ISSN 2201-2796

Relation between the New Anthropometric Obesity Parameters and Inflammatory Markers in Healthy Adult Men

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Abstract- **Background: The aim of this study is to estimate the relationship between the new anthropometric parameters [waist circumference to height ratio (WHtR), body adiposity index (BAI) and visceral adiposity index (VAI)] and some inflammatory markers (hsCRP, fibrinogen and TNF-alpha).**

Methods: Randomly selected 182 healthy adult men included to this study. Height, body weight (BW), waist circumference (WC) and hip circumference (HC) were measured and body mass index (BMI), waist circumferences to hip circumferences ratio (WHR), WHtR, BAI and VAI were calculated (VAI score was calculated after biochemical analysis). Subjects were grouped as Group 1 and Group 2 according to VAI, and normals, overweights and obeses according to BMI. Plasma fibrinogen, serum TNF-alpha and serum hsCRP levels were measured.

Results: All APs and hsCRP were increased in GROUP 2 significantly. TNF-alpha and fibrinogen levels were similar. Age, serum hsCRP and plasma fibrinogen were higher in overweights compared to normals. BMI and WHtR were positively correlated to serum hsCRP and plasma fibrinogen. Also VAI and BAI correlated with hsCRP.

Conclusion: Classical obesity parameters and new antropometric measures were related to some systemic inflammatory markers in our study. Both general and abdominal obesity have a pretendency toward having high

inflammatory markers. New antropometric measures may also reflect these disturbances in overweight adult men.

***IndexTerms*—Visceral Adiposity Index, Body Adiposity Index, Waist circumference to Height Ratio, Inflammatory Markers**

I. Introduction

Obesity is a condition characterized by high weight gain. Several parameters have been used to appraise the obesity such as body mass index (BMI), waist circumference (WC), and ratio of waist circumference to hip circumference (WHR). New measures have been added recently to this armamentarium, which are visceral adiposity index (VAI), body adiposity index (BAI) and waist circumference to height ratio (WHtR) (1-3). Those new anthropometric parameters (APs) have been reported to be a reliable predictor of systemic diseases such as cardiovascular disease and metabolic disorders (1-5).

Some inflammatory markers may be related to those indexes. hsCRP, fibrinogen and TNF-alpha are widely accepted indicators of systemic inflammation. In this study, we investigated the relationship between new APs (VAI, BAI and WHtR) and systemic inflammatory markers (IMs) mentioned above.

II. Materials and Methods

Randomly selected 182 healthy adult men included to this study. All subjects gave informed consent and the study protocol was approved by the local ethics committee.

Patients with acute infection, neoplasia, previous stroke and MI history, Diabetes Mellitus (DM), hypertension, thyroid disorders, taking drugs such as vitamins, anti-inflammatory agents or antibiotics and excessive alcohol consumption (more than 100 ml a week) were excluded from the study.

All subjects were examined physically. Age, height, weight, waist and hip circumferences, alcohol consumption and smoking status were recorded.

Smoking status was defined as smokers and nonsmokers and number of pockets a year.

Anthropometric Parameters (APs)

Height, body weight (BW), WC and (HC) were measured and BMI, WHR, WHtR, BAI and VAI were calculated (5) (VAI score was calculated after biochemical analysis). Persons were grouped as Group 1 (n=126) and Group 2 (n=56) with regard to a cut off level of VAI described by Amato et al (2)

$BMI= BW/height^2$

WHtR= WC (cm)/height (cm)

$BAI= (HC (cm)/ Height (m)^{1,5})-18$

VAI=[WC/(39.68+1.88xBMI)]x[TG (mmol/L)/1.03]x[1.31/HDL-C (mmol/L)] (for males)

A 10 mL of fasting blood sample was collected from the median cubital vein by using vacuum sampling method from each subject at 08:00-09.00 a.m. Samples were promptly centrifuged at 2500 g, at +4 °C, for 10 minutes. Serum and plasma samples were aliquoted and saved at -80 °C until biochemical studies.

Biochemical Studies

Plasma fibrinogen levels were measured using the Clauss clotting method with commercial kit (STA-Fibrinogen Diagnostica Stago) and the STA Compact automated coagulation analyzer (Diagnostica Stago, Albio, France).

Serum levels of TNF-alpha were determined using a chemiluminescence enzyme immunometric assay and commercial kit (Immulite-One, Immunassay Analyzer; BioDPC, Los Angeles CA, USA).

Serum hsCRP levels were measured using nephelometric method with a commercial kit and autoanalyzer (Dade Behring, Germany).

Statistical Analysis

Data were analyzed in SPSS Programme 15.0 (SPSS Inc, Chicago, IL, USA). For comparison Student t test, chi-square test and Mann Whitney-U test were used as appropriate. For correlations, Pearson's correlation test was used. Statistical significance was assumed when the p-value was less than 0,05. Results were expressed as the mean±SD and percent.

III. Results

The demographic, anthropometric and biochemical data according to VAI were listed in table 1. All APs and hsCRP were increased in Group 2 significantly ($p<0.05$). TNF-alpha and fibrinogen levels were similar ($p>0.05$).

Table 2 shows the demographic, anthropometric and biochemical data according to BMI. Age, hsCRP and fibrinogen were higher in overweights compared to normals ($p<0.05$).

Inflammatory markers were correlated with BMI, age and VAI. A detailed list of these correlations can be found in table 3.

IV. Discussion

New APs have been used in medicine for their possible predictive values (1-6). Some authors reported some association between adiposity and inflammation, our study confirmed this, by showing high levels of hsCRP in subjects in Group 2. High VAI especially correlated with high hsCRP. Many studies have showed a strong correlation between BMI and hsCRP (7-12). Al-Daghri claimed that VAI has no association with hsCRP and TNF-alpha, contrary to our study. On the other hand Du et al. reported a positive correlation between VAI and hsCRP.

The relationship between VAI and IMs may arise from the parameters used in VAI calculation. Many studies in the literature exist evaluating the relation between these parameters and IMs. Garcia et al have reported that CRP is independently and positively correlated to WC, and plasma triglyceride level, and negatively correlated to HDL-C in men (13). Bae et al have reported that plasma triglyceride level is correlated with TNF-alpha positively and HDL is correlated with hsCRP negatively (14). In a study the overweight/obese patients have exhibited significantly ($p<0.05$) higher values for abdominal obesity measures, triglycerides, hsCRP, fibrinogen and lower levels of HDL-C (15). Especially these studies support our study showing high VAI and high hsCRP levels association.

Hypertriglyceridemic waist phenotype (the simultaneous presence of WC ≥ 90/80 cm for men/women and plasma triglyceride concentration ≥1.7 mmol/l for both genders) has been identified by Lemieux et al (16). Du et al. have documented that both the VAI and hypertriglyceridemic waist phenotype are the simple and convenient markers of visceral obesity and they are strong and independent risk factors for diabetes. In addition the VAI and this phenotype are parameters are simple and inexpensive alternative approaches and may be served as surrogate markers of visceral adiposity for the quantitative evaluation of fat mass and for assessing viscerally obese individuals at risk for cardiometabolic disease

(4). Oh et al. have conducted a study in Korean population and reported that the VAI can replace visceral CT scanning as a marker for visceral adiposity (17).

In our study, BAI and VAI were related to hsCRP, and BMI related to hsCRP and fibrinogen, similar to study of Ditschumeti et al (18). Some have reported that BMI is more reliable indicator of body fat compared to BAI especially in overweight people (19,20). Also Melmer et al reported that BAI is inferior to BMI to predict anthropometric measures (21). Bozorgmanesh et al reported an association between cardiovascular disease risk and high VAI, but also reported that use of VAI alone instead of other obesity parameters may cause loss of some predictive data. Also they suggested that for the assessment of cardiovascular risk, VAI was not superior to WHR and WHtR (22).

According to our study, WHtR has a marked relationship with inflammatory markers and BMI and WHtR has similar relationship with IMs. Bosy-Westphal et al. reported that WC and WHtR were the best predictors of risk factors for both genders (23). WHtR has previously shown the highest correlation (0.83) with intra-abdominal fat compared with WC, WHR, or BMI (3).

In addition to that VAI is a good indicator of obesity, it has also been reported that age and sex specific VAI levels may maintain better predictive capacity (2,22). Therefore, we used cut off levels of VAI as described by Amato et al (2). Since there is no cut-off level for BAI and WHtR, we were unable to use any cut-off value for these parameters.

We restricted our study to Turkish-Anatolian population. There may be ethnic differences in the associations between APs and obesity (24). Therefore, our results may not be generalized to other ethnicities. One study conducted in Korean population showed that the VAI can replace visceral CT scanning as a marker for visceral adiposity, indicating that the VAI mathematical model can be also suitable for Asian populations (17).

As a result, classical obesity parameters and new APs were related to some systemic IMs in our study. BMI and WHtR were positively correlated to serum hsCRP and plasma fibrinogen. Also VAI and BAI correlated with hsCRP. Both general and abdominal obesity have a pretendency toward having high inflammatory markers. New antropometric measures may also reflect these disturbances in overweight people.

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Table 1: Demographic, anthropometric and biochemical parameters of all subjects and Groups according to VAI

parameters	all subjects (n=182)	Group 1 (n=126)	Group 2 (n=56)	p*
Age, years	29,3±7,9	27,9±7,3	30,6±8,5	0,039
Smoking, %	35,8	35	37,1	0,652
Smoking, pockets/year	188,4±242,2	170,5±241,6	217,2±246,7	0,325
Alcohol consumption, %	15,1	14,3	16,4	0,475
BMI, kg/m2	25,3±3,9	23,9±2,9	27,9±4,6	<0,001
WHtR	0,53±0,07	0,51±0,06	0,58±0,07	<0,001
BAI	26,4±3,7	25,5±3,1	28,6±3,7	<0,001
VAI	2,13±1,78	1,32±0,53	2,21±2,13	<0,001
hsCRP, mg/dL	1,42±1,42	1,04±1,21	2,01±1,59	0,002
Fibrinogen, g/L	1,94±0,61	1,9±0,62	1,85±0,57	0,66
TNF-alpha, pg/mL	9,76±4,42	9,89±4,56	9,72±4,62	0,867

*between GROUP 1 and GROUP 2.
Abbreviations: BAI: body adiposity index, BMI: body mass index, hsCRP: high sensitive C-reactive protein, VAI: visceral adiposity index, WHtR: waist circumference to height ratio, TNF: tumor necrosis factor

Table 2: Demographic, anthropometric and biochemical parameters of Groups according to BMI

parameters	normals (n=102)	overweights (n=59)	obeses (n=21)	p*	p**
Age, years	26,5±5,9	32,3±8,3	34,7±9,3	<0,001	0,293
Smoking, %	36,9	34,5	36,2	0,253	0,212
Smoking, pockets/year	166,4±232,3	207,9±252	266±269,9	0,367	0,329
Alcohol consumption, %	15,4	16,7	14,6	0,324	0,125
BMI, kg/m2	22,7±1,8	27,2±1,4	32,9±3,2	<0,001	<0,001
WHtR	0,49±0,05	0,55±0,03	0,65±0,04	<0,001	<0,001
BAI	24,4±2,7	27,9±2,4	31,9±3,2	<0,001	<0,001
VAI	1,71±1,5	2,21±1,4	4,12±2,73	0,042	<0,001
hsCRP, mg/dL	0,8±0,9	2,2±1,64	2,68±1,32	<0,001	0,245
Fibrinogen, g/L	1,81±0,55	2,11±0,65	2,09±0,62	0,029	0,869
TNF-alpha, pg/mL	9,43±4,25	9,99±4,24	11,28±6,03	0,549	0,67
*between normals and overweights.					
**between overweights and obeses.					

Abbreviations: BAI: body adiposity index, BMI: body mass index, hsCRP: high sensitive C-reactive protein, VAI: visceral adiposity index, WHtR: waist circumference to height ratio, TNF: tumor necrosis factor

Table 3: Correlations between anthropometric and biochemical parameters in all subjects

parameters	Age, years	BMI, kg/m2	WHtR	BAI	VAI
	R	R	R	R	R
Age, years		0,435***	0,511***	0,464***	0,153
hsCRP, mg/dL	0,251*	0,495***	0,447***	0,45***	0,242*
Fibrinogen, g/L	0,288***	0,19*	0,187*	0,036	-0,009
TNF-alpha, pg/mL	0,108	0,129	0,099	0,129	0,099

***Correlation is significant at the 0.001 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

Abbreviations: BAI: body adiposity index, BMI: body mass index, hsCRP: high sensitive C-reactive protein, VAI: visceral adiposity index, WHtR: waist circumference to height ratio, TNF: tumor necrosis factor