Asian Journal of Medical Sciences
http://nepjol.info/index.php/AJMS
eISSN: 2091-0576
A Journal Inclined for Medical Research

ANTHROPOMETRIC INDICATORS AS PREDICTORS OF HIGH BLOOD PRESSURE AMONG THE AO TRIBE OF NORTH-EAST INDIA

ORIGINAL ARTICLE, Vol-4 No.3

Asian Journal of Medical Science, Volume-4(2013) http://nepjol.info/index.php/AJMS

[1] Temsutola Maken and [2]Lalhmunlien Robert Varte. [1]Department. of Anthropology, NEHU, Shillong. [2]DIPAS, DRDO, Lucknow Road, Timarpur, Delhi-110054

CORRESPONDENCE:

Dr. Temsutola Maken
Department. of Anthropology
NEHU, Shillong-793022,
Meghalaya
E- mail:
atolamaken@yahoo.co.in
Mob No: +91-8588806698

"Waist-to-Stature ratio and waist circumference are good predictors of hypertension for the adults of Ao tribe"

ABSTRACT

Objective: Hypertension is related to increased body fat, which can be evaluated by anthropometric indicators among the Aos, a tribe of North-East India.

Methods: Cross-sectional study with a sample of 1804 Ao adults (male= 890) (females= 914) aged 18 to 70 years. We considered the following anthropometric indicators: body mass index, waist circumference, waist-to-hip ratio and waist-to-stature ratio. To identify predictors of high blood pressure, we adopted the analysis of receiver operating characteristic curves with a confidence interval of 95%.

Result: For males, the area under curve with confidence intervals were BMI = 0.691 (0.67-0.712); waist circumference=0.757 (0.739-0.775); waist-to-hip ratio=0.692 (0.671-0.713); waist-to-stature ratio = 0.763 (0.745-0.781) and Conicity index = 0.734 (0.716-0.716). For females, the values were BMI = 0.754 (0.732-0.776); waist circumference = 0.762 (0.74-0.784); waist-to-hip ratio = 0.690 (0.668-0.784), waist-to-stature ratio=0.776 (0.753-0.799) and Conicity index=0.722 (0.701-0.743). Different cut off points of anthropometric indicators with better predictive power and their relevant sensitivities and specificities were identified.

Conclusion: BMI does not show a very good area under the ROC curve. It seems that waist-to-stature ratio is the best predictor, followed by waist circumference and Conicity index among the males and results in high sensitivity and specificity to hypertension. We suggest the use of both waist-to-stature ratio and waist circumference to predict hypertension among males. Among females, waist-to-stature ratio is the best predictor, followed by waist circumference and body mass index.

Keywords: Waist circumference, Body Mass Index, Waist-to-stature Ratio, Hypertension, Ao tribe.

INTRODUCTION

Hypertension is considered a potential risk factor for cardiovascular disease (CVD) and has become a major global burden on public health in many developing countries experiencing epidemiological transition [1, 2]. Hypertension is a disease that affects 972 million people worldwide[3]. It is estimated that the worldwide prevalence of hypertension could increase from 26.4% in 2000 to 29.2% in 2025 [3]. Obesity and weight gain have been identified as the most important determinants of hypertension [4, 5, 6, 7].

The association between obesity and hypertension forms part of a broader relationship between body weight and blood pressure (BP). Asian Indians have increased risk of coronary events, and reasons for this increased risk are thought to be genetic but are yet unclear [8].

In a first of a kind study from India highlighting the perceptions in the community's perspectives of hypertension, hypertension was called as 'BP' (blood pressure) in these communities. The participants explained that if a person 'has BP' means that she/he is hypertensive. They were also aware of low blood pressure and specifically mentioned that 'BP is low' or 'low BP'. Thus, hypertension is referred to as BP and researchers also used 'BP' to refer to hypertension during interviews and discussions [9]. There is a strong correlation between changing lifestyle factors and increase in hypertension in India [10]. Moreover, recent research indicated that low socio-economic communities are not exempted from the risk of hypertension [11, 12]. In this context, there is an urgent need for prevention and control of hypertension[12]. Anthropometric indicators have been used to discriminate the amount of body fat and its distribution effectively especially in epidemiological studies with large samples. While the body mass index (BMI) predicts the overall fat, waist hip ratio measures abdominal obesity, waist circumference (WC) and the Conicity index (C located in the central region of the body. The waist-stature ratio (WSR) considers the proportion of central fat by the individual's height. High blood pressure (BP) indirectly identified through anthropometric indicators may be an efficient strategy for the detection and control, mainly because these measures can be implemented without specialized technical apparatus. Rates of hypertension have been shown to increase in traditional populations undergoing modernization and also among migrant populations from rural to urban habitats [9]. In India, traditional tribes and caste groups, which represent a substantial percent of the country's population, are believed to have lower BP than other ethnic groups [13]. Gradually, with changing social environment, marked increase in BP was noted [14].

Studies on hypertension in North-East India are few, especially among the different tribes and caste populations. Thus, the purpose of this study was to determine the predictive power of anthropometric indicators and establish cut-off points for discriminating high blood pressure in Ao adults.

MATERIALS AND METHODS

A total of 1804 Ao adults, 890 males and 914 females aged 18-70 years of Mokokchung District, Nagaland, North-East India were considered for this study. The Ao people are one of the dominant tribal groups in Nagaland and Mokokchung District is the home of the Ao tribe. The Ao tribe belongs to Mongoloid race and speaks the Tibeto-Burman language and follows the patrilineal system of society where lineage is traced from the male. The data were collected from both rural and urban areas. These areas were selected according to simple random sampling by using random numbers [15]. An attempt was made to cover more than 30% of the total households from each selected sampling unit (i.e., village or locality). No statistical sampling of individuals was applied for collection of data from each selected village or locality to avoid operational difficulties in the field. Instead, an attempt was made to include in our sample all those adults (aged 18-70 years) who are willing to co-operate with the present work.

Height of the subject was measured to the nearest mm, using Harpenden Anthropometric rods. Body weight was measured in light clothing and barefoot to the nearest 0.1 kg with a spring weighing machine, asking the subject to stand on it with an erect posture and light apparel. The weighing machine was checked from time to time with a known standard weight. No deduction was made for the weight of light apparel while taking the final reading.

Body Mass Index (BMI) was calculated by dividing the subject's weight in kilograms by height in metres squared kg/m^2 [16]. Waist circumference (WC) was measured midway between the iliac crest and the lower-most margin of the ribs. Hip circumference was measured at the maximum circumference of the buttocks, with the subject standing and his feet placed together. The mean of three readings of each circumference was taken for the calculation of the waist-to-hip ratio (WHR). WHR was calculated by dividing the waist by the hip circumference.

Waist-to-Stature Ratio (WSR) was measured by dividing waist circumference by standing height in cms. High waist-to-hip ratio was defined as = 0.9 in men and = 0.85 in women. WSR was calculated as the ratio of waist circumference (cm) to height (cm). High WSR was defined as = 0.50 for both males and females. WC was measured with an anthropometric steel tape at the midpoint between the last rib and the iliac crest, and we considered the average of two measurements. Conicity index (C index) was determined by measuring weight, height and waist circumference using the following mathematical equation[17]:

Conicity index or C index = waist circumference (m)/0.109×√{weight (kg)/height (m)}

Mercury sphygmomanometer was used to measure blood pressure of the individuals included in the present study. All measurements were taken on left hand when subjects were being seated position. Each participant was asked to relax and take rest for 10 minutes before taking the measurement. Systolic blood pressure was recorded as the first Korotkov sound (Phase 1). Diastolic blood pressure was taken as the disappearance of the Korotkov sounds (Phase V). Measurements were recorded for three times, and the average of the three was taken as recorded measurement. Digital blood pressure monitor (M2 Model, Omron Health Care Co. Ltd., Japan) was also used to cross-check the measurement. However, mercury type blood pressure measurement was reported for the present study.

Statistical analysis: To compare the means values of continuous variables between males and females, we used the student t -test and chi-square test for categorical variables. The predictive power of anthropometric indicators for high blood pressure were determined by Receiver Operating Characteristic (ROC) Curve, commonly used for the determination of cut-off points in diagnostic or screening tests. At first, the total area under the ROC curve between anthropometric indicators (BMI, WC, WHR, WSR and Conicity index) and hypertension was identified. The larger the area under the ROC curve, the greater the discriminating power of anthropometric indicators for high blood pressure among the Ao adults. To identify predictors of obesity, we adopted the analysis of ROC curves [18]. The confidence interval (CI) determines whether the predictive ability of anthropometric indicators is due to chance and its lower limit should not be less than 0.50 [19]. Subsequently we identified the cut-off points of the anthropometric indicators as predictors of high blood pressure with their relevant sensitivities and specificities closer to each other and not less than 60%. To identify the difference of the areas under the ROC curves, chi-square test was used. The results were considered significant at 5% level. The data were organized and analyzed using SPSS version 17.0.

RESULTS

The sample consisted of 1804 Ao adults (890 males and 914 females). Sample characteristics are presented in Table 1. The males had a higher mean body mass, height and waist circumference (WC) ($p < 0.000$) waist-hip-ratio (WHR) ($p < 0.000$) and Conicity Index ($p<0.006$) than the females. WSR was significantly higher in females ($p < 0.000$).

High blood pressure, in general, resulted in a prevalence of 22.65% in our sample, with a higher frequency among males. The areas under the ROC curve of BMI, WC, WHR, WSR and Conicity index as predictors of high blood pressure in males and females, and their confidence intervals (95%) can be seen in Table 2 and in Figures 1 and 2. All anthropometric indicators had significant areas under the ROC curve.

The cut-off points of anthropometric indicators as predictors of high blood pressure, and their relevant sensitivity and specificity are presented in Table 3. It is noted that among the anthropometric indicators, WC, WSR and Conicity index attained the best sensitivity and specificity percentages for discriminating high blood pressure among the males and BMI, WC, WSR and Conicity index among the females showed the best sensitivity and specificity.

DISCUSSIONS

This study aimed to identify the predictive power and to propose cut-off points of anthropometric indicators for prediction of high blood pressure among the Ao tribe of North-East India. Asians appear to have an increased metabolic risk at

Figure 1: ROC curve for Ao males

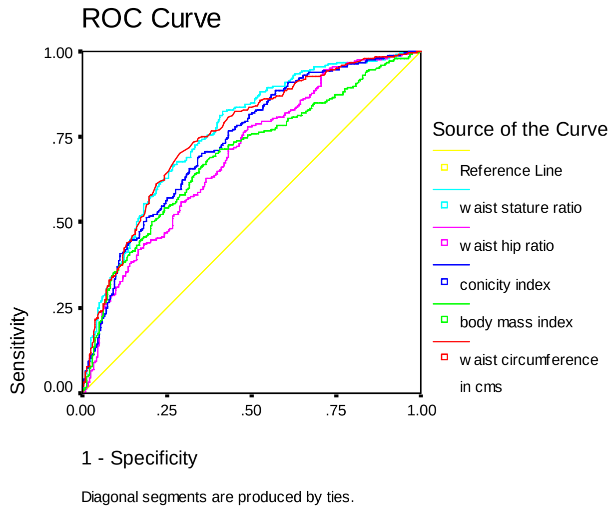
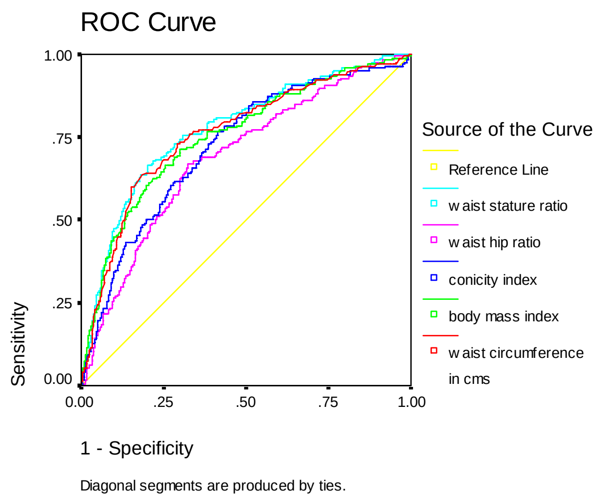


Figure 2: ROC curve for Ao females



lower waist circumference and waist–to-hip ratio than Europeans. Many studies have suggested a lower waist circumference for Asians [20, 21, 22] and some also suggested a lower waist-to–hip ratio [23]. These studies recommends ethnic-specific cut-offs for Asian populations. There is possible evidence that Asians should have a lower WC cut-off than Europeans [24]. Regarding WC, Chinese and South Asian men and women display a greater greater amount of visceral adipose tissue for a given

Table 1 - Mean, standard deviation, minimum and maximum values and percentages of variables analyzed in the study variables. Males (n=890), Females (n=914).

Variables	Males Mean (SE) (n=890)	Females Mean (SE) (n=914)	p value
Age (years)	38.42 (0.49)	37.40 (0.48)	0.137
Body mass (kg)	55.84 (0.24)	48.33 (0.25)	0.000*
Height (m)	164.31(0.16)	152.98 (0.12)	0.000*
BMI (kg/mt^2)	20.7 (0.08)	20.6 (0.10)	0.824
WC (cm)	69.10(0.27)	65.96 (0.29)	0.000*
WHR	0.87 (0.002)	0.83 (0.002)	0.000*
WSR	0.42(0.001)	0.43(0.001)	0.000*
Conicity index	1.09 (0.002)	1.08(0.002)	0.006*
Blood Pressure	**% (n)**	**% (n)**	
Normal	154 (17.3)	355 (38.8)	
Pre-hypertension**	496 (55.7)	392 (42.9)	
Hypertension***	240 (27)	167 (18.3)	Chi sq. 6.00, p=0.199
Nutritional Status	**% (n)**	**% (n)**	
Underweight	184 (20.7)	272(29.8)	
Normal	556 (62.5)	454 (49.7)	
Overweight	89 (10)	92 (10.1)	
Obesity	61 (6.9)	96 (10.5)	12.00, 0.213

*p<0.05 **120-139/80-89 mm Hg *** 140 and above/90 and above mm Hg

Table 2 - Area under the ROC curve and 95%CI between anthropometric indicators of obesity and high blood pressure in males and females.

High Blood Pressure	**Area under the ROC curve (95%CI)**		**Area under the ROC curve (95%CI)**	
	Males	**p**	**Females**	**p**
BMI (kg/mt^2)	0.691 (0.67 -0.712)	<0.001	0.754 (0.732-0.776)	<0.001
WC (cm)	0.757 (0.739-0.775)	<0.001	0.762 (0.74 -0.784)	<0.001
WHR	0.692 (0.671-0.713)	<0.001	0.690 (0.668-0.784)	<0.001
WSR	0.763 (0.745-0.781)	<0.001	0.776 (0.753-0.799)	<0.001
Conicity index	0.734 (0.716-0.716)	<0.001	0.722 (0.701-0.743)	<0.001

p-values for rejecting the null of AUC=0.05

Table 3 – Cut off points, sensitivity, specificity of anthropometric indicators as prediction of high blood pressure in males and females

High Blood Pressure	**Males**			**Females**		
	Cut off point	Sensitivity (%)	Specificity (%)	Cut off point	Sensitivity (%)	Specificity (%)
BMI (kg/mt^2)	19.4	78.3	60.2	18.8	88.0	61.0
WC (cm)	65.0	88.8	60.0	61.2	87.4	60.9
WHR	0.84	81.7	60.3	0.79	87.4	60.9
WSR	0.40	90.4	60.0	0.39	88.6	60.0
Conicity index	1.05	89.6	60.0	1.03	88.0	60.0

waist circumference than Europeans[25] Similarly, a higher percentage of body fat across a range of waist circumference values has been documented among Japanese [26]. In the present study, the cut-off point for WC identified to predict high blood pressure in males is higher than that of females. Moreover, the sensitivity and specificity values of these cut-off points were also higher among males, which may indicate that the predictive power of WC for high blood pressure is higher among males.

Although there is an association between overweight/obesity and high blood pressure, few studies have identified cut-off points of anthropometric indicators that aim to detect pre-hypertension/hypertension[27]. The results of our study indicate that pre-hypertension affect more than half of the males and nearly half of the females of the Ao tribe.

Among the anthropometric indicators, BMI and WC have been widely used in the detection of cardiovascular risk factors[28, 29]. Currently, some studies[30, 31] especially in Asian populations, have used WSR to predict central fat and risk factors associated. The Conicity index is more widely used in research with adult populations[32, 33]. In our study, WSR showed the best AUC in both males (0.763) and females (0.776).

The WHR is also a practical index of regional adipose tissue distribution and metabolic profile[34]. All anthropometric indicators (BMI, WC, WHR, WSR, Conicity index) were good predictors for high blood pressure.

WC, WSR and Conicity index were the best predictors of high blood pressure in males. For females, besides WC, WSR and Conicity index, the BMI was also found to be a good predictor. By comparing the areas under the ROC curve of these indicators, no differences were observed in both sexes, which suggest that, these three anthropometric indicators, viz: WC, WSR and Conicity index can be used to predict high blood pressure among the present community.

Regarding BMI, the cut-off point to predict high blood pressure was higher among the males than the females. However, BMI appears to be less informative than other measures in the present study.

Conicity index showed a good area under curve (AUC) in both males and females. However, literatures of Conicity index among North-East populations are hardly to be found for comparative reviews.

CONCLUSION

WSR showed the best AUC in both male and female population with a proposed cut off of 0.40

among the males and 0.39 among females. WC also exhibited a good AUC. A simple use of a tape measure may be very effective in detecting cardiovascular risk factor in achieving one of the strategies for the prevention of hypertension, which is control of blood pressure. However, caution should be exercised in using the cut-off point of WC found for females, because the age group range is quite large and high blood pressure presented a low prevalence among the females, which may have overestimated the result. Further age wise study is needed to show how best to use WC, WSR and Conicity index to classify individuals who are at risk for hypertension. However, the relatively good agreement between these variables suggests that WC, WSR and Conicity index may serve well in classifying individuals into broad categories corresponding to high blood pressure.

REFERENCES

1. Lawes CM, Vander Hoorn S, Law MR, Elliott P, MacMahon S and Rodgers A. Blood pressure and the global burden of disease 2000. Part II: estimates of attributable burden. Journal of Hypertension 2006; 24:423–443.
2. Reddy KS. Cardiovascular diseases in India. World Health Statistics Quarterly 1993; 46:101-107.
3. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK and He J. Global burden of hypertension: analysis of worldwide data. Lancet 2005; 365:217–222.
4. Dı´az ME. Hypertension and Obesity. Journal of Human Hypertension 2002; 6(1):S18–S22.
5. Ferguson TS, Younger NO, Tulloch-Reid MK, Wright MBL, Ward EM, Ashley DE and Wilks RJ. Prevalence of prehypertension and its relationship to risk factors for cardiovascular disease in Jamaica: Analysis from a cross-sectional survey. BMC Cardiovascular Disorders 2008; 8:20. http://www.biomedcentral.com/1471-2261/8/20.
6. Dalton M, Cameron AJ, Zimmet PZ, et al. 2003. Waist circumference, waist–hip ratio and body mass index and their correlation with cardiovascular disease risk factors in Australian adults. Journal of Internal Medicine 2003; 254:555–563.
7. Kannel WB. Risk stratification in hypertension: new insight from the Framingham study. American Journal of Hypertension 2000; 13:3S–10S.
8. Ashavaid TF, Shalia KK, Kondkar AA, Todur SP, Nair KG and Nair SR. 2002. Gene polymorphism and coronary risk factors in Indian population. Clinical Chemistry and Laboratory Medicine 2002; 40:975-985.
9. Kusuma YS. Perceptions on hypertension among migrants in Delhi, India: a qualitative study. BMC Public Health 2009; 9:267. http://www.biomedcentral.com/1471-2458/9/267
10. Gupta R. Trends in hypertension epidemiology in India. Journal of Human Hypertension 2004; 18:73-78.
11. Kusuma YS, Babu BV and Naidu JM. Prevalence of hypertension in some cross-cultural populations of Visakhapatnam district, South India. Ethnicity and Disease 2004; 14:250-259.
12. Reddy KS, Naik N and Prabhakaran D. Hypertension in the developing world: a consequence of progress. Current Cardiology Reports 2006; 8:399-404.
13. Kusuma YS, Babu BV and Naidu JM. Blood pressure levels among cross-cultural populations of Visakhapatnam district, Andhra Pradesh, India. Annals of Human Biology 2002; 29:502-512.
14. Nirmala, A. Age variation in blood pressure: effect of sex and urbanization in a genetically homogeneous caste population of Andhra Pradesh. American Journal of Human Biology 2001; 13(6): 744–752.
15. Snedecor, G.W. and Cochran, W.G. 1967. Statistical Methods. Iowa: The Iowa State University Press.
16. WHO. Physical Status: The Use and Interpretation of Anthropometry. Report of a WHO Expert Committee, Technical Report Series no. 854. 1995. Geneva: WHO.
17. Valdez R. A simple model-based index of abdominal adiposity. Journal of Clinical Epidemiology 1991; 44 (9): 955-956.
18. Erdreich LS and Lee ET. 1981. Use of relative operating characteristics analysis in epidemiology: a method for dealing with subjective judgment. American Journal of Epidemiology 1981; 114 (5): 649-662.
19. Schisterman EF, Faraggi D, Reiser B and Trevisan M. Statistical inference for the area under the receiver operating characteristic curve in the presence of random measurement error. American Journal of Epidemiology 2001; 154: 174-179.
20. Wildman RP, Gu D, Reynolds K, Duan X, and He J. Appropriate body mass index and waist circumference cutoffs for categorization of overweight and central adiposity among Chinese adults. American Journal of Clinical Nutrition 2004; 80:1129 –1136.
21. Misra A, Vikram NK, Gupta R, Pandey RM, Wasir JS, and Gupta VP. Waist circumference cutoff points and action levels for Asian Indians for identification of abdominal obesity. International Journal of Obesity 2006; 30:106–111 .

22. Ness-Abramof R and Apovian CM. Waist circumference measurement in clinical practice. Nutrition in ***Clinical*** Practice 2008; 23:397-404.
23. Kurpad SS, Tandon H and Srinivasan K. Waist circumference correlates better with body mass index than waist-to-hip ratio in Asian Indians. National Medical Journal of India 2003; 16:189–192.
24. Lear SA, James PT, Ko GT and Kumanyika S. Appropriateness of waist circumference and waist-to-hip ratio cut-offs for different ethnic groups. European Journal of Clinical Nutrition 2010; 64:42-61.
25. Lear SA, Humphries KH, Kohli S, Chockalingam A, Frohlich JJ, and Birmingham CL. Visceral adipose tissue accumulation differs according to ethnic background: results of the Multicultural Community Health Assessment Trial (M-CHAT. American Journal of Clinical Nutrition 2007; 86:353–359.
26. Kagawa M, Binns CW and Hills AP. Body composition and anthropometry in Japanese and Australian Caucasian males and Japanese females. Asia Pacific Journal of Clinical Nutrition 2007; 16 (1):31-36.
27. Kelishadi R, Gheiratmand R, Ardalan G, Adeli K, Gouya MM, Razaghi EM, et al. Association of anthropometric indices with cardiovascular disease risk factors among children and adolescents: CASPIAN Study. International Journal of Cardiology 2007; 117: 340-348.
28. Katzmarzyk PT, Srinivasan SR, Chen W, Malina RM, Bouchard C and Berenson G. Body mass index, waist circumference, and clustering of cardiovascular risk factors in a biracial sample of children and adolescents. Pediatrics 2004; 114: 198-205.
29. Ng VWS, Kong APS, Choi KC, Ozaki R, Wong GWK, So WY, et al. BMI and waist circumference in predicting cardiovascular risk factor clustering in Chinese adolescents. Obesity 2007; 15: 494-503.
30. Sung RY, So HK, Choi KC, Nelson EAS, Li AM and Yin JAT, et al. Waist circumference and waist-to-height ratio of Hong Kong Chinese children. BMC Public Health 2008; 8: 324. http://www.biomedcentral.com/1471-2458/8/324/prepub
31. Savva SC, Tornaritis M, Savva ME, Kourides Y, Panagi A, Silikiotou N, et al. Waist circumference and waist-to-height ratio are better predictors of cardiovascular disease risk factors in children than body mass index. International Journal of Obesity and Related Metabolic Disorders 2000; 24: 1453-1458.
32. Pitanga FJG and Lessa I. Anthropometric indexes of obesity as an instrument of screening for high coronary risk in adults in the city of Salvador-Bahia. Arquivos Brasileiros de Cardiologia 2005; 85: 26-31.
33. Pitanga FJG and Lessa I. Indicadores antropométricos de obesidade como instrumento de triagem para risco coronariano em mulheres. Revista Brasileira de Cineantropometria & Desempenho Humano 2006; 8: 14-21.
34. Deurenberg P and Yap M. 1999. The assessment of obesity: methods for measuring body fat and global prevalence of obesity. Baillieres Clinical Endocrinology and Metabolism 1999; 13: 1–11.