ORIGINAL ARTICLE

ASSOCIATION OF HbA1c, FASTING GLUCOSE LEVELS AND LIPID PARAMETERS WITH ANTHROPOMETRIC INDICES IN A GROUP OF DIABETICS AND NON-DIABETIC INDIVIDUALS

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Abstract

Objective: *Because of the usefulness of anthropometric measurements and indices, they are frequently recommended for prediction of diabetes in clinical practice. The aim of this study is to determine the relationship between HbA1c and fasting plasma glucose (FPG) and lipid parameters of diabetics and non-diabetics and 7 different indices, such as, waist circumference (WC), waist-to-hip ratio (WtHR), body mass index (BMI), Broca-Katsura index, Rohrer index, a body shape index (ABSI), and body roundness index (BRI).*

Methods: *A total of 505 individuals were included in the study (type 2 DM, n=65; type 1 DM, n=265, and 171 controls). Anthropometric measurements were evaluated (weight, height and waist circumference) and from these measurements BMI, Broca-Katsura Index, Rohrer Index, ABSI and BRI were calculated. HbA1c, FPG, LDL-cholesterol, triglyceride and HDL-cholesterol levels were also measured. Data were analysed with SPSS 21.0 statistics program.*

Results: *HbA1c levels and BMIs were significantly high in diabetic patients. None of the indices were significantly correlated with HbA1c, FPG levels, LDL-cholesterol and triglyceride levels in diabetic patients; but body weight, body mass, BMI, WC and Broca-Katsura index were positively correlated with HbA1c levels in controls. On the other hand, FPG levels of controls were positively correlated with body weight, BMI and Broca-Katsura index.*

Conclusion: *Although much of the anthropometric measurements and indices correlated with the levels of HbA1c, FPG and LDL-cholesterol, HDL-cholesterol and triglycerides in control group; none of the indices were correlated with HbA1c levels, FPG, LDL-cholesterol and triglyceride in type 1 and type 2 diabetics. Anthropometric indices, especially recent ones, had limited capacity and usefulness for monitoring of diabetes and dyslipidemia in diabetic patients.*

Key words: *Type 1 diabetes, type 2 diabetes, body mass index, anthropometric measurements.*

Introduction

Obesity and diabetes mellitus are two important public health problems throughout the world. Obesity, especially central obesity, is strongly and directly associated with development of diabetes mellitus (1). It was shown many times that diabetes acts as a vascular disease and if it was uncontrolled, can cause micro and macro vascular diseases. Several studies emphasize the importance of intensive glucose control in diabetic patients (2,3). Control of obesity results in decrease of HbA1c levels and can help control of diabetes.

There are many anthropometric measures and indices used for prediction of obesity. The most frequently used and known index is body mass index (BMI) (4). Other than BMI, waist circumference (WC), waist-to-height ratio (WHtR) and waist-to-hip ratio (WHpR) also used for prediction of obesity and especially central obesity (5). These direct anthropometric measurements have some limitations. BMI focuses on weight and enables to distinguish fat and muscle mass. On the other hand, WC reflects only abdominal fat accumulation and dismisses total body composition (6).

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Because of the limitations of direct anthropometric measurements, in 2011 Body Adiposity Index (BAI), in 2012 A Body Shape Index (ABSI) and in 2013 Body Roundness Index (BRI) were developed (7-9). The aim of this study is to determine the relationship between HbA1c and fasting plasma glucose (FPG) with lipid parameters of diabetics and non-diabetics and 7 different indices (WC, WtHR, BMI, Broca-Katsura Index, Rohrer Index, ABSI and BRI).

Methods:

A total of 505 individuals were included in the study. Sixty-five of these individuals were type 2 diabetics, 265 of them were type 1 diabetics and 171 were non-diabetic controls. All diabetic participants have been diagnosed according to the American Diabetes Association 2015 criteria of FPG 126 mg/dl or HbA1c 6.5% (10). All of the attendants were randomly selected from the Diabetes Clinics of Göztepe Training and Research Hospital between 2013 – 2014. The study was approved by local ethical committee (12.28.2012/29G). Blood samples were obtained after overnight fasting and HbA1c levels were measured by HPLC technique.

All of the anthropometric data were measured by same researcher. Height and weight of the participants were measured with a 0.1 kg and 0.1 cm sensitive electronic scale. The WC was measured from the umbilicus point on the anterior wall of abdomen to both spina iliaca superiors. The indices were calculated according to the formula summarized in Table 1. Data were analyzed with SPSS 21.0 statistics program and also presented as frequencies and means ± SD. Pearson correlation was used to analyze the correlation of indices and HbA1c. A p value <0.05 was accepted as significant.

Results

The female ratio and mean age of type 1 diabetics and type 2 diabetics were 46.7% vs 38.4% and 36.5±10.8 vs 38.2±9.2 years, respectively. Fiftynine percent of the controls were female and the mean age was 37.6±11.4 years. Levels of HbA1c and BMI were significantly high in diabetics. The clinical characteristics of the participants were summarized in Table 2.

The correlation of HbA1c levels and fasting plasma glucose with different indices in three groups was shown in Table 3 and Table 4. It was shown that none of the indices has significant correlation with HbA1c and FPG in diabetics. In controls body weight, BMI, WC and Broca-Katsura index were positively correlated with HbA1c levels. On the other hand, FPG levels of controls were positively correlated with body weight, body mass index and Broca-Katsura index.

The correlation of lipid parameters (LDL-cholesterol, HDL-cholesterol and triglyceride levels) with anthropometric indices in three groups was also analyzed. In type 1 diabetics' group HDL-cholesterol levels were significantly correlated with body weight (r=0,136; p=0.027), WC (r=0.188; p=0.002), WtHR (r=-0.237; p=0.001), BMI (r=0,199; p=0.001), Rohrer Index (r=-0.156; p=0.012), ABSI (r=-0.144; p=0.044), Broca-Katsura Index (r=-0.187; p=0.002); but there was no significant correlation with BRI. Moreover LDL-cholesterol and triglyceride levels in type 1 diabetics do not correlate any of the anthropometric measurements and indices. In type 2 diabetics, HDL-cholesterol levels were significantly correlated with weight (r=0.324; p=0.009), WC (r=0.325; p=0.009), BMI (-0.262; p=0.040), but there was no significant correlation with other indices. In control group, all of the anthropometric indices except BRI were

Table 1. Formulas of anthropometric indices

Name	Abbreviation	Formula
Weight	W	(kg)
Waist circumference	WC	(cm)
Waist to Height Ratio	WtHR	Waist circumference (cm) / Height (cm)
Body Mass Index	BMI	Weight (kg)/ Height ^{2} (m)
Rohrer Index	RI	Weight (kg)/Height^3(m)
Broca-Katsura Index	BKI	Weight (kg) / ([(Height (cm)-100) x0,9]-1)x100
A Body Shape Index	ABSI	$\frac{\text{Waist circumference (cm)}}{BMI^{2/3} \times height^{\frac{1}{2}}(m)}$
Body Roundness Index	BRI	$364.2 - (365.5 \times \varepsilon)$ $\varepsilon = \sqrt{1 - \frac{\left(\frac{WC\ (cm)}{2\pi}\right)^2}{(0.5 \times height\ (m))^2}}$

Table 2. Clinical characteristics of participants

	Type 1 DM (n=265)	Type 2 DM (n=65)	Control (n=171)	*p*
Gender				
Male	141 (53.21%)	40 (61.54%)	70 (40.94%)	*0.006*
Female	124 (46.79%)	25 (38.46%)	101 (59.06%)	
Age (years)	36.5±10.8	38.2±9.2	37.6±11.4	*0.397*
BMI (kg/m^2)	24.7±5.3	29.5±5.0	26.0±4.8	*<0.001*
FPG (mg/dL)	199.3±99.4	173.2±65.9	89.9±11.9	*<0.001*
HbA1c (%)	8.6±1.9	8.3±2.2	5.4±0.2	*<0.001*

BMI: Body Mass Index; FPG: Fasting Plasma Glucose; HbA1c: Glycated Hemoglobin

Data are presented as n (%) or median (minimum – maximum), where appropriate.

Table 3. The correlation of HbA1c with different indices in three groups

Anthropometric measures and indices		Type 1 DM (n=265)	Type 2 DM (n=65)	Control (n=171)
Weight (kg)	r	-0.024	0.095	0.279
	p	0.690	0.450	<0.001
BMI (kg/m^2)	r	-0.080	0,013	0.295
	p	0.890	0.911	<0.001
Waist circumference (cm)	r	-0.027	0.014	0.323
	p	0.658	0.911	<0.001
Waist/ Height	r	-0.033	0.026	-0.137
	p	0.601	0.840	0.075
Broca-Katsura Index	r	-0.030	0.023	0.314
	p	0.630	0.855	<0.001
Rohrer Index	r	-0.025	0.002	-0.144
	p	0.690	0.989	0.062
ABSI	r	-0.013	-0.074	0.094
	p	0.835	0.564	0.227
BRI	r	0.001	-0.021	0.100
	p	0.992	0.871	0.193

ABSI: A Body Shape Index; BMI: Body Mass Index; BRI: Body Roundness Index,
DM: Diabetes Mellitus
Pearson correlation test

significantly correlated with HDL-cholesterol levels namely; weight (r=-0.302; p<0.001), WC (r=-0.310;p<0.001), BMI (r=-0.175; p=0.04), WtHR (r=0.199; p=0.009), Broca-Katsura Index (r=0.242; p=0.002); ABSI (r=0.191; p=0.013). LDL-cholesterol levels of control groups were significantly correlated with weight (r=0,216; p<0.001); WC (r=0.296; p<0.001); BMI (r=0.252; p=0.001); ABSI (r=0.191; p=0.013) and Broca-Katsura Index (r=0.241; p=0.002). Moreover, triglyceride levels of control group also significantly correlated with weight (r=0.422; p<0.001); WC (r=0.388; p<0.001); BMI (r=0.336; p<0.001); ABSI (r=-0.317; p<0.001) and Broca-Katsura Index (r=-0.222; p=0.002).

Discussion

We found that all of the anthropometric indices do not correlate with HbA1c levels in diabetics; whereas weight, WC, BMI were positively associated with HbA1c levels in controls. The levels of HbA1c are valuable measurements for monitoring glucose levels over the proceeding 2-3 months and therefore it is useful for evaluation of clinical monitoring of diabetic patients (10).

Because of the simpleness and usefulness of weight, waist circumference and BMI, they have been recommended for prediction of diabetes in clinical practice (11). Hartwig et al. found that weight, waist circumference and weight-to-height ratio were anthropometric markers of type 2 diabetes. Among them WtHR is the strongest predictor of type 2 diabetics (12). In another study conducted in China with 11687 type 2 diabetics, it was found that increased BMI, WC, WHtR and ABSI values were related with the incidence of type 2 DM. But after adjustment of multi-covariates, it was shown that the risk of type 2 diabetes increased with elevated ABSI, but not differs with increase of BMI, WC and WtHR (13). However, BMI has been criticized especially for the discrimination of fat, lean body mass and fat distribution (14). Therefore, new anthropometric indices were proposed as alternatives, ABSI and BRI. But it was shown that neither ABSI nor BRI were superior to BMI, WC, or WHtR for predicting the presence of DM. ABSI showed the weakest predictive ability, while BRI showed potential for use as an alternative obesity measure in the assessment of DM (15). We found that HDL-cholesterol levels were significantly correlated with weight, WC, and BMI in three groups, but LDL-cholesterol and triglyceride levels of diabetics do not correlated with any measurements and indices. On the other hand, all of the lipid parameters were significantly correlated with weight, WC, BMI, ABSI and Broca-Katsura Index in control group.

Table 4. The correlation of fasting plasma glucose with different indices in three groups

Anthropometric measures and indices		Type 1 DM (n=265)	Type 2 DM (n=65)	Control (n=171)
Weight (kg)	r	0.035	0.026	0.234
	p	0.576	0.839	0.002
BMI (kg/m^2)	r	0.056	-0.056	0.217
	p	0.370	0.662	0.005
Waist circumference (cm)	r	0.083	-0.075	-0.047
	p	0.181	0.555	0.544
Waist/Height	r	0.092	-0.060	-0.047
	p	0.134	0.640	0.544
Broca-Katsura Index	r	0.058	-0.036	0.209
	p	0.354	0.735	0.006
Rohrer Index	r	0.056	-0.051	-0.051
	p	0.368	0.656	0.511
ABSI	r	0.016	-0.041	0,052
	p	0.800	0.742	0,952
BRI	r	0.028	-0.056	-0.051
	p	0.600	0.657	0.511

BMI: Body Mass Index; ABSI: A Body Shape Index; BRI: Body Roundness Index,
DM: Diabetes Mellitus
Pearson correlation test

In a study from Korea with the sample size of 1032 adults, it was shown that lipid parameters were significantly correlated with weight, WC, WtHR and BMI in women. BMI was not significantly correlated with lipid parameters in men (16). It was shown that ABSI was significantly correlated with LDL-cholesterol and triglycerides levels in healthy young adult men (17). Zaid et al. compared recently described indices, ABSI and BRI for assessment capacity of type and severity of dyslipidemia. As a result, they found that the dyslipidemia prediction capacity of BRI was comparable, but not superior to BMI and WC. On the other hand, the ABSI could not detect the presence or absence of dyslipidemia (18).

In conclusion, although much of the anthropometric measurements and indices correlated with HbA1c levels, FPG, LDL-cholesterol, HDL-cholesterol and triglycerides levels in healthy controls, none of the indices were correlated with HbA1c levels, FPG, LDL-cholesterol and triglyceride in type 1 and type 2 diabetics. But HDL-cholesterol levels were associated with conventional measurements in diabetics. So anthropometric indices, especially recent ones, has limited capacity and usefulness for monitoring of diabetes and dyslipidemia in diabetic patients.

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