Nutrition, Metabolism & Cardiovascular Diseases (2014) **24**, 900–907

Available online at www.sciencedirect.com

Nutrition, Metabolism & Cardiovascular Diseases

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

Evaluation of waist-to-height ratio to predict 5 year cardiometabolic risk in sub-Saharan African adults

L.J. Ware [a], K.L. Rennie [b], H.S. Kruger [c], I.M. Kruger [d], M. Greeff [d], C.M.T. Fourie [a], H.W. Huisman [a], J.D.W. Scheepers [a], A.S. Uys [a], R. Kruger [a], J.M. Van Rooyen [a], R. Schutte [a], A.E. Schutte [a,*]

[a] *Hypertension in Africa Research Team (HART), Faculty of Health Sciences, North-West University, Private Bag X6001, 2520, South Africa*
[b] *Centre for Lifespan and Chronic Illness Research, University of Hertfordshire, United Kingdom*
[c] *Centre of Excellence for Nutrition (CEN), Faculty of Health Sciences, North-West University, South Africa*
[d] *Africa Unit for Transdisciplinary Health Research (AUTHeR), Faculty of Health Sciences, North-West University, South Africa*

Received 16 December 2013; received in revised form 6 February 2014; accepted 11 February 2014
Available online 22 February 2014

KEYWORDS
Waist circumference;
Waist-to-height ratio;
Cardiovascular disease;
Hypertension;
Diabetes;
Dyslipidaemia;
Risk factors;
Sub-Saharan Africa

Abstract *Background and aims:* Simple, low-cost central obesity measures may help identify individuals with increased cardiometabolic disease risk, although it is unclear which measures perform best in African adults. We aimed to: 1) cross-sectionally compare the accuracy of existing waist-to-height ratio (WHtR) and waist circumference (WC) thresholds to identify individuals with hypertension, pre-diabetes, or dyslipidaemia; 2) identify optimal WC and WHtR thresholds to detect CVD risk in this African population; and 3) assess which measure best predicts 5-year CVD risk.
Methods and results: Black South Africans (577 men, 942 women, aged >30years) were recruited by random household selection from four North West Province communities. Demographic and anthropometric measures were taken. Recommended diagnostic thresholds (WC > 80 cm for women, >94 cm for men; WHtR > 0.5) were evaluated to predict blood pressure, fasting blood glucose, lipids, and glycated haemoglobin measured at baseline and 5 year follow up. Women were significantly more overweight than men at baseline (mean body mass index (BMI) women 27.3 ± 7.4 kg/m^2, men 20.9 ± 4.3 kg/m^2); median WC women 81.9 cm (interquartile range 61–103), men 74.7 cm (63–87 cm), all $P < 0.001$). In women, both WC and WHtR significantly predicted all cardiometabolic risk factors after 5 years. In men, even after adjusting WC threshold based on ROC analysis, WHtR better predicted overall 5-year risk. Neither measure predicted hypertension in men.
Conclusions: The WHtR threshold of >0.5 appears to be more consistently supported and may provide a better predictor of future cardiometabolic risk in sub-Saharan Africa.

Introduction

Some of the most rapid increases in obesity and the associated cardiometabolic disease are currently occurring in sub-Saharan Africa (SSA) [1,2] creating a growing demand for suitable tools that can be employed to determine risk. Measures of central obesity, such as waist circumference (WC) and waist-to-height ratio (WHtR), are simple to collect, appropriate for low-resource settings, and better discriminators of cardiovascular disease (CVD) risk than body mass index (BMI) [3]. However, it is unclear which markers of central obesity perform best in SSA adults to predict CVD.

* Corresponding author. Tel.: +27 (0) 18 299 2444; fax: +27 (0) 18 299 1053.
E-mail addresses: Alta.Schutte@nwu.ac.za, alta.schutte1977@gmail.com (A.E. Schutte).

0939-4753/$ - see front matter © 2014 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.numecd.2014.02.005

Abbreviations

WC	waist circumference
WHtR	waist-to-height ratio
BMI	body mass index
WHO	World Health Organisation
SSA	sub-Saharan Africa
CVD	cardiovascular disease
PURE	Prospective Urban & Rural Epidemiological study
HIV	human immunodeficiency virus
HDL-C	high density lipoprotein cholesterol
SBP	systolic blood pressure
DBP	diastolic blood pressure
HbA1c	glycated haemoglobin
TG	triglycerides
IFG	impaired fasting glucose
ROC	receiver operating characteristic
AUC	area under the curve
OR	odds ratio
CI	confidence interval
IQR	interquartile range
NS	not significant
n	number of observations
SD	standard deviation
P	probability

Current recommended diagnostic thresholds for WC in Africa from the World Health Organisation (WHO; $WC_{WHO} > 94$ cm for men, >80 cm for women) [4] are based predominantly on prospective analyses in Caucasian reference populations. However, recent evidence from cross-sectional studies in SSA would suggest that these may not be appropriate for African populations [5–10] and ethnicity specific thresholds (such as those recommended for Asian populations [4]) may be required. While the recommended WHtR threshold of 0.5 has largely been determined from Caucasian and Asian populations [11,12], this WHtR threshold requires validation in SSA populations.

The aims of this study were: 1) To compare the accuracy of existing WC and WHtR thresholds to cross-sectionally identify individuals with hypertension, pre-diabetes, or dyslipidaemia; 2) to determine the optimal WC and WHtR thresholds for detection of these CVD risk factors in an African population; and 3) to determine whether these thresholds prospectively predict 5-year CVD risk.

Methods

Study population

The Prospective Urban Rural Epidemiology (PURE) study is a multinational cohort study examining the environmental, societal and biological determinants of obesity and chronic health problems. Study design, methodology, and specific recruitment procedures for PURE South Africa are described in detail elsewhere [13,14]. In brief, the first South African cohort began in 2005, with 5 year follow-up (2010). Black African men and women ($n = 2010$, age > 30 years, no previous HIV diagnosis) were recruited from 6000 randomly selected households in two urban ($n = 1004$, 60% female) and two rural ($n = 1006$, 65% female) North West Province communities. Trained field-workers speaking the participants' home languages (predominantly Setswana) were used and all participants provided written informed consent prior to taking part in the study. Participants were followed up in 2010. The study complied with the ethical principles for medical research involving human subjects as stated in the Declaration of Helsinki [15] and was approved by the North-West University Ethics Committee.

Measurements

Height (without shoes) was measured to the nearest 0.1 cm with a stadiometer (SECA, Hamburg Germany). Weight in light clothing was measured to the nearest 0.01 kg on portable electronic scales (A&D Medical, Abingdon UK). WC was measured midway between the iliac crest and the lower margin of the last palpable rib in the mid-axillary line using a steel anthropometric tape measure (Lufkin, Apex USA). BMI and WHtR were calculated using the formulae BMI = weight (kg)/height $(m)^2$ and WHtR = WC (cm)/height (cm), respectively.

Blood samples were drawn at the antecubital fossa following an overnight fast. Plasma glucose, serum high-density lipoprotein (HDL)-cholesterol and triglyceride concentrations were determined using two Sequential Multiple Analyser Computers (Cobas Integra 400 plus, Roche, Basel Switzerland; Konelab 20i, Thermo Scientific, Finland). Glycated haemoglobin (HbA1c) was analysed using the D-10 Hemoglobin Testing System (Bio-Rad Laboratories, Hercules USA). Human Immunodeficiency Virus (HIV) status was determined with the First Response (PMC Medical, Nani Daman India) rapid HIV card test using whole blood. If positive, the test was repeated with the Pareeshak (BHAT Bio-tech, Bangalore India) card test. Following 10 min rest, systolic (SBP) and diastolic blood pressure (DBP) were measured on the right upper arm using an automated monitor (HEM-757, Omron Healthcare, Tokyo Japan) and appropriate size cuff and participants seated with their arm supported at the level of the heart. A second BP measure taken after 5 min was used for analysis.

Metabolic risk factor definitions

The diagnostic criteria for elevated CVD risk were: hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg or on antihypertensive treatment); low HDL-C (<1 mmol/l in men, <1.3 mmol/l in women); elevated triglycerides (TG > 1.7 mmol/l or 150 mg/dl); impaired fasting glucose