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Relationship between Body Anthropometric Measurement and Parathyroid Hormone in Female Subjects

Mabruratussania Maherdika, Meita Hendrianingtyas

Department of Clinical Pathology, Faculty of Medicine, Diponegoro University/Dr. Kariadi Hospital, Semarang, Indonesia. E-mail: dikamaherdika@gmail.com

ABSTRACT

The distribution of fat tissue is related to the risk of metabolic diseases. Parathyroid Hormone (PTH) is an essential hormone for calcium homeostasis. According to several types of research, body fat affects PTH levels. Currently, Body Mass Index (BMI) is not the only parameter needed to identify the body fat distribution in accordance with chronic disease risks such as Waist Circumference (WC), Waist to Hip Ratio (WHR), and Waist to Height Ratio (WHtR). The study aimed to determine the relationship between body anthropometric measurement and PTH. A cross-sectional study was performed on a healthy population of 75 healthy female volunteers with a BMI ≥ 23 kg/m2. Waist circumference, WHR, WHtR, and BMI measurements were carried out and followed by the PTH fragment 1-84 (PTH1-84) test. Data were analyzed using the Spearman test with a significance of p<005. There was no significant correlation between PTH and WHR (r=0.057; p=0.628). There was weak correlation between PTH and BMI (r=0.268; p=0.020), WC (r=0.287; p=0.012) and WHtR (r=0.238; p=0.04). Body mass index, WC, and WHtR can be used as anthropometric parameters to determine PTH disorders.

Keywords: Parathyroid hormone, body mass index, waist circumference, waist to hip ratio, waist to height ratio

INTRODUCTION

Currently, the distribution of fat tissue is often associated with an emerging risk of metabolic diseases. This is evidenced by the finding of a relationship between visceral obesity to the risk of metabolic syndrome and subcutaneous fat as adipokine protective factors.[1] Obesity can affect bone metabolism and increase with aging. Dysregulation of the common progenitor stem cell, inflammation in obesity can compromise bone health.[2]

Body Mass Index (BMI) has become the choice for measuring body size and composition, diagnosing underweight, normal weight and overweight but it cannot differentiate between visceral and Subcutaneous Adiposity Tissue (SAT). Waist Circumference (WC), Waist to Hip Ratio (WHR), and Waist to Height Ratio (WHtR) can describe fat mass distribution. Research from Tutunchi *et al*. showed that the measurement of WC and WHtR is a stronger indicator of obesity or overweight than WHR. Waist circumference and WHtR increase along with weight gain, whereas WHR has a large variation in weight gain and loss.[3]

Parathyroid Hormone (PTH) is a hormone produced by the parathyroid glands and acts as the regulator of calcium and bone homeostasis. The PTH also acts on several organs in the body, such as bones, kidneys, intestines and heart. Other minerals including phosphate, calcium, vitamin D also affecting vascular system.[4,5] There is study that suggest negative correlation between PTH and High-Density Lipoprotein (HDL).[6]

Parathyroid hormone in the circulation circulates as two types of fragments, such as 1-84 PTH and 7-84 PTH. Fragments 1-84 are active PTH fragments. Parathyroid hormone measurements have been developed from generation one to three. The third generation measures PTH fragments 1-84 (PTH1-84) as active fragments.[7,8] Hyperparathyroidism triggers multiple organ system disorder. Clinical manifestations of hyperparathyroidism include osteoporosis, hypercalciuria and nephrolithiasis.[9]

Obesity is a risk factor of hyperparathyroidism. Increasing PTH levels correlated with total and regional fat mass among subjects with vitamin D deficiency.[10] Receptor vitamin D expressed in adipose tissue. Individuals with hypovitaminosis D are at increased risk for metabolic disease because Vitamin D regulates adipogenesis, metabolism and endocrine function of adipose tissue.[11] DeLuccia *et al*. describes that an increased PTH can affect BMI, fat mass and insulin resistance. Insulin resistance occurs

because PTH interacts with pancreatic islet cells through PTH receptors, thereby affecting insulin synthesis and secretion.[4] Research by Ha *et al.* found that serum PTH has positive correlation with metabolic obesity among female subject.[12] It was in contrast to the research of Temizkan *et al.*, which found no correlation between serum PTH and obesity according to metabolic parameters.[13] Based on difference in studies results, the researcher aimed to conduct further research.

METHODS

This study was a cross-sectional study, which was conducted from July to September 2020 at hospital of National Diponegoro, Semarang. The research subjects consisted of 75 healthy female volunteers ranging from 25 to 45 years old with overweight and obesity based on WHO Asia-Pacific Regions criteria (BMI ≥ 23). Inclusion criteria were females who had not experienced menopause and body temperature within normal limits. Subjects with kidney disorder were excluded. Ethical clearance was obtained from Health Research Ethics Committee, Faculty of Medicine, Diponegoro University, Semarang with number of 32/EC/KEPK/FK-UNDIP/III/2020.

All subjects were asked to be fasting 8 hours prior to sampling in the morning. The sample used was whole blood stored in tubes without anticoagulant, then centrifuged at 1000xg speed for 15 minutes. The serum was taken for PTH1-84 measurements, using a third generation PTH test and the Enzyme Linked Fluorescent Immunoassay (ELFA) principle (VIDAS, Biomerieux SA, France). The normal value of PTH1-84 in healthy subjects was 9.2-44.6 pg/mL.

The measurement of WC was carried out by measuring the area between the ribs (costa) and above the iliac crest past the center (cm). Hip Circumference (HC) was measured at the superior border of the iliac crest and gluteal (cm). Body mass index was calculated by dividing body weight with height squared (kg/m^2). Waist to height ratio was obtained from the division of WC with the body height, while WHR was obtained from the division of WC and HC.

The results of the study showing normal data distribution were presented as mean±standard deviation followed by the Pearson correlation test. The distribution of abnormal data was presented as median and followed by the Spearman correlation test. The results of the study with $p < 0.05$ was stated significant.

RESULTS AND DISCUSSIONS

This study involved 75 subjects with age ranging from 25 to 45 years and BMI ≥ 23. Kolmogorov-Smirnov test was used to determine the normality of the data. Data with normal distribution in this study were age, body height, HC, and WHR. In contrast, data with abnormal distribution in this study were systole, diastole, body weight, BMI, WC, WHtR, and PTH. The results of the data characteristics of research subjects can be seen in the following Table 1.

The median of PTH in this study was 20.3 (6.7-48.3) pg/mL. Decreased PTH levels were found in 1.3% of respondents, increased PTH levels were found in 1.3% respondents, and normal PTH levels were found in 97.4% respondents. Correlation

Table 1. Characteristics of research subjects

Variable (n=75)	Mean±SD	Median (min–max)
Age (years)	34.59±6.04	34 (25-50)
Systole (mmHg)*	113,47±11.68	110 (90-150)
Diastole (mmHg)*	72.13±10.56	70 (60-110)
Body weight (Kg)*	75.44±11.79	72 (60-108)
Body height (cm)	154,43±4.99	154 (145-170)
BMI (Kg/m^2)*	31.61±4.38	30.5 (26-42.3)
Waist circumference (cm)*	92.68±9.76	90 (79-120)
Hip circumference (cm)	109,18±8.99	109 (90-129)
Waist to hip ratio	0.85±0.06	0.85 (0.70-1)
Waist to height ratio*	0.60±0.06	0.59 (0.51-0.76)
Parathyroid hormone (pg/mL)*	22.15±7.59	20.3 (6.7-48.3)

Note: SD (Standard Deviation); min (minimum); max (maximum), *Abnormal data distribution

Table 2. The correlation between body anthropometric measurement and parathyroid hormone levels

Parameter	Parathyroid Hormone	
	p	r
WC	0.012*	0.287
WHR	0.628	0.57
WHtR	0.04*	0.238
BMI	0.020*	0.268

Spearman's test *p < 0.05

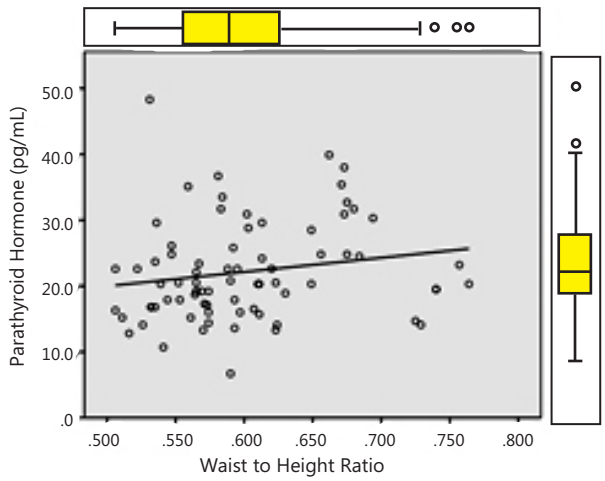

Figure 1. The correlation between the value of WHtR and PTH

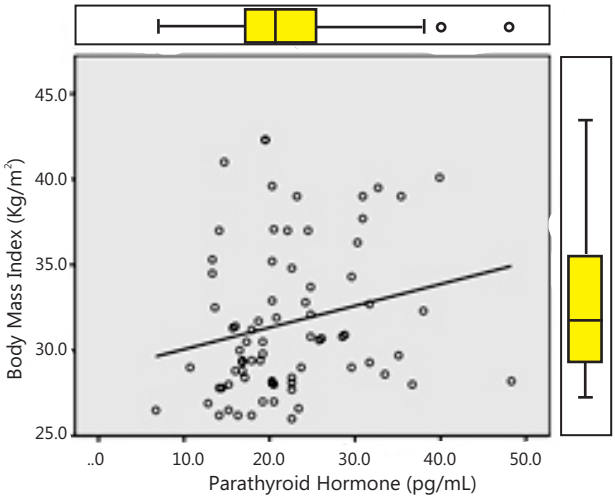

Figure 2. The correlation between the value of BMI and PTH

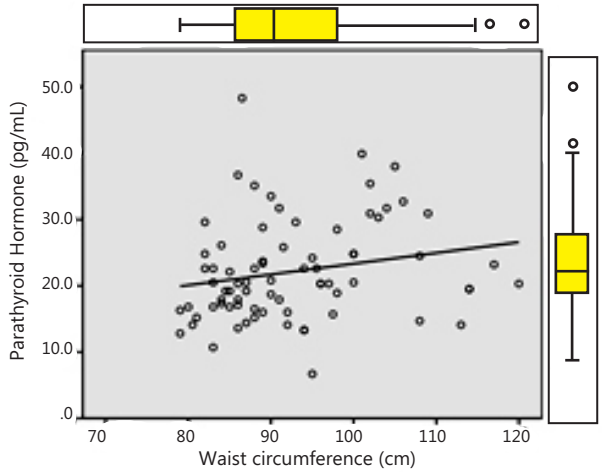

Figure 3. The correlation between the value of WC and PTH

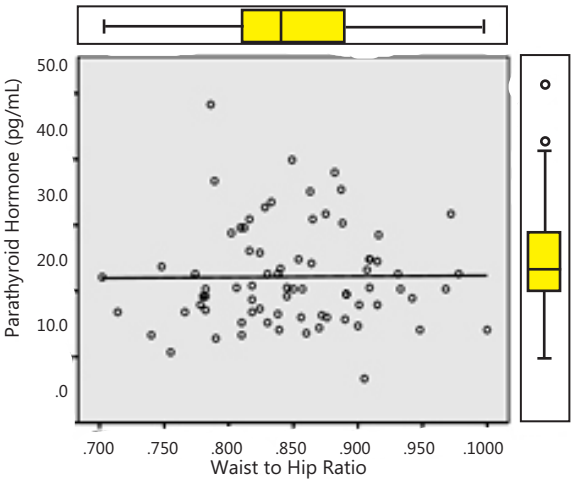

Figure 4. Correlation between the value of WHR and PTH

between body anthropometric measurement and PTH can be seen in Table 2.

This study showed weak correlation between PTH and BMI (r=0.268; p=0.020), WC (r=0.287; p=0.012) and WHtR (r=0.238; p=0.04). Scatter plot correlation between the value of PTH and BMI, WC, WHR, WHtR can be seen in Figure 1-4. The results of this study were in line with research from Vaidya *et al.*, which stated that body size was independent and modifiable risk factor for primary hyperparathyroidism in female. Greater body anthropometric correlated with higher serum PTH.[14]

The increasing leptin in obese individuals can stimulate PTH production, conversely PTH stimulate leptin production in adiposa tissue.[15] Parathyroid hormone through Protein Kinase A (PKA) mediated phosphorylation of Hormone Sensitive Lipase (HSL).[16] Parathyroid hormone can suppress lipoprotein lipase activity in adipocytes along with the increase of glucose phosphorylation transporter type 4 (GLUT 4), which results in the decrease of lipolysis and fat accumulation.[4]

Underlying mechanism of the relationship between obesity and hyperparathyroidism remains uncertain. Obesity is often associated with vitamin D deficiency and increasing PTH. Leko *et al*. stated that BMI, deficiency vitamin D and calcium showed association with PTH levels.[17] The research by Jumaahm *et al*. also found hypovitaminosis D in obesity subject that can cause increasing PTH level.[18] Adipose tissue stores vitamin D easily because vitamin D is fat-soluble and it can be sequestered in fat of obese individuals. Sequestration of 25-OHD in subcutaneous adipose tissue decreased bioavailability of vitamin D leading to the disruption of calcium absorption and compensatory increase in PTH.[18,19]

This study has limitation because it only involved overweight and obese females of the same ethnicity but did not consider the diet pattern of the respondents. The use of cross-sectional design in this study made it difficult to determine whether the exposure or outcome, which occurred first.

CONCLUSIONS AND SUGGESTIONS

There was a weak relationship between BMI, WC, and WHtR with PTH. It was suggested to perform further research on underweight, normal weight individuals, additional gender characteristics, and inflammatory markers.

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