



## Waist circumference as a predictor for blood glucose levels in adults

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### ABSTRACT

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Anthropometric indexes such as body mass index (BMI), waist circumference (WC), hip circumference (HC), and waist-hip ratio (WHR), are all useful anthropometric measurements to provide important information on blood glucose concentrations. The aim of this study was to determine different anthropometric measurements, in particular BMI, waist circumference, hip circumference and waist-to-hip ratio, in their ability to predict the blood glucose levels in men and women 40 to 60. A cross-sectional study was conducted on a sample of 44 men and 127 women aged 40 to 50 who lived in Cipete Selatan subdistrict, South Jakarta. Blood glucose levels was assessed and anthropometric measurements comprising BMI, WC, HC, WHR were collected. Multiple linear regression analysis was used to determine the best predictor for blood glucose levels. The study showed that the prevalence of DM type 2 was 25.7% and the prevalence was higher in men (40.9%) compared to women (23.5%). The significant predictive variables in the simple regression analysis were age and waist circumference. Multiple linear regression showed that after adjustment for age, WC was positively associated with blood glucose levels. Standardized a value was 0.172 ( $p=0.026$ ). WC predict blood glucose levels, beyond that explained by traditional diabetic risk factors and BMI. These findings provide support for the recommendation that WC be a routine measure for identification of diabetes mellitus type 2 in men and women aged 40 to 60 years.

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### INTRODUCTION

The increase in the number of diabetes mellitus (DM) type 2 patients all over the world have been predicted by the experts.<sup>(1)</sup> The

prevalence rate of DM in the developing world, especially in the Asia-Pacific region, increasingly compared with other countries. In Thailand the increase in the prevalence of DM type 2 among the population aged  $\leq 35$  was 9.6%,

an increase of 20% over a period of 5 years.<sup>(2)</sup> According to the survey that was carried out by the World Health Organization (WHO) in the year 2000, Indonesia occupied the 4th place in the number of DM patients in the world after India, China and the United States. During 2000, the prevalence of the DM was 8.4 million and in 2030 will be increased to 21.3 million.<sup>(1)</sup> Whereas data from the Indonesian Department of Health showed that the number of DM inpatients and outpatients treated in hospitals occupied the first place from all over endocrine disorders.<sup>(3)</sup> In developing countries the highest prevalence of DM type 2 was in people 45 to 65 years of age.<sup>(4)</sup> The complications that could result from DM, including coronary heart disease (CHD), necessitate larger expenditures for medical treatment.

Therefore, early diagnosis and prevention of DM are very important to prevent CHD as a complication after the onset of diabetes. Several factors that could increase the incidence of DM type 2 are sedentary habits, obesity, excessive consumption of polyunsaturated fats and refined sugars, and smoking. Several studies showed that obesity was correlated with the increase in the prevalence of hypertension, DM and dyslipidemia.<sup>(5)</sup> The importance of obesity as a risk factor for type 2 diabetes and hypertension has been well recognized, but its role as a coronary heart disease (CHD) risk factor in nondiabetic, normotensive individuals has been less well established.<sup>(6)</sup> Anthropometric indices, such as body mass index (BMI), waist circumference (WC), and waist-hip ratio (WHR), are anthropometric measurements that could give risk information on DM and CHD.<sup>(7)</sup> The WHO and the National Institute of Health have defined BMI, WC, and WHR cut-off levels for white, black and Hispanic American adults; however, these definitions cannot be readily applied to other populations.<sup>(8,9)</sup> It is beneficial to healthcare to assess which anthropometric measurements

are associated with the presence of DM in different populations. Although it is argued that there is no justification for general population screening, early detection of individuals at risk of diabetes could be beneficial because early intervention has the potential to prevent the development of diabetes and its complications. The identification of individuals at risk of diabetes and treatment of risk factors is therefore relevant to prevent cardiovascular disease and mortality in addition to diabetes.<sup>(10)</sup> The aim of this study was to determine which anthropometric measurements, in particular BMI, WC, and WHR, were able to predict the risk of type 2 diabetes in people 40 to 60 years of age.

## METHODS

### Research design

We carried out a cross-sectional study during October to November 2007 among people 40 to 60 years of age.

### Study subjects

The subjects of the study were men and women 40 to 60 years of age who lived in Cipete Selatan subdistrict. The inclusion criteria were age 40 to 60 years and no history of diabetes. After exclusion of participants with any history of severe diseases (cancer, liver cirrhosis), mental retardation and lack of communication, data were collected on subject characteristics, such as age, gender, level of education, exercise and occupation.

### Measurements

The anthropometric measurements used to calculate BMI, using standardized procedures, were height and weight. Height was measured using a portable microtoise to the nearest 0.1 cm and weight was measured using sage portable scales to the nearest 0.1 kg. BMI was calculated as the weight (kg) divided by the square of the

height (m). WC was taken as the minimum circumference between the umbilicus and xiphoid process and measured to the nearest 0.5 cm. Hip circumference (HC) was measured as the maximum circumference around the buttocks posteriorly and the symphysis pubis anteriorly and measured to the nearest 0.5 cm. Then WHR was calculated from WC and HC. Blood was taken at any time for measurement of plasma glucose (PG). Blood glucose level was measured using gluco-test and gluco-strip. The American Diabetes Association criteria were used to diagnose diabetes.<sup>(11)</sup> Diabetes was defined by the presence of classic DM symptoms and a casual plasma glucose level of  $\geq 200$  mg/dL (11.1 mmol/L).

### Statistical analysis

Differences between men and women were examined by Student's t test. To test the contribution of age, WC, HP, BMI, WHR on casual blood glucose concentrations as dependent variable we used a single regression analysis. Furthermore a multiple step-wise regression analysis, including all variables that were significantly ( $p < 0.05$ ) associated with casual blood glucose levels, was used to determine the best predictor of casual blood

glucose concentrations. All analyses were performed using the SPSS/PC statistical program (version 11.0 for Windows; SPSS, Inc.Chicago, IL).

### RESULTS

The subjects consisted of 127 (74.3%) women and 44 (25.7%) men. The prevalence of DM type 2 was 25.7%. The age, anthropometric indices, blood glucose levels and prevalence of type 2 DM of the subjects are summarized in Table 1. The means of height and weight were significantly higher in men compared to women. In men, WC ( $88.3 \pm 10.8$  cm) was statistically significantly higher compared with women ( $83.5 \pm 9.4$  cm) ( $p = 0.005$ ). HC and WHR differences were also statistically significant between men and women, but the difference in blood glucose levels was not statistically significant ( $p = 0.197$ ).

Table 2 presents the results of the simple linear regression analysis in which several anthropometric indices were used to predict the blood glucose levels. The analysis showed that age and WC had a statistically significant positive association with casual blood glucose levels, whereas BMI, HC, and WHR were statistically not significantly associated with

Table 1. Anthropometry and prevalence of type 2 DM in the studied population

Anthropometry index	Men (n=44)	Women (n=127)	p value
Age (yr)	51.3 (6.3)	47.6 (6.1)	0.001
Height (cm)	162.8 (7.0)	151.8 (5.1)	0.000
Weight (kg)	77.6 (10.3)	59.1 (10.1)	0.000
BMI *	25.2 (3.3)	25.7 (4.1)	0.393
WC (cm) **	88.3 (10.8)	83.5 (9.4)	0.005
WH ratio ***	0.98 (0.06)	0.93 (0.04)	0.000
HC (cm) ****	92.6 (9.4)	96.2 (9.8)	0.041
Blood glucose level (mg/dl)	136.6 (70.4)	120.8 (69.6)	0.197
DM §	40.9%	23.5%	0.081

\*BMI = body mass index; \*\*WC = waist circumference; \*\*\*WHR = waist to hip ratio; \*\*\*\* HC = hip circumference; §DM = diabetes mellitus type 2; Values are expressed as mean and standard deviation (in parentheses).

Table 2. Simple regression analysis for predictors of blood glucose levels in men and women

Predictors	B	p
Age	1.684	0.048
BMI*	0.383	0.827
WC**	1.351	0.011
HC***	0.491	0.303
WHR****	103.371	0.345

\*BMI = body mass index; \*\*WC = waist circumference; \*\*\*\*WHR = waist to hip ratio; \*\*\* HC = hip circumference

casual blood glucose levels. Multiple linear regression models showed that WC was the best predictor for casual blood glucose levels among men and women 40 to 60 years of age. WC had a statistically significant positive association with casual blood glucose levels ( $p=0.026$ ) (Table 3).

## DISCUSSION

In the present study the prevalence of DM type 2 was 25.7% among men and women 40 to 60 years of age. This result was similar with that of a survey in Mexico, where the prevalence of DM type 2 among men and women over 20 was 26.6%.<sup>(12)</sup> However, the prevalence of DM in our study was higher than that found in the American survey (DM 7.8% in both genders), probably because in the latter the data were analyzed based on age groups and not on gender, whereas in our

Table 3. Multiple linear regression model for age and WC on blood glucose levels

Model	$\hat{a}$	Standardized $\hat{a}$	p
Aged	1.348	0.121	0.115
WC*	1.202	0.152	0.026

\*WC = waist circumference

study the analysis was on gender and not on age groups.<sup>(13)</sup> The primary finding of our study is that WC significantly predicts the levels of blood glucose. The study by Janiszewski et al<sup>(14)</sup> of approximately 3,000 men and 2,800 women showed similar results. After controlling for age, sex, race, smoking status, cardiometabolic risk factors, and BMI, patients with WC in the medium and high categories had a twofold and fivefold increased risk of diabetes, respectively. Schulze et al. showed that WC had the strongest association of single anthropometric measures for type 2 DM.<sup>(15)</sup> Several previous cohort studies<sup>(16-19)</sup> that compared different anthropometric measurements with regard to diabetes risk prediction suggest that anthropometric measurements that describe central fat distribution, in particular WC, may be superior to measurements of general adiposity. A study in Central Jakarta on men and women 35 to 55 years of age, showed a similar result, namely that WC was the best predictor for screening DM type 2, compared with BMI, waist to height ratio and WHR.<sup>(20)</sup> WC by itself was also strongly related to risk of myocardial infarction, and this association remained significant after adjustment for other risk factors.<sup>(21)</sup>

In the present study, WC significantly predicted the levels of blood glucose, but BMI did not predict diabetes after consideration of common diabetic risk factors and WC. The recent consensus statement of the American Diabetes Association, the Obesity Society, and the American Society for Nutrition questions the sequence of clinical measures of diabetes mellitus and more importantly, the relevance of WC measurement in clinical practice.<sup>(22)</sup>

One of the limitations of this study was that we were unable to include the fasting and 2 hour glucose concentration to determine a better diagnosis for DM type 2. The simplest parameter for identifying those at risk of diabetes is WC, beyond that explained by commonly evaluated

diabetic risk factors such as weight, BMI and WHR.

## CONCLUSIONS

We found that among men and women, WC appeared to be the best predictor than any other single direct measure. WC was a better predictor of diabetes occurrence than BMI among men and women. Generally, measurement of anthropometric characteristics beyond WC had little predictive information. WC can be used for early intervention to delay or prevent type 2 DM.

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