THE ASSOCIATION BETWEEN A BODY SHAPE INDEX (ABSI) AND BODY FAT COMPOSITION

by

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THESIS SUBMITTED IN PARTIAL FULLFILMENT OF THE REQUIREMENT OF THE DEGREE OF BACHELOR OF HEALTH SCIENCES (NUTRITION)

JUNE 2013

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.

I certify that Ms NG AI PING has carried out her study entitled The Association between A Body Shape Index (ABSI) and Body Fat Composition 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.

ACKNOWLEDGEMENT

I acknowledge, with deepest gratitude, my debt of thanks to my supervisor, Dr. Hamid Jan bin Jan Mohamed from Nutrition Programme, School of Health Sciences, Universiti Sains Malaysia, Kelantan, Malaysia for his patiently advice. Without his guidance and encouragement, this dissertation would not have been possible.

I would like to express my appreciation to Miss Loy See Ling, post-graduation student from Nutrition Programme, School of Health Sciences, Universiti Sains Malaysia, Kelantan, Malaysia for her aid in giving me a clearer and detail concept of my study, as well as guiding me for the statistical analysis.

In addition, millions of thanks to the supporting staffs of Nutrition and Dietetics Programme in the laboratories as well as the selected student who had giving me their fully co-operation and commitment throughout my data collection process. I also thank my family, course-mates, and friends who are always be there for me to support and encouragement me throughout the study. Thanks for those who had helped me to collect data in the field and enlighten me the statistical analysis knowledge.

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LIST OF SYMBOL, ABBREVIATION AND ACRONYMN

ABSI	- A Body Shape Index
BIA	- Bioelectrical impedance analysis
BMI	- Body mass index
CDC	- Centers for Disease Control and Prevention
CI	- Confidence interval
DEXA	- Dual-energy X-ray absorptiometry
FFM	- Fat free mass
MESA	- Multi-Ethnic Study of Atherosclerosis
MRI	- Magnetic Resonance Imaging
NCEP-ATPIII	- National Cholesterol Education Program's Adult Treatment Panel III
NHANES III	- National Health and Nutrition Examination Survey III
NHLBI	- National Heart Lung and Blood Institute
PPSK	- School of Health Sciences (Pusat Pengajian Sains Kesihatan)
SAQ	- Self-administered questionnaire
SD	- Standard deviation
STEPS	- STEPwise Approach to Surveillance
TBF	- Total body fat
TBF%	- Total body fat percentage
TBW	- Total body water

TF	- Trunk fat
TF%	- Trunk fat percentage
US	- United States
USMKK	- Healthy Campus Universiti Sains Malaysia (Universiti Sains Malaysia Kampus Kesihatan)
VFR	- Visceral fat rating
VFR1	- Visceral fat rating using TANITA SC330S,
VFR2	- Visceral fat rating using TANITA AB140M
WC	- Waist circumference
WHO	- World Health Organization
WHR	- Waist-hip ratio
WHtR	- Waist-to-height ratio

ABSTRAK

Berdasarkan WHO, sekurang-kurangnya 2.8 juta orang dewasa mati akibat berat badan berlebihan atau masalah yang berkaitan dengan obesity pada setiap tahun. Objektif kajian ini adalah untuk menentukan hubungan antara A Body Shape Index (ABSI) dan komposisi lemak badan. Kajian ini dijalankan untuk mengenal pasti kelaziman masalah berat badan berlebihan dan obesiti di kalangan pelajar PPSK di USMKK. Komposisi lemak badan 87 orang lelaki dan 101 orang pelajar perempuan USMKK yang berumur 19 hingga 28 tahun telah dinilai dengan kaedah bio-impedans (TANITA). 'Independent t-test' telah digunakan untuk membandingkan min BMI dan WC. Kelaziman BMI di kalangan pelajar adalah 14.9%, 61.2%, 17.0%, dan 6.9% bagi berat badan kurang, berat badan normal, berat badan berlebihan dan obesity masing-masing. Didapati bahawa 17.6% orang pelajar mempunyai WC> 102cm dan >88cm bagi lelaki dan perempuan, masing-masing. Terdapat perbezaan yang ketara bagi min TBF%, VFR, TF%, ABSI, and WHtR tanpa mengira jantina. Walau bagaimanapun, ia tidak menunjukkan sebarang perbezaan yang ketara bagi min WC dan BMI. Analisis 'Pearson correlation' telah digunakan untuk menentukan hubungan antara WC, BMI, ABSI, WHtR dan komposisi lemak badan. ABSI telah menunjukkan hubungan yang lemah dengan TF% ($r = 0.206$, $p=0.05$) dan WC ($r = 0.267$, $p<0.001$) tetapi menunjukkan hubungan negatif dengan BMI, WHtR, TBF%, dan VFR. 'Multiple linear regressions' telah digunakan untuk meramalkan hubungan antara ukuran antropometri dan komposisi lemak badan. Didapati bahawa WC, BMI, WHtR boleh meramal TF% ($p <0.001$) tetapi ABSI bukan satu indicator yang berkesan untuk mengganggarkan komposisi lemak badan.

ABSTRACT

According to WHO, at least 2.8 million adults die over overweight or obese related disorders yearly. The objective of this study was to determine the association between A Body Shape Index (ABSI) and body fat composition. This study was carried out to identify the prevalance of overweight and obesity among students of PPSK in USMKK. 87 male and 101 female students of USMKK aged 19 to 28 years were evaluated for body fat composition, using validated bio-impedance equipment (TANITA). Independent t-test was used to compare the mean values of BMI and WC. The prevalence of BMI among the students were 14.9%, 61.2%, 17.0%, and 6.9% for underweight, normal weight, overweight, and obese, respectively. It was found out that 17.6% of the students have either WC >102cm and >88cm for male and female, respectively. There was a significant difference of mean TBF%, VFR, TF%, ABSI, and WHtR across sex. However, it did not show any significant difference of mean for WC and BMI. Pearson correlation analysis was used to determine the association between WC, BMI, ABSI, WHtR and body fat composition. ABSI showed positive correlation with TF% (r=0.206, p=0.05) and WC (r=0.267, p<0.001) but showed negative correlation with the BMI, WHtR, TBF%, and VFR. Multiple linear regressions were used to predict the relationship between anthropometric measurements and body fat composition. It was found out that WC, BMI, and WHtR were predictive for trunk fat (p<0.001) but ABSI showed non-significant relationship. In short, ABSI was not an indicator to predict body fat composition.

CHAPTER 1 INTRODUCTION

1.1. Study Background

Overweight and obesity are the common risk factors of the top 10 worldwide leading causes of death, namely ischaemic heart disease, stroke and other cerebrovascular disease, and diabetes mellitus (Hoyert, 2012; Kochanek, 2011; WHO, 2011). According to World Health Organization (WHO), overweight and obesity rank as the fifth leading risk for global deaths which kill more people than underweight. At least 2.8 million adults die over overweight or obese related disorders yearly. Since 1980, obesity has increased twofold globally, and in year 2008, more than 1.4 billion 20-year-old and older adults were overweight. Of these over 200 million men and nearly 300 million women were obese. Overall, more than one in ten of the world's adult population was obese (WHO, 2012). Alarmingly, the prevalence of obesity in Malaysia had increased from 4.4% in 1996 to 14.0% in 2006 (Mohamud, W. N., 2011).

An adult with a BMI of 25 to 29.9 and 30 or higher is considered overweight and obese, respectively. World Health Organization (WHO) defines overweight and obesity as an abnormal or excessive fat accumulation over the body which may result in health impairment, National Heart Lung and Blood Institute (NHLBI) refers overweight and obesity to the body weight which is greater than what is generally considered healthy for a certain height, while Centers for Disease Control and Prevention (CDC) states that overweight and obesity are both labels for ranges of weight that are greater than what is considered healthy for a given height which have been shown to link to certain diseases and other health problems (CDC, 2012; NHLBI, 2012; WHO, 2012).

Overweight and obesity among adults are commonly classified by simple obesity indices, namely body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) (Gill et al., 2003; Len Kravitz, 2010). BMI is a simple index of weight-for-height which is defined as the weight in kilograms divided by the square of the height in metres (kg/m2) (WHO, 2012). WC is an index for fat distribution that can be measured either at the narrowest part of the waist, in a horizontal plane around the abdomen at the level just above the uppermost lateral border of the iliac crest (superior border of the iliac crest, WCiliac crest), just below the lowest rib (i.e. distal border of the lowest rib, WCrib), or midway between both sites (measured distance, WCmiddle) (Bosy-Westphal et al., 2010; Chen et al., 2009). WHR is the measurement of waist circumference divided by the hip circumference where the waist is measured at the narrowest part of the waist, between the lowest rib and iliac crest, and the hip circumference is taken at the widest area of the hips at the greatest protuberance of the buttocks (Len Kravitz, 2010). WHtR is the measurement of waist divided by the height (Weili et al., 2007).

The indices of body fat deposits have been reviewed from time to time. Concern and controversy of the best predictors of obesity-related disorders have been arisen. The diagnosis of overweight and obesity using inappropriate indices might underestimate or overestimate the body fat deposits, misclassifying the subjects. Take BMI as an example, it might not able to distinguish between fat mass and lean body mass. BMI also shows limitation to characterize adiposity across age, ethnicity and gender (Chen et al., 2009; Daniels, 2009; Nevill Am Fau et al., 2006; Wang et al., 1994).

A single universal cut-off level for BMI, WC, WHR and WHtR should not be used to classify obesity for all populations. Studies show that Asian populations require a lower cut-off level than western populations to define abdominal obesity (Wang et al., 1994). No single indices should be used alone in predicting body fatness. BMI, WC, WHR and WHtR can be obtained simultaneously as simple useful obesity indices in predicting obesity related disorders (Chen et al., 2009). In July 2012, Krakauer et al. had introduced a new body shape index - A Body Shape Index (ABSI). It combines BMI and WC, expressed as $ABSI \equiv \frac{WC}{BMI^{\frac{2}{3}} height^{\frac{1}{2}}}$. It perhaps could be a better alternative for body fat deposits predictor (Krakauer et al., 2012).

In our study, we aimed to determine the association between A Body Shape Index (ABSI) and body fat composition. We wished to determine whether A Body Shape Index (ABSI) could be used as surrogate indicator to estimate the body fat composition, specifically the abdominal adipose tissue mass.

1.2. Objectives

1.2.1. General Objective : To determine the association between A Body Shape Index (ABSI) and body fat composition.

1.2.2. Specific Objective :

a) To determine the association between A Body Shape Index (ABSI) with total body fat, visceral fat and trunk fat.

1.3. Research Questions

1.3.1. What is the relationship between between A Body Shape Index (ABSI) and total body fat composition?

1.4. Research Hypothesis

1.4.1. Null Hypothesis

There is no association between A Body Shape Index (ABSI) and body fat composition.

1.4.2. Alternative Hypothesis

There is an association between A Body Shape Index (ABSI) and body fat composition.

1.5. Significance of the Study

Through this study, the prevalence of overweight and obesity among students of School of Health Sciences (PPSK) in Healthy Campus Universiti Sains Malaysia (USMKK) was determined and it might alarm the school authorities to take actions to encourage the students to maintain a normal, healthy weight range. Besides, once the association between ABSI and body fat composition is significantly stronger than the other obesity indices, it might be used as a better predictor for obesity-related disorders in the future.

CHAPTER 2 LITERATURE REVIEW

2.1. Overweight and Obesity

According to WHO 2013, overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health, as a result of an energy imbalance between calories consumed and calories expended. It is believed that an increased intake of energy-dense foods that are high in fat, and an increase in physical inactivity due to the increasingly sedentary nature of many forms of work, changing modes of transportation, and increasing urbanization are the fundamental causes of overweight and obesity nowadays. Overweight and obesity is a major risk factor for non-communicable diseases such as cardiovascular diseases (mainly heart disease and stroke), diabetes, musculoskeletal disorders (especially osteoarthritis - a highly disabling degenerative disease of the joints), and cancers (endometrial, breast, and colon). However, overweight and obesity, as well as their related non-communicable diseases, are preventable (WHO, 2013).

2.2. Body Composition

Body composition divides body mass into two or more compartments using atomic, molecular, cellular or tissue models. Brozek et al. (1963) developed a two-component molecular level models which divided the body mass into fat and fat-free body compartments. During the derivation of the two-compartment model, Brozek et al. (1963) divided the body into four chemical groups mainly water, protein, ash or bone mineral, and fat. The two and four compartment models served as the basic of developing body composition methods.

Human body composition is assessed by two types of methods, namely traditional and new methods. Assessments like total body water, total body potassium, urinary creatinine excretion, densitometry, and anthropometry are examples of traditional method while assessments like neutron activation analysis, muscle metabolites, absorptiometry, electrical conductance, computerized tomography, subcutaneous adipose tissue thickness, and magnetic resonance imaging are examples of new body composition measurement method (Lukashi, 1987). The ideal method of assessing body composition should be relatively cost-friendly, easily to be operated, highly reproducible and yield accurate results.

There are various highly sophisticated methods that can be used as reference measures of body composition. However, according to Wells et al. (2006), the gold standard for body composition analysis is cadaver analysis. There is no any highest accuracy in vivo technique of measuring body composition. No any single technique can be used sufficiently accurate to act as a reference for body composition measurement. Different body composition measurement technique has its advantages and disadvantages because in vivo body composition measurement is not a perfect process, which might subject to various constraints.

Body fat composition includes total body fat, trunk fat, and abdominal visceral fat. True obesity is determined not by weight but by trunk fat. Trunk fat consists of the fat at head, neck, chest, abdomen, and lower back. In the Skinfold model, trunk fat was defined as the sum of chest, subscapular, and abdominal skinfolds, and total fat was the sum of triceps, biceps, chest, subscapular, abdomen, thigh, and calf. In the Dual-energy X-ray absorptiometry (DEXA) model, trunk fat was defined as the Lunar DXA trunk region, and total fat was whole body fat mass (TANITA, 2011).

Abdominal visceral fat is also known as stomach fat, belly fat, or abdominal fat, which deposited in the midsection of the body around the abdominal organs. Individuals who have large deposits of abdominal fat tissue are at increased risk for hypertension, adult-onset diabetes mellitus, cardiovascular disease, gallstones, arthritis, and some forms of cancer (NHANES, 2007).

2.3. Bioelectrical Impedance Analysis (BIA)

According to Houtkooper et al. (1996), BIA is a quick, easy, relatively inexpensive, safe, noninvasive, portable method of estimating body composition, especially providing accurate and reliable estimates of fat-free mass (FFM) and total body water (TBW) among healthy population, which is based on empirical relation between the volume of a conductor and its electrical impedance.

BIA is always preferable in field or clinical setting because it does not require a high degree of professional or technical skill, it is more comfortable and less intrusive for the subjects, and this method can be used to estimate body composition among the obese individuals. For better accuracy result of BIA measurement, it is suggested that quit eating or drinking within 4 hours 7days of the test, no exercise within 12 hours 7days of the test, urinate within 30 minutes 7days of the test, no alcohol consumption within 48 hours 7days of the test, no diuretic medication within 7days of the test, no testing of female subjects who perceive they are retaining water during that stage of their menstrual cycle (Heyward, 2001).

However, Dehghan et al. (2008) stated that BIA did measure body fat accurately in controlled clinical conditions but it showed inconsistent performance in the field. BIA might be influenced by factors such as contact between limbs and trunk, inaccurate body weight, consumption of food and drink before measurement, moderate to intense level physical activity 2-3 hours before measurement, medical conditions impacting fluid and electrolyte balance, ambient temperature, individual characteristics like abdominal obesity, muscle mass, weight loss, menstrual cycle, and ethnic variation.

The Abdominal Fat Analyzer AB140M and Body composition Analyzer SC330S using bioelectrical impedance analysis for measurement by TANITA company used in this study were tested and validated based on data from approximately 600 Japanese subjects of a variety of physiques from infants to athletes, healthy adults and people with spinal injuries (TANITA, 2011).

2.4. Anthropometry

According to NHANES III (2007), anthropometry is literally 'the measurement of man'. It could encompass any physiological, psychological or anatomical trait, referring specifically to morphological traits which can be externally measured. It includes the measurement in terms of the dimensions of bone, muscle, and adipose tissue. Examples of anthropometry are stature, weight, skin folds, girths, and breadths. Higher subcutaneous adipose tissues are reported to be at increased risks for hypertension, adult-onset diabetes mellitus, and cardiovascular disease. Anthropometry is a relatively quick, simple, and cheap means of nutritional assessment. However, it has its limitations, too. Its limitations include the extent to which measurement error can influence interpretation, and the length of time needed to take measurements. Terms like reliability, reproducibility, undependability, precision, imprecision, bias, validity, and accuracy are needed to be taken into consideration when taking anthropometric measurement.

According to Report on a WHO Expert Consultation on waist circumference and waist-hip ratio, WHO STEPwise Approach to Surveillance (STEPS) protocol stated that the measurement of waist should be made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest while the United States (US) National Institutes of Health (NIH) protocol provided in the NIH Practical guide to obesity (NHLBI Obesity Education nitiative, 2000) and the protocol used in the US National Health and Nutrition Examination Survey (NHANES) III (Westat Inc, 1998) indicate that the waist circumference measurement should be made at the top of the iliac crest.

The NIH also provided a protocol for the measurement of waist circumference for the Multi - Ethnic Study of Atherosclerosis (MESA) study. This protocol indicates that the waist measurement should be made at the level of the umbilicus or navel (WHO, 2008). Some other studies, on the other hand, have assessed the waist circumference at the point of the minimal waist.

Men with WC greater than 102cm (40in) and women with 88cm (35in) were considered at increased cardiovascular risk. Klein et al. (2007) stated that WC was often used as a surrogate marker of abdominal adiposity because it correlated with subcutenous and intra-abdominal fat mass, associated with cardiovascular disease risk. In a study by Rankinen et al. (1999) which evaluated the merit of body mass index, body fat percentage, waist circumference and waist-to-hip ratio as predictors of abdominal visceral fat level, they found out that waist circumference was the best overall predictor of abdominal visceral obesity.

However, some studies stated that WC cannot distinguish abdominal subcutaneous fat, total abdominal fat, and total body fat, and it was strongly correlated with BMI. In a study by Kee et al. (2011), they assessed the sensitivity and specificity of WC, compared with the cut-off points based on BMI. Their findings demonstrated that the current recommended WC cut-off points had low sensitivity for identification of overweight and obesity in Malaysian men but had accepatable sensitivity in women for identification of overweight and obese. In the study by Misra et al. (2005) also found out that

Asians appeared to have higher mortality at lower cut off points for WC than do white Caucasians. Heterogeneity of body composition of abdominal tissues with metabolic factors and cardiovascular risk factors in different ethnics did not have a standard cut off points that could be applied uniformly.

BMI was developed by Adolphe Quetelet during the 19th century. During the 1970s and based especially on the data and report from the Seven Countries study, researchers noticed that BMI appeared to be a good proxy for adiposity and overweight related problems. It is formerly called the Quetelet index, is a measure for indicating nutritional status in adults. It is a measure of weight relative to height, denoted as weight in kilograms divided by height in metres squared (kg/m^2). It is an easy and acceptable proxy for thinness and fatness which has been directly related to health risks and death rates in many populations. BMI falls into below 18.5 as underweight, 18.5 to 24.9 as normal weight, 25.0 to 29.9 as pre-obesity, 30.0 to 34.9 as obesity class 1, 35.0 to 39.9 as obesity class 2, and above 40 as obesity class 3.

BMI is very easy to measure and calculate. Thus, it becomes the most commonly used tool to correlate risk of health problems with the weight at population level. However, like any other measure. BMI is not perfect. It does not take into consideration different levels of adiposity based on age, physical activity levels and sex, only dependant on height and weight. Therefore, it might overestimate adiposity in some cases and underestimates it in others.

In the study of Gómez-Ambrosi et al. (2011), they assessed the degree of misclassification on the diagnosis of obesity using BMI as compared with direct body fat percentage (BF%) determination and compared the cardiovascular and metabolic risk of non-obese and obese BMI-classified subjects with similar BF%. They found out that BMI although was an valuable tool for epidemiological studies, underestimated BF% especially in the overweight category. The use of BMI for diagnosing obesity in clinical practice might underestimate the true prevalence of obesity, increasing life-threatening conditions or disorders.

In another study by Frankenfield et al. (2001) on the limits of BMI to detect obesity and predict body composition, they found out that percent of body fat and body fat divided by height were predictable from BMI, but the accuracy of the prediction was lowest when the BMI was below 30 kg/m^2. They concluded that measurement of body fat was a more appropriate way to access obesity in people with a BMI below 30 kg/m^2.

The ratio of waist to hip circumference is widely used to characterize fat distribution patterns. Men with WHR value greater than 0.94 and women with WHR value greater than 0.88 are found to correspond to a critical accumulation of visceral adipose tissue. However, Rankinen et al. (1999) stated that WHR was a poor indicator of abdominal visceral fat among the women and it should not be used as a surrogate measure of visceral fat. Molarius et al. (1999) also concluded in their study that waist circumference reflected mainly the degree of overweight whereas WHR did not.

WHtR is denoted in the formula waist divided by height. Sahin et al. (2011) stated that WHtR had been adopted as more accurate predictors of obesity-related cardiovascular risk, compared with BMI. They concluded that WHtR was a simple and effective index to identify health related risk. In a systematic review of WHtR as a screening tool for the prediction of cardiovascular disease and diabetes, Browning et al. (2010 found out that WHtR and WC were more significant than BMI in predicting cardiometabolic outcomes. By comparing WHtR and WC, they realized that WHtR may be a more useful global clinical screening tool than WC, with a weighted mean boundary value of 0.5.

Hsieh et. al. (2003) also studied on WHtR. In their findings, they stated that WC was improved by relating it to categorized fat distribution of different genders and ages. WHtR was a simple and practical anthropometric index that can be used to identify people at higher metabolic risk within the normal and overweight range. Wu et. al. (2009) also supported that WHtR predicted visceral fat better than WC, BMI, and WHR.

In a study by Krakauer et. al in July of 2012, a new body shape index was developed to predict the mortality hazard independently of body mass index. A Body Shape Index (ABSI) was a formula based on (WC) adjusted for height and weight, denoted in the formula ABSI = WC/[(BMI2/3)*(height1/2)]. They found out that body shape appeared to be a substancial risk factor for premature mortality in the general USA population derivable from basic clinical measurements.

According to Krakauer et al. (2011), this newly developed and applied ABSI was based on WC, weight and height. High ABSI indicated that WC was higher than expected for a given height and weight, corresponding to a more central concentration of body volume. They found out that ABSI showed little correlation with BMI. They also found out that ABSI was positively correlated to trunk fat mass as extimated from X-ray scans. ABSI was proven to be able in predicting mortality risk across age, sex and weight, expressing the excess risk from high WC in a convenient form that was complementary to BMI and to other known risk factors.

2.5. Conceptual Framework

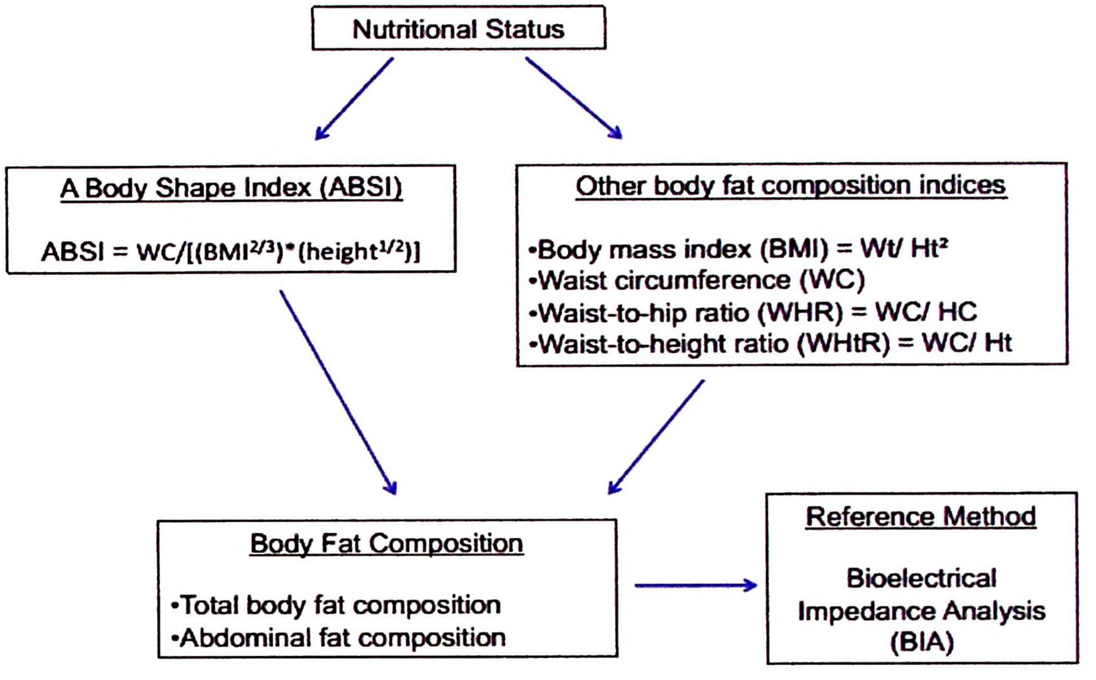

Figure 2.1 Conceptual Framework

CHAPTER 3 METHODOLOGY

3.1. Study Design

A cross-sectional study was conducted from March 2013 until May 2013 among the students in Health Campus of Universiti Sains Malaysia, Kubang Kerian (USMKK), Kelantan. Data collection was started after obtaining the ethical approval from Universiti Sains Malaysia Human Research Ethnics Committee on March 2013. The respondents were systematic randomly selected from the name list of students obtained from the Pejabat Akademik Pusat Pengajian Sains Kesihatan (PPSK). The sampling interval was calculated by dividing the population size by the sample size. Every tenth of the female students and every two of the male students were selected in alphabetical order from the namelist. The selected respondents were contacted via phone and Facebook. The written informed consent was obtained A total of 192 students was recruited for the body fat composition assessment. Of these 192 students, only 188 of them were able to complete the study, 4 students were excluded due to bandaging of foot resulting in undetectable measurement of Tanita SC330 S Body Composition Analyser, and incomplete anthropometric measurements. Respondents were requested to fill in a basic demographic questionnaire (age, sex, and race). They were then measured for height, weight, waist circumference, hip circumference, and body fat composition using validated anthropometric measurement instruments. The anthropometric data was recorded, analyzed and interpreted.

3.1.1. Setting

The study was carried out in the Dietetics Laboratory of School of Health Sciences, Universiti Sains Malaysia, Kelantan from March 2013 until May 2013.

3.1.2. Study Sample

3.1.1.1. Sample Size

The target group of this study was the students of School of Health Sciences (PPSK) in Healthy Campus Universiti Sains Malaysia (USMKK). By using sample size calculation formula by Daniel (1999), the sample size was calculated as below:

$$n = \left[\frac{z}{\Delta}\right]^2 p(1-p)$$

where,

n = estimated sample size

z = standard value at confidence level at 95% (z=1.96)

p = estimated prevalence of overweight

Δ = margin error set at 5%

$$n = \left[\frac{1.96}{0.05}\right]^2 0.14(1-0.14)$$

$$= 185$$

Based on NHMS III (2006), the prevalence of obesity among Malaysian adults was found to be 14.0%.

Therefore, by considering a 10% of non-respondent, a sample size of 204 was estimated.

3.1.1.2. Inclusion and Exclusion Criteria of the Study Sample

3.1.1.2.1. Inclusion Criteria

a) Physically and mentally healthy Malaysian.

b) Students who are at the age of 19-29 years.

3.1.1.2.2. Exclusion Criteria

a) Students who are diagnosed with illness, proven by a medical statement.

b) Pregnant women.

3.2. Instrumentation

3.1.2. Questionaire/ Form

3.1.2.1. Basic Demographic Questionnaire

Self-administered questionnaire (SAQ) was used to obtain the information of basic demographics (age, sex, race) of the respondents. The SAQ was distributed to the respondents and they were required to answer the questionnaire by themselves before further anthropometric measurement.

3.1.2.2. Anthropometric Measurements Form

Anthropometric measurements including height, waist and hip circumference, trunk fat percentage, and visceral fat rating were recorded in the form. Other measurements like weight, and total body fat percentage were printed from Tanita SC330 S Body Composition Analyser and kept together with the form.

3.1.3. Anthropometric Measurements Instruments

3.1.3.1. Tanita Viscan AB140M

Tanita Viscan AB140M was used to estimate the waist circumference and percentage of trunk fat of the respondents. Waist circumference was measured in centimeter. Respondents were measured in the supine position with no or minimum clothing at their abdominal part.

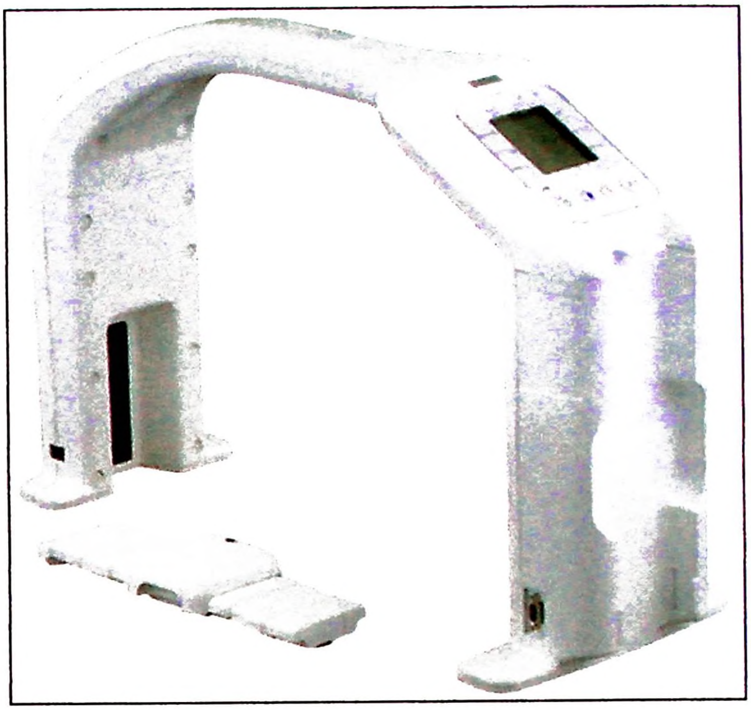

Figure 3.1 TANITA Viscan AB140M (Source: TANITA, 2011)

Figure 3.2 TANITA Viscan AB140M (Source: TANITA, 2011)

3.1.1.1. Tanita SC330 S Body Composition Analyser

Tanita SC330 S Body Composition Analyser was used to estimate the percentage of total body fat and weight of the respondents. Weight of the respondents was measured in kilogram (kg). Respondents were required to wear light or minimum clothing and possibly remove any accessories.

Figure 3.3 Tanita SC330 S Body Composition Analyser (Source: TANITA, 2011)

3.1.1.2. Measuring Tape

Measuring tape was used to measure the hip circumference of the subjects. Hip circumference was measured in centimeter, taken at the widest point around the greater trochanter. Respondents were required to stand and breathe normally.

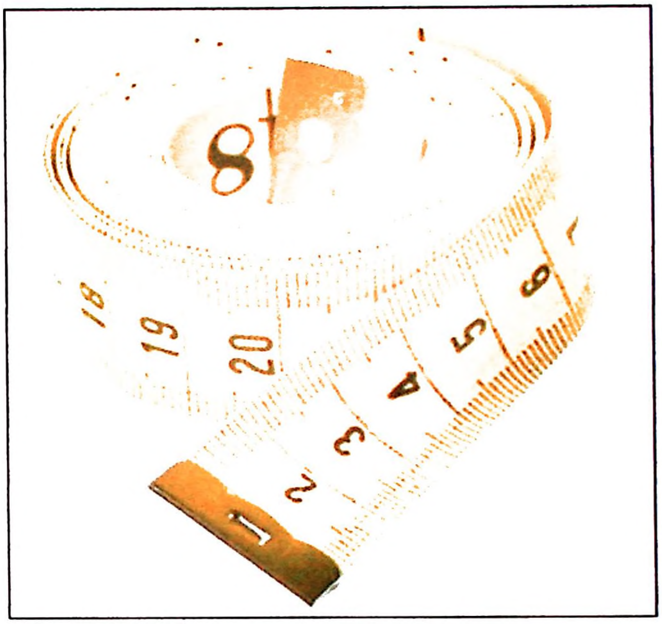

*Figure 3.4 Measuring Tape (Source: **Grantham** N. Retrieved from http://nickgrantham.com/a-coach-is-no-better-than-a-measuring-tape/)*

3.1.1.3. SECA 222 Body Meter Scale

SECA Body Meter Scale was used to measure the height of the subjects. Height of the subjects was measured in meter (m). Respondents were required to take off shoes, socks, or any hair accessories during measurement. They were asked to stand straight with heels close to the vertical surface of the body meter scale, with arms hanging normally at two sides of the body, head in the Frankfort horizontal plane and relaxed shoulders.

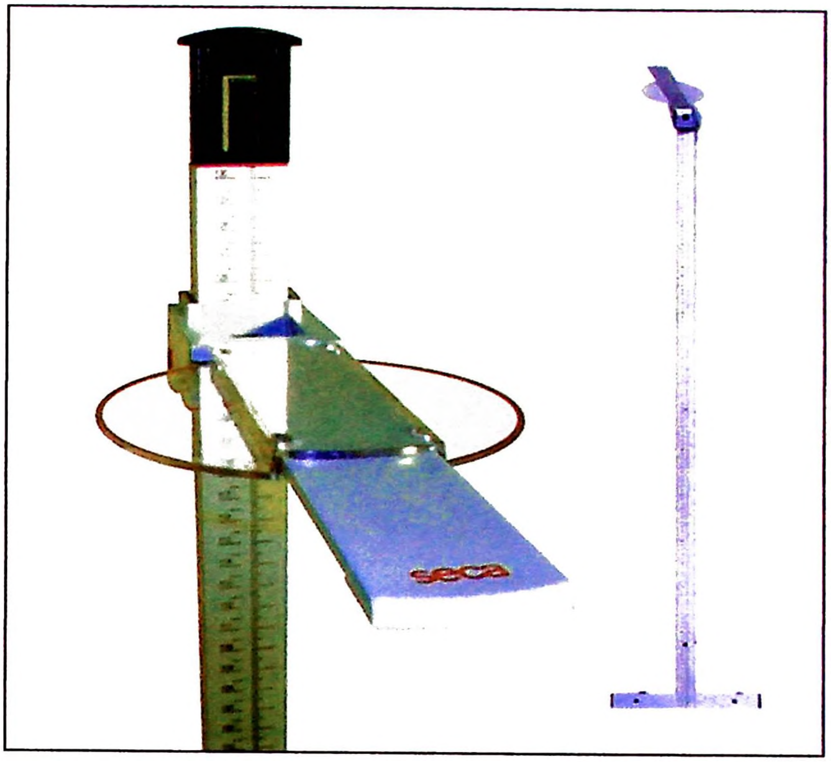

Figure 3.5 SECA Body Meter Scale (Source: SECA, 2008)