Contents lists available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

International Diabetes Federation

Using anthropometric indices to predict cardio-metabolic risk factors in Australian indigenous populations

Ming Li *, *Robyn A. McDermott*

Division of Health Sciences, University of South Australia, Adelaide, SA, Australia

ARTICLE INFO

Article history:
Received 6 May 2009
Received in revised form
17 September 2009
Accepted 1 December 2009
Published on line 19 January 2010

Keywords:
Anthropometric indices
Cardio-metabolic risk factors
ROC analysis
Australian Indigenous populations

ABSTRACT

Aims: To compare the predictive power of anthropometric indices (BMI, waist circumference (WC), waist-to-hip ratio (WHpR) and waist-to-height ratio (WHtR)) for diabetes, hypertension and dyslipidemia in Australian Aboriginal and Torres Strait Islander (TSI) adults.

Methods: Cross-sectional study of 2862 Indigenous Australians aged over 15 living in rural communities in Far North Queensland during 1999–2001. The predictive values of anthropometric indices for cardio-metabolic disorders were compared using receiver operating characteristic (ROC) analysis.

Results: BMI was the poorest predictor while WHpR was the best among the four measures. The optimal WHtR and WHpR cut-off points for the cardio-metabolic risks in both women and men in the two Indigenous populations were 0.5–0.6 and 0.9 respectively. Optimal BMI cut-offs for diabetes, hypertension, and dyslipidemia were much lower in Aborigines than the recommended WHO BMI cut-offs, while those in TSIs were around WHO BMI criteria. The optimal WC cut-points varied by gender and ethnicity.

Conclusions: BMI was not a good discriminator of cardio-metabolic risk factors in Australian Indigenous populations compared with other anthropometric indices. WHpR is more closely associated with the risk of cardio-metabolic in these high-risk populations.

1. Introduction

The Australian Indigenous population has higher prevalence and incidence of obesity and cardio-metabolic risk factors including hypertension, type II diabetes, and dyslipidemia than other Australians [1–4]. Epidemiological studies show that obesity is closely associated with this cluster of cardio-metabolic risk factors [3,5]. WHO recommends Body Mass Index (BMI) to define overweight and obesity across populations [5] although there appear to be large differences in risk in different ethnic groups at given BMI levels [6]. Other clinical measures of central obesity, waist circumference (WC), waist-to-hip ratio (WHpR), have been found to more accurately predict cardiovascular risk and have replaced BMI in some definitions for clinical diagnosis of metabolic syndrome [7]. Australian Aborigines have a different BMI distribution to Caucasian populations [8] and similarly for Australian Torres Strait Islanders [4]. The performance of simple anthropometric indices in predicting chronic cardio-metabolic risks using receiver operating characteristic (ROC) curves in different ethnic groups including Europeans, Africans, Chinese, Japanese, Thai have been reported [9] but none among Indigenous Australians. The purpose of this study is to determine the accuracy of anthropometric indices, BMI, WC, WHpR, and

* *Corresponding author at*: Division of Health Sciences, University of South Australia, North Terrace, City East Campus, Adelaide, SA 50, Australia. Tel.: +61 8 83021051; fax: +61 8 83022030.
E-mail address: ming.li@unisa.edu.au (M. Li).
0168-8227/$ – see front matter
doi:10.1016/j.diabres.2009.12.004

waist-to-height ratio (WHtR) to predict cardio-metabolic risk in Australian Aboriginal and TSI populations.

2. Subjects, materials and methods

2.1. Study population

Between 1999 and 2001, 2862 Indigenous adults aged between 15 and 74 years living in 23 rural communities in far north Queensland participated in a larger community study, the ''Well Person's Health Check''. Methods for this study have been reported in detail elsewhere [10]. The study was approved by the Cairns Base Hospital Human Research Ethics Committee with support from the peak Indigenous Health Organisations, Apunipima Cape York Health Council and the Torres Strait and Northern Peninsula Area Health Council.

Based on local census and housing data, the study achieved a participation rate of 44.5% with greater participation noted in smaller communities. Participants overall were not different demographically from the age and sex distribution of the Indigenous population as a whole, based on census data [10].

2.2. Measurements

Participants were asked to remove foot wear and heavy clothing and weighed to the nearest 0.1 kg. Height, WC and hip circumference were recorded to the nearest centimetre with standardized protocol by the same technician. BMI was calculated as weight (kg) divided by the height squared (m^2). Physical activity was measured using a 7-day recall method in which participants were asked to report daily physical activities of at least 30 min duration and moderate intensity performed during the week before their health check. Current smokers were asked how many cigarettes they smoked daily. Frequency and the daily amount of drinks of current drinkers were recorded. The physical activity, smoking and alcohol intake measures are similar to those used in other studies [11,12].

Total cholesterol, HDLC, triglycerides, and glucose were measured on blood collected in the early morning after at least an 8 h fast [10]. Blood glucose and blood lipids were measured using photometric enzyme endpoint assay with Cobas Integra 700/400 (Roche Diagnostic, USA). Three seated blood pressure measurements were taken at 2 min intervals after 10 min rest using a Dinamap automated oscillometric device (Critikon Corporation), and the average of the three was used in all analyses.

Diabetes was defined as either clinical diagnosis of diabetes verified by participants' medical records, or 2 h glucose tolerance test or fasting blood glucose level equal to or greater than 7.0 mmol/l using WHO criteria [13]. Hypertension was defined as having blood pressure > 140/90 mmHg according to the WHO guidelines [14]. Dyslipidemia was defined as having triglycerides > 2.0 mmol/l or high-density-lipoprotein cholesterol (HDL) < 1.0 mmol/l based upon the recommendations by the National Heart Foundation [15] and the Australian Diabetes Society [16].

Physical activity level was defined by American Heart Association criteria in which ''active'' reflects moderate to vigorous physical activity for at least 30 min per day on 5 days in the week before the survey [17].

2.3. Analysis

BMI was classified into 3 categories: <25, 25–30, 30+ kg/m^2 using WHO criteria where overweight is defined as BMI 25–30 kg/m^2 and obese as BMI > 30 kg/m^2 [18]. The Student's t-test was used to compare differences between means and the chi square test was used to compare differences in proportions between the two ethnical groups within gender strata. ROC analysis is used to evaluate the accuracy of a diagnostic test by summarizing the potential of the test to discriminate between absence and presence of an abnormality [19]. The area under the ROC curves (AUCs) was used to assess the diagnostic accuracy of each index and compared between genders. An AUC of 1 is considered to have perfect discriminatory power, and an AUC of 0.5 indicates the predicting performance is no better than chance. AUCs of 0.6–0.7 were considered poor and 0.7–0.8 are fair [20]. Optimal cut-offs on the ROC curves were chosen to maximize sensitivity and specificity of the indices with each above 50%. Sensitivity in this report was defined as the proportion of people with the cardio-metabolic risk factors who have a positive test while specificity was the proportion of people without the risk factors who have a negative test. The analysis was carried out using STATA 10 (STATAcorp, College Station, TX, USA) and significance level was set as $P < 0.05$.

3. Results

Among the 2862 participants, 2609 Indigenous people were included in this report after excluding 253 participants who were identified as both Aborigines and Torres Strait Islanders. There were 1641 Aborigines (881 were females) and 968 were Torres Strait Islanders (471 were females). Table 1 shows the anthropometric behavioural and metabolic characteristics of the two study populations. In general TSI had greater height, weight, waist and hip measurements than Aborigines. Aborigines had lower SBP, fasting blood sugar level, and higher DBP, triglycerides, and HDL cholesterol than TSIs. Aboriginal women and men had higher prevalence of smoking, drinking and lower levels of physical activity than TSI adults. The prevalence of type II diabetes in TSI adults was higher than in Aborigines, and highest in TSI women (22.7%) compared to Aboriginal women (12.9%), but the opposite was found for hypertension, and dyslipidemia.

Table 2 shows the performance of BMI, WC, WHtR, and WHpR in predicting hypertension, dyslipidemia and diabetes in the two groups. There is poor predictive power for hypertension in both Aborigines and TSIs, and BMI generally had relatively lower AUCs than WC, WHtR, and WHpR in the two populations (Fig. 1). All the anthropometric indices poorly predicted hypertension and dyslipdemia, except in Aboriginal men where dyslipidemia was better predicted than in Aboriginal women.

Optimal anthropometric cut-points for predicting cardio-metabolic risk were generally much lower in Aborigines than in TSI. The optimal BMI cut-off values for predicting diabetes,