ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (*IJMSIR*)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 6, Issue – 4, July – 2021 , Page No. : 01 - 08

Comparison between the impact of rate pressure product and insulin resistance in obese and non-obese

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Citation this Article: Rashmi Hada, Manila Jain, "Comparison between the impact of rate pressure product and insulin resistance in obese and non-obese", IJMSIR- July - 2021, Vol – 6, Issue - 4, P. No. 01 – 08.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Rate pressure product is a valuable marker of cardiac functioning. It is the product of heart rate and systolic blood pressure. Obesity plays a very important role in cardiac functioning. Also, Obesity is also, associated with insulin resistance.

Materials and method: 120 subjects of both sexes were taken and were categorized into obese and non-obese. BMI and other anthropometric indices were taken. Blood samples were taken for lipid profile and blood sugar assessment. Heart rate and blood pressure was taken.

Result: the findings of the study show obese individuals has increased insulin resistance than non-obese and RPP was increased in obese as compared to non-obese comparison of BMI, Homa IR, and waist circumference in obese and non- obese participants was done $p < 0.001$ was significant in obese as compared to non-obese.

Conclusion: The finding of the present study suggests that there is an impact of RPP and insulin resistance and obesity, and obesity is associated with hyperinsulinemia.

Keywords: RPP, NFHS-4, CVD, WHO.

Introduction

Globally, based on the world health organization (WHO), the incidence of obesity has tripled since 1975, as in 2016 only more than 1.9 billion adults of age 18 years and greater were overweight, of which 650 million were obese (1). Obesity plays a very dynamic role in the development of cardiovascular disease (CVD) (2, 3, 4). Quite a few simple anthropometric parameters have been greatly related with cardiovascular risk factors (5) and thus their relationship with hemodynamic parameters needs to be explored.

The prevalence of obesity in India is fluctuating from rural to urban and state-wise also which is due to various factors. The main factors for disparity in obesity are geographical condition, life style and dietary pattern. For example, population in high socioeconomic states (like Chandigarh and Goa) where the sedentary life style and high calories food intake are the main reason for higher frequency obesity (i.e., more than 30% in both the sexes) as related to lower socioeconomic states (like Jharkhand, Chhattisgarh, Madhya Pradesh and Bihar) (NFHS-4). In South India (i.e., Andhra Pradesh, Kerala and Pondicherry), populations were having higher occurrence (i.e., more than 25%) of obesity as associated to other states. Mishra et al. (6) in one of the recent studies reported high prevalence of obesity (i.e. 37.5%) due to urbanization of Bhil and their sedentary life style and dietary pattern as compared to rural Bhil population (i.e. 20.78%). Das & Bose (7) studied prevalence of obesity in Marwari population (i.e., high socioeconomic status) stated more than 40% in both the sexes. Sindhu & Kaur (8) reported high prevalence of obesity in urban population (i.e., 43.88%) as associated to rural (i.e., 22.26%). From 1998 to 2015, it was observed that the prevalence of obesity is threefold increases in Andhra Pradesh which is due to changes in dietary pattern and lifestyle variables ([9,10,11).

The double product corresponding to the product of heart rate and systolic blood pressure has a well-established correlation as a parameter expressing the load on the heart muscle. As an easily available parameter, it has been used in clinical trials for many years (12) and still proves its diagnostic (13) and prognostic (14,15) usefulness.

Heart rate (HR) has been projected as a simple global index of the autonomic nervous system influence on the heart. Elevated HR may reflect a shift in autonomic balance toward enhanced sympathetic and suppressed vagal tone (16).

This study aims to recommend a relationship between the degree of obesity and rate-pressure product, which can used as an indirect index of myocardial oxygen consumption and work of the heart.

Under resting conditions, the safer RPP varies between 70 and 90 in an apparently healthy adult. The value of RPP more than 100 is a clear indicator of cardiovascular risk. [17,18]..

Methodology

Study protocol was explained to the study subjects. Medical history and relevant clinical examination were done of those participants who are fulfilling the study inclusion criteria were included into the study. A total of 120 subjects of both genders were recruited in the present study. The subjects were matched for age and sex. The subjects were recruited based on their BMI levels using WHO Asia Pacific guidelines.BMI, formerly called the Quetelet index, is a degree for indicating nutritional status in adults. It is defined as a person's weight in kilograms divided by the square of the person's height in meters (kg/m2)

During screening, 25 subjects were excluded from the present study due to various reasons. The reasons for exclusion of 25 patients include: presence of either diabetic or due to hypertensive and other pathological complications. Study procedure was explained to the study subjects. Medical history and relevant clinical examination were done of those participants who are fulfilling the study. Inclusion criteria were included into the study. Anthropometry and blood pressure dimensions was done as per the standard procedure to derive anthropometric indices.

Anthropometry and blood pressure measurements were done as per the standard procedure to derive anthropometric indices of obesity. The subjects were matched for age and sex and was classified into underweight (BMI < 18.5), normal weight (BMI from 18.5 to 24.9), overweight (BMI from 25 to 29.9) and obese (BMI >30) groups using WHO Asia Pacific guidelines.

Anthropometric measurements

Assessment of Weight (kg) was done in light clothing without shoes using calibrated weighing machine to the nearest 0.5 kg. Wall mounted Stadiometer was used to measure Height to the nearest 01cm. Mid upper arm circumference (MUAC) and Waist circumference (WC) was measured by a non-elastic measurement tape to the nearest 01cm at midway between acromion process of scapula and olecranon process of ulna; the lowest rib and the iliac crest respectively. Hip circumference (HC) was measured transversely around the widest portion of the buttocks.

Calculation of Anthropometric indices of Obesity:

The following obesity indices were calculated using the following formula:

Body Mass Index (BMI) = Weight (kg) / Height (m^2)

Waist to Hip ratio (WHR)= WC (cm)/HC (cm).

Blood Pressure measurements

For determination of RPP blood pressure was recorded by standardized sphygmomanometer from 10:00 AM to the 12:00 PM from right arm in after giving adequate rest to the subject. All the measurements were done using standard protocol by the investigator of the project.Blood pressure (BP) was measured after 5 minutes of rest in a seated position using standardized and calibrated sphygmomanometer with appropriate size of cuff applied to the right upper arm. Korotkoff phase-I was recorded as SBP and Korotkoff phase-V as DBP. Two readings with an interval of one minute will be recorded. Mean of last two readings was used as final measurement.

Calculation of HR

It was recorded in supine position with continuous electrocardiographic (ECG) on Cardiomin machine using standard limb lead-II. The ECG record was analyzed for determining HR recorded. The R-R interval was measured on ECG with a ruler.

Calculation of Rate Pressure Product (RPP)

The following formula was used for its calculation:

RPP = HR × SBP × 10-2 mmHg

SBP: Systolic BP in mmHg

HR: Heart rate in beats per minutes

The value thus obtained was expressed as mmHg beats per min.

Cutoff limits of RPP: The values <Mean ±2SD was used as normal RPP where

Biochemical parameters

1. Blood glucose.
2. Lipid profile.
3. HOMO-IR
4. HbA1c

Inclusion and Exclusion criteria of participants:

a Inclusion Criteria

1. Age: 35-60yrs.
2. No other pathological conditions
3. Normal Sinus rhythm
4. non- diabetic
5. Non-hypertensive subjects

b Exclusion Criteria:

1. Hypertensive
2. History of medications and Systemic diseases
3. Evidence of cardiac disease or conditions responsible for hypertension,hypotension
4. Inability or Unwillingness to participate in the study

Results

Table 1: comparison of BMI, Homa IR, and waist circumference in obese and non- obese participants

Variables	Non obese (n = 42)	Obese (n = 43)	P
Age (years)	67.9 ± 9.2	65.8 ± 6.9	NS
Body mass index [kg/m²]	26.7 ± 2.0	33.8 ± 2.8	< 0.001
Waist circumference [cm]	98.3 ± 12.1	104.6 ± 16.3	< 0.02
Glucose level [mmol/L]	5.3 ± 0.5	7.5 ± 0.6	< 0.014
Insulin level [µU/mL]	7.3 ± 2.6	12.0 ± 7.3	< 0.01
HOMA-IR [µU/mL × mmol/L]	1.8 ± 0.7	3.0 ± 2.0	< 0.01
HOMA-IR > 2.7 [µU/mL × mmol/L, %]	9.1	31.3	< 0.02

HOMA-IR — Homeostasis model assessment of insulin resistance. There was a higher waist circumference in obese than in nonobese patients. The subgroups did not differ in fasting glucose levels, although insulin levels were significantly lower in the nonobese than the obese group. Insulin resistance defined by Lebovitz's classification was observed three times more often in the obese subgroup than the nonobese (Table 1). In the total group, there was a significant relationship between HOMA-IR and obese.

Table 2: Independent and interaction effects of risk factor variables on the double product by gender

Independent Variable	Regression Coefficient	
	Male	Female
Age	-108.20*	80.47
BMI	9.10	6.62
TG/HDL-C	-827.64	-3266.48
HOMA-IR	422.24*	741.80*
Age x BMI	1.70	0.47
Age x TG/HDL-C	28.32	114.20
Age x HOMA-IR	0.62	13.57

BMI, body mass index; HOMA-IR, homeostasis model assessment of insulin resistance; TG/HDL- triglycerides/high density lipoprotein cholesterol ratio.

Table 3: correlation between various ambulatory blood pressure cardiovascular risk markers

Ambulatory blood pressure and cardiovascular risk markers		
Variable	Obese	Non- Obese
Cholesterol (mmol l − 1)	4.45	5.40
Glucose (nmol l − 1)	5.17	5.68
SBP (mm Hg)	133	123
DBP (mm Hg)	82	76
Heart rate (b.p.m.)	79	74

Double product(mm Hg.b min-1)	10 267	8826
HbA1C (%)	5.7	5.40

Abbreviations: DBP, diastolic blood pressure, ; HbA1c, glycated hemoglobin, ; SBP, systolic blood pressure

Discussion

Anthropometric indices such as WHR, waist circumference (WC), and BMI were found to be significantly associated with RPP among health young adults (19, 20), and an important predictor of cardiovascular events (21). Obesity nowadays is considered as a major health threat worldwide. Overweight and obesity are associated with a number of diseases such as hypertension, cardiovascular diseases (CVDs), diabetes, elevated cholesterol level, arthritis, anesthesia risk, respiratory problem, breast cancer, menstrual aberrations, ovarian dysfunction, and many more (22) The prevalence of obesity is increasing in both developed and developing countries nowadays. (23)

Excessive fat concentration in the abdominal region is related to a higher incidence of metabolic alterations, particularly cardiovascular diseases (24), and anthropometric indicators of abdominal obesity can predict morbidity and mortality for these diseases (25). These high fat concentrates in the abdominal region have been linked to metabolic and cardiovascular alterations regardless of age. A new study by Adams and co-workers published in 2006 addresses the association between mortality and weight more conclusively than previous studies. These aspects are known to affect the relationship between mortality and weight and have been controlled for statistically in most previous studies. The results of this study specify positive association between, increase in mortality in both men and women who were overweight in midlife, and a 2- to 3-fold increased risk of mortality among obese individuals. These results provide strong support for the idea that even modest increases in weight may reduce lifespan in the latest of a series of studies of the relationship between fitness, obesity, and all-cause mortality, Blair and co-workers examined data from a prospective study of over 2600 adults 60 yr. of age or older followed for a mean of 12 yr. This analysis demonstrated that the increased risk of overall mortality seen in individuals with increased waist circumference.

The major findings of the study which was conducted by rpp1 et al suggested that obese subjects SBP, HR, and RPP were more increase than normal and overweight subjects. It was also noted that the subjects of WC >90 cm had higher SBP, HR, and RPP than the subjects of WC ≤90 cm. The subjects of WHR ≥0.90 had higher SBP, HR, and RPP than WHR < 0.05) and there was significant correlation between RPP and anthropometric indices, i.e., BMI, WC, and WHR.

Several studies have proposed, that both generalized and abdominal obesity are associated with increased risk of morbidity and mortality. The main cause of obesity-related deaths is CVD, for which abdominal obesity is a predisposing factor. The observation noted in my study shows positive association between increased cardiac parameters and increase in waist to hip ratio, and waist circumference.

The association found among the anthropometric indicators of central obesity (CI and WtHR) and serum lipids in the present study is justified by other studies, one of which evaluated 1,213 Brazilian adults the study assessed that dyslipidemias is associated to central obesity and correlated them to a significant increase in levels of triglycerides and/or a decrease in the levels of HDL-cholesterol38,.Precisely the result we found, in the present study indicates positive association with TG and inverse with HDL. Similarly, Hu et al, studying a sample of American Indians, found that the main lipid abnormalities related to obesity were HDL-cholesterol reduction and triglycerides increase, especially in men. These authors also observed that central adiposity was significantly associated to abnormal lipid profiles. TG and HDL association to abdominal adiposity was also similar to the results found by other researchers (26,27). The present study also supports the findings of the above-mentioned researchers. The present study noted that there was positive association between increased anthropometric measurement and increased in lipid profile in obese individuals as compared to non-obese.

Various studies have proposed that in overweight, obese as well as in subjects of abdominal obesity, hemodynamic variables such as SBP, HR, and RPP increased may be due to increased sympathetic activity. The findings of the present study show positive correlation between increase in blood pressure in obese as compared to non-obese. Furthermore, Obesity is also, associated with insulin resistance; hyperinsulinemia is associated with sympathetic overactivity which explains the increase in parameters of hemodynamic variables (28).

The gold standard of IR estimation is a hyperinsulinaemic-euglycaemic clamp: a procedure that is a intricate invasive procedure used almost exclusively in experimental circumstances. But there is a more common and simpler clinically useful method: homeostasis model assessment (HOMA-IR) is based on fasting plasma glucose and insulin levels (29).

Conclusion

The present study establishes the possible relation between obesity, IR and RPP and its impact on cardiac functions. But further study is required to find out relation between gender variations, obesity and RPP. In addition to this, various other methods should be used to further assess the relation between obesity and RPP.

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