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Body Fat Percentage Distribution of an Orang Asli Group (Aborigines) in Cameron Highlands, Malaysia

Azuwani AR, Noor Khairiah K, Cheong YZ, Kok CC, Aw NSL, Nadiah Mhd S & Abdul Rashid K

Department of Public Health Medicine, Penang Medical College, 4, Jalan Sepoy Lines, 10450 Georgetown, Pulau Pinang, Malaysia.

ABSTRACT

Background: Although body fat percentage (BFP) is a widely accepted indicator of total body fat, it has not been extensively used in studies conducted among the Orang Asli in Peninsular Malaysia. **Objective**: This study was undertaken to determine the BFP distribution in a group of Orang Asli adults living in Cameron Highlands, Malaysia. **Methods**: Kampung Sungai Ruil, one of the Orang Asli settlements in Cameron Highlands, was conveniently selected for this cross-sectional study. A total of 138 respondents aged 18 years and above were assessed. Skinfold thickness was measured using the Slim Guide skinfold caliper to calculate BFP. Waist circumference, BMI, blood pressure and random plasma glucose were also measured. **Results:** The mean BFP of the females (29.7%) was higher than the males (18.9%) and the respondents with abdominal obesity (36.2%) had higher mean BFP compared to those with normal waist circumference (23.7%) Those in the age group of 18-28 years old (22.1%) had lower BFP than respondents in the age groups 29-39 years old (27.3%) and 40-50 years old (29.1%) (p=<0.001) and married respondents (26.8%) had higher mean BFP than single (21.2%) respondents. According to the BMI categorisation, respondents categorised as overweight (25.9%) had higher mean BFP than the normal weight/healthy (19.2%) respondents, and obese (32.0%) more than underweight (18.1%), normal weight/healthy (19.2%) and overweight (25.9%) respondents. Linear regression showed age (regression coefficient = 0.16, p=<0.001), BMI (regression coefficient = 1.06, p=<0.001) and being a woman (regression coefficient = 8.26, p=<0.001) were significant predictors of BFP. **Conclusion:** The BFP is higher in women and is significantly associated with age and BMI.

Key words: Aborigines, body fat percentage, body mass index, Malaysia, waist circumference .

INTRODUCTION

Obesity, now a pandemic, is especially of concern in low and middle income countries. There is an association between obesity and metabolic syndrome related diseases. As these illnesses are preventable, a vast array of conventional parameters have been developed in an attempt to measure body fatness. Despite many choices of

* Corresponding author: Azuwani Abd Rahim: *Email: azuwani@ms.pmc.edu.my* or *crazeecatz_mafia@yahoo.com*

anthropometric measures available, none of these parameters including commonly used body mass index (BMI), waist circumference and waist hip ratio (WHR) actually serve as a better measurement for health related risks compared to body fat percentage.

The aborigines in Malaysia are termed as 'Orang Asli' which in Malay literally means 'original people'. The Orang Asli are the indigenous minority people of Peninsular Malaysia. There are three main groups of Orang Asli. The majority of them are Senoi followed by Proto Malay and Negrito / Semang. The nutritional status of the aborigines is generally poor especially among the women and children. The nutrient intake of women is mostly below the required level. Studies in Pahang found that less than half of the women had normal weight (Lim & Chee, 1998). A study among adult Orang Asli of the Che Wong tribe in Krau Wildlife Reserve, found that 13.8% men and 25.0% women were underweight (Haemamalar, Zalilah & Neng, 2010). The prevalence of underweight and stunting in Orang Asli young children was found in more than a third of the population groups studied (Khor & Zalilah, 2008). The poor nutritional status of aborigines is attributed to factors like poverty, poor diet quality, inappropriate cultural beliefs, lack of nutrition knowledge, poor hygiene practices, and high helminthic infestations.

Being cognizant that there is a dearth of studies using body fat percentage as an indicator of nutritional status among the aborigines and acknowledging the substantial variation in body fatness among ethnic groups, the objective of this study was to determine body fat percentage distribution among the aborigines of Cameron Highlands, Malaysia.

METHODS

Setting and study design

This cross-sectional study was conducted in an aborigine settlement in Sungai Ruil in Cameron Highlands, Pahang, Malaysia in April 2012. There were 145 households with approximately 1,300 residents in the village which is located about 5 km from the town of Tanah Rata. Approximately 182 of the residents were aged 18 years and above.

Sampling

A purposive convenience sampling was done. Sample population was taken from Kampung Sungai Ruil, Cameron Highlands which is one of the settlements developed by the Malaysian government mainly for the aborigines. All residents aged 18 years old and above, who consented and were able to communicate effectively and who had been living in this settlement for at least six months were eligible to participate.

Instruments

The data for this study was acquired by questionnaire and physical examination. A uniform protocol covering questionnaire and physical examination procedures, inclusion and exclusion criteria for each measurement was set up to minimise error and bias. Occupation was categorised into six major categories as described in International Standard Classification of Occupation (ISCO) by the International Labour Office. Data was collected by 29 fourth-year medical students who visited the participants' homes. The students were trained comprehensively on the accurate method of data collection including physical examination to avoid variations and to ensure uniformity in measurement technique. The measurements were recorded to the smallest scale on the respective tools used for the measurement. Body fat percentage was calculated from skinfold thickness measured using Slim Guide skinfold caliper. Skinfold thickness was measured from four sites, that is, biceps, triceps, subscapular and suprailiac regions as described by Durnin & Womersly (1974). All the measurements were taken on the right side of the body for standardisation. Height was measured to the nearest 0.1cm using portable (hard) measuring tape. Body weight of the respondents was measured to the nearest 1kg using bathroom analogue weighing scale 'Healthscale' while the subjects were dressed in light clothing. Waist and hip circumference was measured using a non-stretchable constant pressure tape to the nearest 0.1cm. Waist circumference was measured around the circumference of the abdomen, mid-way between the top of the iliac crest and the bottom of the rib cage. Hip circumference measurement was taken at the widest part of buttocks (WHO STEPS, 2008). Blood pressure, random plasma glucose and peak expiratory flow rate were also measured using standardised methods (National Health and Nutrition Examination Survey (NHANES), 2009; Manzela , 2006; Higgins , 2005).

Determination of BMI, WC and body fat classification

The subjects were divided into six groups on body fat classes, four groups based on their body mass index (BMI) classes, two groups on the basis of waist circumference (WC) and waist hip ratio (WHR). Body fat classification was based on body fat percentage which is derived from calculated end product involving predicted body density. Body density was calculated from the sum of the four measurements of skinfold thickness using Durnin and Womersley body density equations (Durnin & Womersly, 1974). The density value was then converted to body fat percentage using Siri Equation (Siri, 1961). The respondents' body fat was classified separately for gender as essential fat, athletes, fitness, acceptable, and obese as described by the American Council on Exercise (Digate Muth, 2009). The BMI of each respondent was calculated using the formula of body weight in kilograms divided by height in metres squared (kg/m^2). The respondents were categorised as underweight (less than 18.5 kg/m^2), healthy weight (18.5 to 23.9 kg/m^2), overweight (24.0 to 26.9 kg/m^2) and obese (27.0 kg/m^2 and more) based on their BMI measurement (WHO, 2004). A cut-off point for WC of more than 102 cm in men and more than 88 cm for women was used to define abdominal obesity (WHO, 2008).

Approval from the Department of Public Health Medicine Research and Ethics Committee and from the Department of Orang Asli (JAKOA) was obtained prior to the commencement of the study. Informed consent was obtained from each respondent before starting the interview and physical examination. The examinations were carried out by at least two examiners of the same gender to respect the participant's modesty. The respondents were assured of confidentiality and anonymity of the information obtained from the participants.

Data analysis

Data was analysed using SPSS version 20.0. Data was tabulated and presented descriptively. Inferential statistics was done using either independent *t*-test or ANOVA and Scheffe Post Hoc test was used to compare the significant difference between means of different groups within the 95% confidence limit. Linear regression was used to identify significant predictor variables.

RESULTS

A total of 138 out of the eligible 182 residents responded to the study (response rate 75.8%). As shown in Table 1, most of the participants were Senoi (97.1%), female (59.4%), aged between 18-28 years old (42.0%), Muslim (42.0%), married (65.9%), highest level of education up to secondary school (55.8%) and with elementary occupation (45.7%). Elementary occupations as classified by the ISCO include cleaners and helpers, agricultural, forestry and fishery labourers, labourers in mining, construction, manufacturing and transport, food preparation assistants, street and

Table 1. Baseline profile of participants

Variables	*Frequency*	*Percentage (%)*
Gender (N=138)		
Male	56	40.6
Female	82	59.4
Age (N= 138)		
18-28	58	42.0
29 – 39	40	29.0
40 – 50	30	21.7
>50	10	7.3
Ethnicity (N=138)		
Senoi	134	97.1
Others	4	2.9
Religion (N=138)		
Islam	58	42.0
Christian	29	21.0
Atheist	51	37.0
Marital status (N=138)		
Single	36	26.1
Married	91	65.9
Separated, divorced, widowed or living together	11	8.0
Level of education (N=138)		
Illiterate	26	18.8
Non formal & primary	29	21.0
Secondary	77	55.8
Pre-university & Tertiary	6	4.3
Occupation (N=138)		
Tourism	14	10.1
Elementary	63	45.7
Housewife	27	19.6
Unemployed	10	7.2
Professionals	9	6.5
Others	15	10.9
Blood pressure status (N=138)		
Hypertensive	58	42.0
Normotensive	80	58.0
Diabetic status (N=137) [a]		
Diabetes	2	1.5
Normal	135	98.5

[a] One person refused to participate in this part of the examination

related sales and services workers and refuse workers and other elementary workers. Only two participants had diabetes mellitus.

Table 2 shows the BMI, WC and BFP distribution of the participants. The mean BMI, WC and BFP were 25.7 kg / m^2 (SD 4.61 kg / m^2), 79.2 cm (SD 12.53 cm) and 25.3% (SD 8.8%) respectively. According to the BMI categorisation, most were normal / healthy (37.7%) followed by obese (34.8%), overweight (25.4%) and underweight (2.2%). According to the waist hip ratio, 26.8% had central obesity whereas according to the waist circumference, 13% had central obesity. Most of the participants had acceptable body fat percentage (36.2%) followed by obese (31.2%) and fitness (16.7%).

Table 2. BMI, WC and BFP distribution of the participants

Classifications	*Frequency*	*Percentage (%)*
Body Mass Index (N=138)		
Mean = 25.7 kg/m^2, SD = 4.61		
Underweight	3	2.2
Healthy / Normal	52	37.7
Overweight	35	25.4
Obese	48	34.8
Waist Circumference (N=138)		
Mean = 79.2cm, SD = 12.53		
Normal	120	87.0
Abdominal obesity	18	13.0
Waist Hip Ratio (N=138)		
Mean = 0.83, SD = 0.08		
Normal	101	73.2
Abdominal obesity	37	26.8
Body Fat Percentage (N=138)		
Mean = 25.3%, SD = 8.8		
Too low [a]	1	0.7
Essential fat	1	0.7
Athletes	20	14.5
Fitness	23	16.7
Acceptable	50	36.2
Obese	43	31.2

[a] Oneperson had body fat percentage that is too low <2% for male and <10% for female that does not fit into any body fat percentage classification by American Council of Exercise

As shown in Table 3, the mean body fat percentage of the females was higher than the males (p=<0.001) and the respondents with abdominal obesity had higher mean body fat percentage compared to those with normal waist circumference (p=<0.001). The differences in the mean body fat percentage of the different age groups (p=<0.001), marital status (p=0.004) and body mass index (p=<0.001) were statistically significant. Post Hoc Scheffe test showed that the respondents in the age group 18-28 years old had significantly lower body fat percentage than those in the age group 29-39 years old and participants in the age group 40-50 years old. Married respondents had higher mean body fat percentage than single individuals. Respondents who were obese according to the BMI had a higher mean body fat percentage compared to those who were underweight, normal / healthy and overweight and those categorised as overweight had a higher mean body fat percentage compared to individuals categorised as normal / healthy.

As shown in Table 4, there is a statistically significant positive correlation between body fat percentage and age (p=0.006),BMI (p=<0.001) and WC (p=<0.001).

A multiple linear regression model using age, gender and body mass index was developed to determine the significant predictor variables for BFP (Table 5). For every one year increase in age, the body fat percentage increased by 0.159% (p=<0.001); similarly for every unit increase in t body mass index there was an increase of 1.062% of body fat percentage (p=<0.001). Being female is associated with higher body fat

Table 3. Mean body fat percentage and associated factors

Body fat percentage Variables	*N=138*	*Mean (±SD)*	*t-test or ANOVA / p-value*	*Post-Hoc Test*
Gender (N=138)				
Male	56	18.9 (5.79)	3.88 / <0.001*	
Female	82	29.7 (7.74)		
Age (N=138) years				
18-28	58	22.1 (8.23)	5.65 / <0.001*	(18-28) < (29-39)
29-39	40	27.3 (8.42)		(18-28) < (40-50)
40-50	30	29.1 (8.05)		
>50	10	24.9 (9.71)		
Marital status (N=138)				
Single	36	21.2 (7.39)	5.76 / 0.004*	Married > single
Married	91	26.8 (8.98)		
Separated, widowed, divorced and living together	11	26.4 (7.38)		
Education (N=138)				
Illiterate	26	27.9 (8.21)	0.91 / 0.438	
Non formal / Primary	29	24.8 (9.73)		
Secondary	77	24.7 (8.71)		
Pre-university / Tertiary	6	25.0 (6.66)		
Occupation (N=138)				
Tourism	14	24.8 (9.16)	0.82 / 0.541	
Elementary	63	25.5 (9.32)		
Housewife	27	27.7 (8.08)		
Unemployed	10	24.7 (9.87)		
Professionals	9	22.6 (6.79)		
Others	15	22.9 (7.58)		
Body Mass Index (N=137) [a]				
Underweight	3	18.2 (4.99)	29.80 / <0.001*	overweight>healthy obese>underweight
Healthy / Normal	51	19.2 (6.45)		obese>healthy
Overweight	35	25.9 (6.49)		obese>overweight
Obese	48	32.0 (7.60)		
Waist circumference (N=138)				
Abdominal obesity	18	36.2 (6.54)	1.61 / <0.001*	
Normal	120	23.7 (7.86)		
Blood pressure (N=138)				
Hypertensive	58	25.9 (9.01)	0.63 / 0.532	
Normotensive	80	24.9 (8.63)		

* Significant *p* value ($p < 0.05$)

[a] 1 person's BMI data was incomplete

Table 4 . Correlation between body fat percentage and age, BMI and WC

	Body fat percentage (%)	
	Pearson correlation (r)	*p-value*
Age (N=138)	0.235	0.006
BMI (N=137)	0.692	<0.001
Waist circumference (N=138)	0.470	<0.001

Table 5. Multiple linear regression using age, gender and body mass index as predictor variables for BFP

Model	*B Unstandardised coefficient*	*t*	*p-value*	*95.0% Confidence interval*
Age	0.159	3.881	<0.001	0.078;0.241
Gender of respondent	8.256	8.688	<0.001	6.374;10.139
BMI	1.062	10.487	<0.001	0.862;1.263

Coding for gender: Male = 1, female = 2

percentage (p=<0.001). In summary, this table indicates that body fat percentage will increase significantly if the aborigine is a female, older and has a high body mass index.

DISCUSSION

WHO defines overweight and obesity as abnormal or excessive fat accumulation that presents a risk to health (WHO, 2012). Body fat / fat mass together with lean mass / fat free mass and water constitute total body composition. Body fat depicts total adipose or fatty tissue in the body and is divided into subcutaneous fat and visceral fat. Because body fat measurement gives total adiposity, it is an ideal parameter to delineate obesity and thus provides a crude population measure of nutritional status and health risk predictor.

BMI has long and widely been used as a simple anthropometric index that reflects obesity and body fat content (WHO, 2012) and was used for the Malaysian National Health Survey (Institute of Public Health, 2008). But due to its numerous limitations, initially waist hip ratio and later waist circumference have been used to measure abdominal / central obesity as a proxy for visceral fat. However, body fat is a better indicator of non-abdominal body fat and abdominal subcutaneous fat and it better depicts risk to overall metabolic diseases (Fox *et al*., 2007). Although there are a wide variety of methods to measure true body fat / fat mass, skinfold thickness measurement has been proven to be effective (Treuth *et al*., 2001).

According to the the present study based on body fat percentage , only one (0.7%) person had too low BFP and by BMI categorisation, only three (2.2%) persons were underweight. This is much lower compared to the reported prevalence in the general population which is 8.5%. However, the prevalence of normal BMI (37.7%) in this population is lower than the general population (48.4%). The prevalence of obesity according to the BFP (31.2%) and BMI (34.8%) is significantly higher than the national prevalence of 18% (Institute of Public Health, 2008). There has been a steady rise in overweight and obesity among the aborigines. A study conducted in 1993 among the aborigines in the settlements at Carey Island and Ulu Langat outside Kuala Lumpur showed that obesity was almost non-existent (Ali *et al*., 1993). Lim & Chee (1998), in a study conducted among the aborigines in Kuantan, Pahang, reported that 21% of them were overweight and obese and later, a survey conducted in 2004 involving 149 aborigines women from 14 peri-urban villages in Sepang and Pulau Carey, Selangor found that almost half of the women were overweight and obese (Wendy, 2004). The present study showed an increase in overweight and obesity to almost three times compared to 14 years ago and about a 20% increase compared to 8 years ago. The increase in overweight and obesity among the aborigines is cause for concern. As the aborigines venture closer to the cities and towns, they tend to adopt unhealthy eating habits of the general Malaysian population and tend to have a more sedentary lifestyle (Poh *et al*., 2010). These new eating habits which are high in sugars and animal fat along with physical inactivity invariably leads to weight gain. Continuing this lifestyle and persistent weight gain will resilt in a gradual increase in BMI and this will subsequently be followed by increasing body fat.

Studies have shown that there is a steady linear increase in body fat with ageing until early old age which is later followed by a decrease in body fat (Tchkonia *et al.,* 2010). Complex interrelating factors account for the increasing relative fatness and corresponding reduction in fat free mass with increasing age. These factors include disuse / physical inactivity, altered hormone / cytokine metabolism and protein-energy malnutrition. There is a notable change in body composition as one ages. As one ages, there is a loss of body mass accompanied by loss of body weight and relative increase in body fat. A physiological explanation highlighted sarcopenia or loss of skeletal muscle in the ageing process as the major factor contributing to this change in body composition. Sarcopenia acts by increasing body fatness and decreasing basal metabolic rate and daily energy needs (Evans, 2004).

In the present study, an increase in BMI was found to be associated with an increase in body fat percentage. The GOOD Study published in 2009 (Kindblom *et al.,* 2009) found a significant association between BMI increase during childhood and adolescence and the amount of visceral and sub-cutaneous adipose tissue in young adult men. A cohort study done in New Delhi also demonstrated BMI changes during late childhood and adolescence were associated with predicted adulthood adiposity increase using skinfold thickness as the anthro-pometric measurement (Sachdev *et al*., 2005). As weight forms part of the BMI index, its increase will largely affect BMI value. A study (Forbes, 1999) done to ascertain influence of body weight on longitudinal change of fat free mass in adults showed the inevitable tendency to lose fat free mass and increase body fat as one ages. Hence it is a fallacy that a general healthy weight is maintained as long as one keeps a stable body weight, because even with a stable body weight, fat free mass is lost and an equivalent amount of body fat is gained. This could possibly explain the relationship found in the present study between weight and body fat.

It is well established that females generally have higher total adipose tissue compared to males who generally have higher total lean mass. Females tend to accumulate fat more peripherally giving them a gynaeoid / pear body type, while males have more central / abdominal fat storage synonymous with android / apple body type. Even after adjusting for height difference, females have greater fat mass than males and this difference continues throughout adult life. The difference in sex deposition of fat is manifested very early in a female life, even at foetal stage, and becomes more pronounced during puberty (Wells, 2007). Hormone sensitive lipase and lipoprotein lipase (LPL) are lipolysis enzymes which regulate free fatty acid mobilisation. LPL are situated in blood vessel walls throughout the body and act as 'gatekeeper' as they act on triglycerides (TG) within lipoproteins in blood stream, hence control fat distribution in various storage sites of the body. In females, LPL is found to be of higher concentration on hip and thigh region compared to the abdominal region (Vella & Kravitz, 2002). Because of this, females are more likely to retain and store fat compared to males due to the gynaeoid fat distribution which is less favoured molecularly for fat mobilisation. Gender fat discrepancy can also be attributed to the effect of sex steroid hormone oestrogen produced in females. A study conducted by (Macdonald *et al*., 2003) suggested an average female experiences 0.68kg per year increase in body weight during their 40s and 50s regardless of their menopausal factor. Females tend to store fat peripherally which is less favoured for fat mobilisation. Together with the tendency to gain weight and peripheral fat distribution in females, there is an inclination of higher body fat in females. The lack of testosterone in females has also been suggested for the increase in fat mass, reduced muscle mass and obesity (Derby *et al.,* 2006).

CONCLUSION

There is an increasing prevalence of overweight and obesity worldwide. A similar increase was found in this study which was conducted among a group of aborigines in Cameron Highlands, Malaysia. The prevalence of obesity in this community was found to be higher than the national prevalence. Factors which were found to be significantly associated with increasing body fat percentage were increasing age, increasing BMI as well as being a female. In addition to under-nutrition, which has been a traditional source of malnutrition among this group of people, obesity is now another cause of malnutrition. It is imperative that public health professionals along with other allied health professionals work with the JAKOA to develop programmes to prevent obesity in this community.

CONFLICT OF INTEREST

The authors declare there is no conflict of interest with regard to this study.

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