last but not least, this thesis is dedicated to my family who has always giving support and help throughout my life. I would also like to give very special thanks to all my friends who always supported and encouraged me in all these years.

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LIST OF ABBREVIATIONS

BMI	-	Body mass index
SPSS	-	Statistical Package for Social Sciences
USM	-	Universiti Sains Malaysia
WHR	-	Waist-hip ratio
WHO	-	World Health Organization

DEFINITION OF KEY TERMS

- Accelerometer - Accelerometer is a device that measures the acceleration of the body or body segments in one or more directions, which serves as an objective measurement of physical activity (Warrant et al., 2010).
- Physical activity - Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen et al., 1985)
- Nutritional status - Nutritional status is known as a measurement of the extent to which an individual's physiological need for nutrients is being met.

CHAPTER 1 INTRODUCTION

1.1 Introduction

Physical activity involves any bodily movement produced by skeletal muscles that results in energy expenditure. The amount of physical activity varies between individuals depending on their personal choice and capabilities (Caspersen et al., 1985). Physical activity has three main components, the occupational work, household and other chores and leisure-time physical activity. An individual that participate in passive behaviors and produce minimal body movement throughout the day is determined to be physically inactive (Malaysia Dietary Guidelines, 2010).

A prolonged sedentary time is associated to an independent risk factor for early death and poor health outcomes (Thorp et al., 2012). People with low physical activity levels and has ample access to energy-rich foods are at increased risk of becoming overweight or obese (Anderson et al., 2009). Obesity has become one of the most significant public health challenges which demands for both effective prevention and treatment (Jakicic & Otto, 2005). Decreasing physical activity over time seems to increase risk of both fat and weight gain (Peterson & Tucker, 2008). Many evidences supported that physical activity combined with modifications of energy intake is the most effective behavioral approach in addressing the obesity epidemic. Improving physical activities in daily life helps to maximize weight control and corresponding improvements in health related outcomes (Jakicic & Otto, 2005).

Physical inactivity could lead to the risk of non-communicable diseases such as cardiovascular disease, type 2 diabetes and some cancers (WHO Global Health Risks, 2009). This is supported by Owen et al. (2010), as habitual sedentary behavior is identified as a novel risk factor for cardio-metabolic disease and all-cause mortality, independent of time spent in exercise. Physical inactivity also is associated to the cardiorespiratory and muscular fitness, bone health and depression especially among adults (WHO Global recommendations on Physical Activity for Health, 2010). Meanwhile, moderate-to-vigorous intensity physical activity has been identified as a key preventive role in cardiovascular disease, type 2 diabetes, obesity, and some cancers (Hamilton et al., 2008).

Physical activity is complex and difficult to accurately measure all of its aspects. That is why assessment of the impact on outcome parameters of physical activity such as energy expenditure became intricate (Plasqui & Westerterp, 2007). Selection of method to assess physical activity can influence the accuracy of result of a physical activity study. Accelerometer can be a useful tool to assess the amount and intensity of physical activity in a population study. It is indentified that objective measure (accelerometer) of physical activity level is more accurate than subjective measures.

As Malaysia has a limited data on accelerometer-determined physical activity as compared to other countries, therefore, further exploration on the assessment of physical activity level using objective methods is required. Meanwhile, questionnaire-based research on the association between physical activity level and chronic risk

factors is somewhat established (Zahratul et al., 2012). Thus the purpose of the current study was to determine the association between physical activity and nutritional status among USM staff based on accelerometer step counts.

1.2 Background of the Study

During past several decades, there have been observed striking reductions in human energy expenditure and increases in sedentary behavior. Nowadays, everything have been re-engineered in ways that minimized human movement and muscular activity be it at work sites, schools, homes or public spaces. This makes people to move less and sit more. In occupational settings, activity that is undertaken during the course of work is depending on the task-based activities. Employees with less or inactive jobs engaged in more sedentary time (Thorp et al., 2012).

Accelerometer can be used to assess physical activity level in the population studied. It can provide information about the total amount, the frequency, the intensity and duration of physical activity in daily life (Plasqui & Westerterp, 2007). Assessment method for physical activity level highly contributed to the accuracy of the result obtained (Zahratul et al., 2012). The selection of method to assess physical activity may be a trade-off between degree of validity and feasibility, but the method must be suitable for the aims of the study (Warren et al., 2010). Previous research had identified that objective measure of PA level is more accurate than subjective measures (Zahratul

et al., 2012). Therefore, accelerometer can be a useful tool to assess the amount and intensity of physical activity in a population study (Yoshioka et al., 2005).

1.3 Rationale of the Study

Increase in physical activity is an effective therapeutic intervention in the prevention and treatment of obesity and its related disease. Therefore, the amount as well as the intensity of physical activity might be important potential determinants of overweight and obesity in a population. Valid and feasible instruments are needed to assess the level and pattern of physical activity in the population. This research helps to explore the field of physical activity assessment. This research is conducted to determine the significant association between accelerometer-determined physical activity and nutritional status among USM staff.

This research also will indicate the use of accelerometer as an accurate and easy measure of physical activity. Besides that, the knowledge that will be gained from this research later can be widely used in monitoring and managing lifestyle especially among population studied. Assessment of physical activity level enables preventive actions to be taken prior to risks of poor health outcomes associated to physical inactivity.

1.4 Problem Statement

Employees are at increased risk of becoming overweight or obese. Automation and labor-saving devices promote sedentary setting for many workers at workplaces (Anderson et al., 2009). These settings caused people to move less and sit more (Owen et al., 2010). Apart from workplace factors, habitual sedentary behavior doubles the risk of non-communicable diseases and all-cause of mortality. Increased efforts are needed to encourage all adults to adopt an active lifestyle and engage in ≥ 30 minutes of physical activity on most days of the week (Kruger et al., 2008).

Accelerometer is an objective measure that can be used to assess physical activity level in a population study. This method of physical activity assessment level is identified to have a limited data in Malaysia as compared to other countries. Therefore, further exploration on accelerometer-determined physical activity is required (Zahratul et al., 2012). Thus the purpose of this study is to determine the association between physical activity and nutrition status among USM staff based on accelerometer step counts.

1.5 Objectives of the Study

The overall purpose of this study is to determine the accelerometer-determined physical activity and nutritional status among USM Staff. The specific objectives are:

- i. To describe the physical activity level among USM staff by using accelerometer.
- ii. To determine the nutritional status among USM staff.
- iii. To determine the association between accelerometer-determined physical activity and body mass index (BMI), waist circumference, waist hip ratio and body composition.

1.6 Conceptual Framework

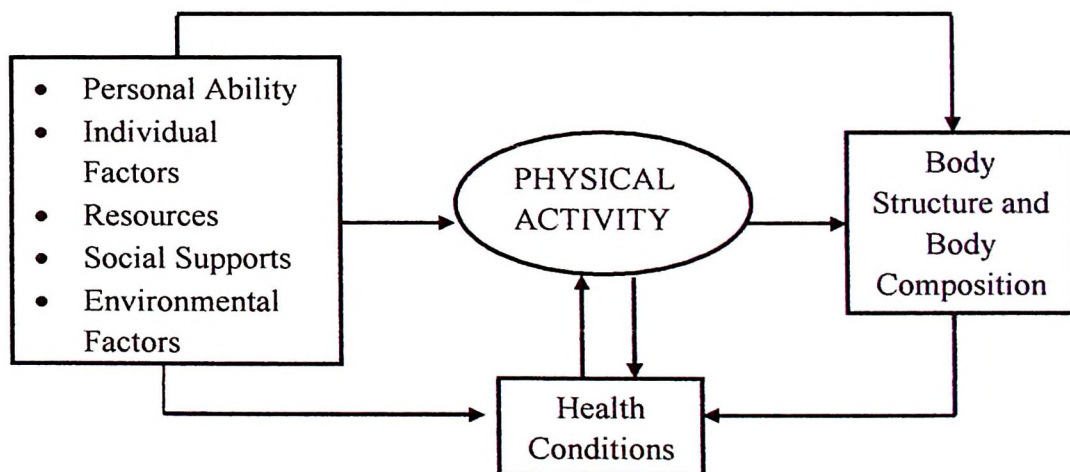


Figure 1.1: Conceptual framework of the study

1.7 Research Questions

- i. What is the level of physical activity among USM staff?
- ii. Does nutritional status affected by physical activity?
- iii. Is there any association between accelerometer-determined physical activities with body mass index, waist circumference, waist hip ratio and body composition?

1.8 Research Hypothesis

Null hypothesis, H_0 : There is no significant association between accelerometer-determined physical activity and nutritional status among USM staff.

Alternative hypothesis, H_A : There is significant association between accelerometer-determined physical activity and nutritional status among USM staff.

CHAPTER 2 LITERATURE REVIEW

2.1 Physical Activity Concept

Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure. The amount of physical activity depends on individual choice and may vary considerably from person to person as well as for a given person over time (Caspersen et al., 1985). On the other hand, activities that do not increase energy expenditure substantially above the resting level such as sleeping, sitting, lying down, and watching television is define as sedentary behavior (Pate et al., 2008).

Physical activity is a complex behavior. In daily life, it can be categorized into occupational, sports, conditioning, household or other activities (Caspersen et al., 1985). Physical activity has an impact on energy expenditure, and the extent to which body movement leads to energy expenditure is dependent on body size and body composition (Plasqui & Westerterp, 2007). Thus, physical activity is a key determinant of energy expenditure, and is fundamental to energy balance and weight control (World Health Organization, 2004).

Physical activity dimensions include intensity, frequency, and duration, which together make up the total volume of activity (Corder et al., 2008). Intensity level depends on the type of activity conducted such as leisure-time physical activity,

resistance training or occupational physical activity. Frequency is described based on the number of activity sessions per day, week or month and duration typically refers to the number of minutes of activity in each session. These dimensions are used to describe the dose of physical activity, which can bring changes in the levels of a defined health parameter such as risk factor, disease, anxiety level and quality of life (Howley, 2001).

2.2 Physical Activity Prevalence and Recommendation

Sedentary activities appear to be most prevalent amongst adult Malaysians (Poh et al., 2010). A survey by Poh et al. (2010) found out that Malaysian adult population spent most of their time in sedentary activities such as sitting and sleeping or lying down. Results from the Malaysian Non Communicable Diseases Surveillance of 2005/06 have demonstrated that the prevalence of physical inactivity among Malaysian was 60.1% (Ministry of Health, 2006).

Physical inactivity is recognized as major public health problem and this has led to the promulgation of public health recommendations for physical activity (Blair et al., 2004). It is recommended that individuals engage in adequate level of physical activity throughout their life. Different types and amounts of physical activity are required for different health outcomes. Current public health recommendations for physical activity are for at least 30 minutes of regular, moderate-intensity physical activity each day. This recommendation provides substantial benefits on health outcomes such as reduced

risk of cardiovascular disease and diabetes, colon cancer and breast cancer (World Health Organization, 2004).

2.3 Physical Activity, Nutritional Status and Health

Physical activity has a positive influence on body composition (Peterson & Tucker, 2008). Active individuals also more likely to achieve weight maintenance, have a healthier body mass and composition (World Health Organization, 2011). Significant associations between physical activity levels assessed by an accelerometer and the indices of obesity including BMI, waist circumference and body fat percentage has been shown in a study by Hazizi et al. (2012). Among 233 Malay government employees in Penang, approximately 50.2% of the respondents were overweight or obese. There were negative but significant relationships between body mass index, body fat percentage, waist circumference, and physical activity level. Zahratul et al. (2012), also identifies the association of accelerometer-determined physical activity with BMI, waist circumference, body fat percentage and blood profile. The prevalence of inactivity in the present study was higher than available national data and stronger correlations were observed between the objectively assessed physical activity level and health indicators.

Individuals with low physical activity levels are at increased risk of becoming overweight or obese (Anderson et al., 2009). Sedentary individuals had a higher risk than moderate to active individuals of having a BMI more than or equal to 25 kg/m², an-risk classified waist circumference and a body fat percentage classified as unhealthy

(Hazizi et al., 2012). A study conducted among Japanese population using accelerometer-determined physical activity assessment showed that overweight and obese individuals had a lower step rate and spent less time for moderate to vigorous physical activity. Moreover, overweight was inversely related with time spent in vigorous physical activity (Yoshioka et al., 2005).

Regular participation in physical activity and exercise results in positive health-related outcomes (Howley, 2001). Poor health outcomes (Thorp et al., 2012) and risk of getting cardio-metabolic disease (Owen et al., 2010) are greatly associated to a prolonged sedentary time.

2.4 Physical Activity at Workplaces

Variation in task-based activities (Thorp et al., 2012) and use of automation and labor-saving devices (Anderson et al., 2009) at workplaces promotes employees to move less and sit more (Owen et al., 2010), which is a key setting for sedentary behavior. Among 233 Malay government employees in Penang, 65% of the respondents were categorized as sedentary (Hazizi et al., 2012). A study conducted among government employees at government agencies in Kangar, Perlis identified that, 44.9% of the respondents were categorized as active to vigorous while 55.1% were sedentary (Zahratul et al., 2012). However, Siti Affira et al. (2011) indicated there is no association between job category and physical activity level among respondents.

Thorp et al found that working hours among Australian employees from different workplace settings were mostly spent sedentary (77%), with approximately half of this time accumulated in prolonged bouts of 20 minutes or more. This study found that the majority of work hours were spent sedentary and that work time involved a substantial proportion of time spent in prolonged sedentary bouts. This finding suggests the need for further device-based measurement studies in workplaces and for clarifying the potential health risk for workers who are exposed to prolonged periods of unbroken sitting.

2.5 Physical Activity Assessment

Physical activity assessment is important to determine whether physical inactivity is a problem and setting goals for physical therapy interventions to increase physical activity. The assessment also serves as basis to provide incentives and track adherence to recommendations made for increasing physical activity. Physical activity assessment can be used as an outcome measure for physical therapy interventions (Berlin et al., 2006). Physical activity assessment methods can be divided into subjective and objective methods, which assess different aspects of physical activity and may be combined in any study (Corder et al., 2008).

Subjective or self-report assessment includes questionnaires, diaries, logs and recalls (Warren et al., 2010). This method is suitable to be used for all populations and reduce the respondent burden. Self-report method eases data collection process and

analysis instead of being inexpensive (Warren et al., 2010). However, a research which uses self-reporting assessment shows that the data are subjected to potential misclassification bias (Kruger et al., 2008). The ability to accurately recall all relevant details retrospectively may influence the accuracy of information collected. The information also can be influenced by the opinion and perception of the participant, proxy reporter or investigator (Corder et al., 2008). Limitation occurs as respondents may be prone to provide socially desirable responses, thus results in over- or underestimation of the actual behavior (Kruger et al., 2008).

Meanwhile, objective measures involve motion sensors, accelerometers and pedometers, heart rate monitoring, direct observation and doubly-labeled water (Warren et al., 2010). Objective methods involve the measurement of physiological or biomechanical parameters and use this information to estimate physical activity outcomes, such as instantaneous and daily physical activity energy expenditure (PAEE) (Corder et al., 2008).

Accelerometry gives the objective indicator of body movement and suitable to be used for all populations. Inaccurate assessment of a large range of activities gives accelerometry some disadvantages. Pedometry involves objective measure of common activity behavior and relative ease of data collection. This method is limited due to its inability to examine the rate or intensity of movement and is specifically designed to assess walking only (Warren et al., 2010).

Heart rate monitoring provides easy and quick measurement of heart rate and information about the intensity. This method only useful for aerobic activities and concerns must be taken account as conditions unrelated to physical activity also can cause an increase in heart rate (Warren et al., 2010). Meanwhile, doubly-labeled water is a technique that can provides an accurate measure of total energy expenditure (TEE). However, this technique is expensive and do not provide information on physical activity patterns in terms of frequency, duration and intensity (Plasqui & Westerterp, 2007).

2.6 Accelerometer

Accelerometry involves the measurement of acceleration of the body or body segments in one or more directions. Therefore, it serves as an objective measure of overall physical activity and time spent in activities of varying intensities. This method is suitable for all populations and has low burden onto respondent (Warren et al., 2010). The accelerometer is small, light and easy to use (Yoshioka et al., 2005). Besides that, accelerometer provides information about the total amount, the frequency, the intensity and duration of physical activity in daily life (Plasqui & Westerterp, 2007).

According to Sisson et al. (2012), objective monitoring is useful in measuring all domain of physical activity which is not easily captured on surveys. Zahratul et al. (2012) also states that the use of objective measure (accelerometer-determined) of physical activity level is more accurate than subjective measures. This study also

suggested that a larger sample size is needed in future studies to confirm the advantages of objective measures of physical activity level as compared to subjective measures.

However, disadvantages of using accelerometer are inaccurate assessment of a large range of activities and financial cost also may be an issue (Warren et al., 2010). Accelerometers have several important limitations, notably, potential underestimation of overall activity because they cannot accurately capture activities that are not step-based (for example, swimming, cycling). In addition, accelerometers do not measure the added energy expenditure associated with upper body movement (for example, weight-lifting, shoveling snow), load carrying, or walking up an incline (Colley et al., 2011).

Most research that uses accelerometer to measure physical activity in a population study will require all respondents to wear the accelerometer during all waking hours and not to remove the device except for water-based activities and sleeping (Hazizi et al., 2012; Thorp et al., 2012). Differences in wear time of accelerometer among respondents may affect the estimates of physical activity. Therefore, Herrmann et al. (2012) purposed a study to determine hours of wear time that represents a valid day. The study suggested that using accelerometer wear time criteria of 12 h/day or less may underestimate step count and time spent in various physical activity levels.

Allowing physical activity data with less wear time may underestimate the amount of activity performed. Generally, longer wear times provided significantly

greater amounts of steps and time in inactivity, light intensity and moderate intensity physical activity. Furthermore, the amount of error was greater with less wear time for all variables (step count, physical inactivity and physical activity). This study demonstrated that with increased accelerometer wear time there were significantly more minutes recorded in inactivity and light to moderate intensity physical activity. Meanwhile, the duration spent in vigorous intensity activity was insufficient to be affected by accelerometer wear time (Herrmann et al., 2012).

Number of days participants need to wear an accelerometer is also important. Sufficient number of days of monitoring activity must be met, so that the resulting daily average reflects an individual's usual or habitual level of physical activity. Among adults, 3-5 days of monitoring is required to reliably estimate habitual physical activity, whereas at least 7 days was required to reliably assess patterns of inactivity (Troost et al., 2005).

Steps per day have become the frequently used metric to assess physical activity (Sisson et al., 2012). There are emerging studies indicate the health benefits of attaining 10,000 steps per day. 10,000 steps per day appear to be a reasonable estimated of daily activity for apparently healthy adults. This recommendation is simple, easy to remember and provides people with a concrete goal for increasing activity (Tudor-Locke & Basset, 2004).

CHAPTER 3 METHODOLOGY

3.1 Study Design

This research project used cross-sectional design to determine the association between the parameter studied. This study was conducted by collecting data on the level of physical activity and nutritional status among Universiti Sains Malaysia (USM) staff in order to determine the association between these two parameters.

3.1.1 Population and Setting

The participants included in this cross-sectional study are employees working in Universiti Sains Malaysia, Healthy Campus, Kubang Kerian, Kelantan. Staffs age between 18 to 60 years old were recruited into this study based on the study criteria. The staffs that were involved in this study are all Malay. All participants were asked to read and sign informed consent document prior the assessment (Appendix 2).

3.1.2 Sample Size

Sample size calculation is performed by Stata statistical software by using results of relationship between body mass index and physical activity level, $r = -0.353$ (Hazizi et al., 2012).

Estimated sample size for Pearson Correlation Test

Assumptions:

Alpha	= 0.050
Power	= 0.800
Null Rho	= 0.000
Alt Rho	= 0.353 (r value)

Estimated required sample size, $n = 61$

Considering drop out compensation of 10%, the total estimated sample size:

$$n = 67$$

The calculated sample size for this study was 61 respondents. With the addition of 10% drop-outs, the sample size proposed was 67.

3.1.3 Sampling Method

This research study was conducted using convenience sampling method. During recruitment period, staffs working at various departments in USM Healthy Campus were approached by the researcher. However, only 52 staffs agreed to participate in the study. After eliminating the respondent who was dropout from the study, there were 41 staffs included in the analysis.

3.1.4 Inclusion and Exclusion Criteria

Upon the approval from Universiti Sains Malaysia Human Research Ethics Committee (USMKK/PPP/JEPeM [260.4.(3.6)]) (Appendix 5), the study has recruited respondents based on the following criteria:

The inclusion criteria were:

1. Staff of USM Healthy Campus
2. Age between 18 to 60 years old
3. Physically and mentally healthy

The exclusion criteria were:

1. Unable to complete 7 days of activity assessment
2. Respondents with physical disabilities
3. Pregnant and lactating mothers

3.2 Instrumentation

The assessment of demographic background, physical activity level and anthropometric measurement of respondents were conducted during data collection process. A variety of instruments, including accelerometers, body meter, and body composition analyzer were used in the data collection. The following section includes a brief description of these instruments.

3.2.1 Demographic Background

A demographic form was given to each respondent. The form asked about variables such as sex, current age, race, phone number, email address, marital status, occupation and average working hours per day. This demographic form is attached (Appendix 3).

3.2.2 Physical Activity Assessment

Daily physical activity of each respondent was monitored by using Lifecorder e-Step (Kenz, Suzuken Japan). Respondent were given explanation and guidelines on how to wear the accelerometer. All respondents were asked to wear the accelerometer during all waking hours for seven days. During the time frame, respondents were instructed not to alter their usual physical activities, to wear the accelerometer during all waking hours

and not to remove the device except during water-based activities and sleep. The accelerometer was worn at the waistline, clipped to a belt or clothing of the respondent.

Daily steps were summed and divided by the number of days the accelerometer was worn to derive average steps per day. The established pedometer-determined physical activity cut points for healthy adults (Tudor-Locke & Basset, 2004) were used to organize steps per day-defined activity levels. The accelerometer data was organized in the following physical activity categories (Table 3.1):

Table 3.1: Step per day-defined activity levels

Category	Step counts (steps/day)
Sedentary	<5000
Low active	5000-7499
Somewhat active	7500-9999
Active	10,000-12,499
Highly active	≥12,500

Source: Tudor-Locke & Basset, 2004

3.2.3 Anthropometry Measurement Instruments

Anthropometry measurement involve in this study were weight, height, waist circumference, hip circumference and body composition. The following section includes a description of all the measures that were analyzed in the current study.

3.2.3.1 Body Height

Respondent's height was measured using a portable measuring unit (Seca 206, Germany). This Seca 206 Body Measuring Tape has a measuring range of 0 to 220 centimeters and is available in either inch measurements or centimeter measurements. However, the current study uses centimeter measurements in the reading of respondent's height.

The respondents were asked to remove their sandals or shoes prior measuring their height. The respondent stood in correct position below the body meter, straightened their legs with heels together. Heels, buttocks and scapulae of subject were against the vertical surface of the wall with relaxed shoulder, arms to the side and head were in the horizontal plane.

Before the measurement were taken, respondents were asked to inhale deeply, hold the breath and maintain an erect posture while the headboard was lowered on the highest point of the head with enough pressure to compress the hair. The measurement

was conducted two times and average reading was recorded to obtain a more accurate reading. The measurement was read to the nearest 0.1 cm.

3.2.3.2 Body Mass Index

Body Mass Index (BMI) of the respondents was defined as the weight in kilograms divided by the square of the height in meter (kg/m^2). This index is commonly used to classify underweight, overweight, and obesity in adults. The classifications of BMI from World Health Organization (2000) were used and are shown in Table 3.2.

Table 3.2: The international classification of adult underweight, overweight and obesity according to BMI

Classification	BMI (kg/m^2)
Underweight	<18.50
Normal	18.50-24.99
Overweight	25.00-29.99
Obese	≥ 30.00

Source: World Health Organization (2000)

3.2.3.3 Waist and Hip Circumference

Waist circumference is a valuable additional alternative method in identifying individuals at increased risk as it is positively correlated with abdominal fat. A non-stretchable measuring tape was used to measure waist and hip circumference. Respondent was asked to stand upright with feet 25 to 30 cm apart to make sure the weight is evenly distributed.

Measurement was taken on the right or left side of the respondent. Waist circumference is measured at the midpoint between the lowest rib and the iliac crest, whereas hip circumference is measured at the level of maximal gluteal protrusion. Both reading was taken twice, nearest to 0.1 cm. Average from the reading was recorded as the waist or hip circumference of respondent. The proposed waist circumference cut-off points by WHO/IASO/IOTF (2000) were adopted as in Table 3.3.

Table 3.3: Waist circumference cut-off points for increased risk to metabolic diseases

	Men	Women
WHO/IASO/IOTF (2000)	≥90 cm (35 inches)	≥80 cm (32 inches)