

Comparison of Resting Rate Pressure Product in Obese and Non-Obese Women

Ruta A. Raut¹, Amita Mehta²

¹Cardiorespiratory Physiotherapist, Jaslok Hospital & Research Centre, 15 Dr. G. Deshmukh Marg, Mumbai-400026

²Prof. & Head, Physiotherapy, Physiotherapy school & centre, Seth G.S. Medical College, KEM Hospital, Parel, Mumbai-400012

Corresponding Author: Ruta A. Raut

ABSTRACT

Obesity has now become a global epidemic. It is one of the most significant contributors to a large number of health problems. A variety of adaptations/alterations in cardiac structure and function occur in the individual as adipose tissue accumulates in excessive amounts. Rate pressure product is a valuable marker of oxygen requirement of the heart. It is the product of heart rate and systolic blood pressure.

Aims: Our study aimed to compare the rate pressure product at rest between obese and non-obese women.

Settings and Design: It is a comparative, cross sectional type of study including 62 women (31 obese and 31 non-obese respectively) aged between 31 to 40 years.

Methods and Material: Participant after being classified as obese or non-obese based on the body mass index was assessed for rate pressure product at rest. They were allowed to rest for 10 minutes in seated position. Brachial blood pressure and Heart rate was recorded in this position.

Statistical analysis: The rate pressure product values were analysed between obese and non-obese women using Mann Whitney test.

Results and conclusion: We found that the resting rate pressure product in obese women was significantly higher than non-obese women indicating there is increased myocardial oxygen consumption suggesting larger hemodynamic stress on the heart.

Key-words: rate pressure product, body mass index, heart rate, systolic blood pressure, myocardial oxygen consumption, obesity.

INTRODUCTION

Obesity is a condition in which excess body fat accumulates to an extent that it may have a negative effect on health.

^[1] Obesity now has become a global epidemic. The prevalence of obesity worldwide has more than doubled since 1980. ^[2] It is now reaching epidemic proportions even in India and is of great concern because it is associated with increased risk of morbidity and mortality.

India has been ranked third in the world with about 30 million obese population. ^[3] Obesity rates are higher

among women (40.4 percent) as compared to men (35.0 percent). From 2005 to 2014, the obesity rate among women increased by 5.1 percent, while the rate among men only increased by 1.7 percent. Body Mass Index (BMI) is the most commonly used screening tool for obesity. Asian Indians are at risk of developing obesity related comorbidities at lower levels of body mass index when compared to international levels. ^[4] Hence, ethnicity specific body mass index guidelines suitable for Indian population have been used to classify BMI which categorizes normal BMI as 18.5 -22.9

kg/m², overweight as a BMI of 23.0 – 24.9 kg/m² and obese as a BMI \geq 25 kg/m².

A variety of adaptations in cardiac structure and function occur in obese individuals, even in the absence of comorbidities.^[5] Due to essentially aerobic metabolism of the heart, changes in myocardial oxygen consumption correlate highly with coronary circulation and myocardial oxygen demand. Rate pressure product (RPP), a product of heart rate and systolic blood pressure, is an accurate, non-invasive and an easily measurable index which correlates well with myocardial oxygen consumption and hence can be used to indirectly determine the workload on the heart.^[6] Thus the objective of this study was to compare the rate pressure product in obese women with non-obese women and to determine the hemodynamic stress on the heart. Heart rate (HR) and systolic blood pressure (SBP) are two main factors which determine the cardiac workload. Hence, one can consider that both heart rate and systolic blood pressure at rest are an expression of cardiac functionality reflecting cardiac adaptations in obese subjects.

MATERIALS AND METHODS

This comparative, cross sectional study was conducted in the physiotherapy department of a tertiary care hospital. Ethical approval was obtained from the institutional ethics committee.

As hemodynamic parameters are affected by age, women with normal menstrual cycle between age group of 31 to 40 years were included and then were divided in obese (BMI \geq 25 kg/m²) and non-obese (BMI between 18.5 to 22.9 kg/m²) groups. Exclusion criteria included participants with any cardiac, pulmonary or neuroendocrine disorders or other serious systemic diseases, sports person, yoga practitioners or trained athletes. Smokers, alcoholics or those taking medications interfering with vascular reactivity were also excluded.

Participants were informed about the nature of the study, the study protocol,

familiarized with the set up and informed written consent was obtained. Each subject was studied in the morning at room temperature. Subjects were refrained from caffeine or meal consumption or performance of a vigorous physical activity for at least 90 minutes before assessment.

Body weight was measured to the nearest 0.10 kg, with participants lightly dressed, without footwear using a portable digital beam scale.^[7] Body height was measured to the nearest millimetre in bare feet using a wall mounted measuring tape with the subjects back and heels touching the wall. BMI was calculated as body weight (in kg) divided by height (in mts) squared. Sixty two women who met the study criteria and agreed to participate in the study were included of which 31 were obese and 31 were non-obese. Participants were allowed to rest for 10 minutes in seated position with back supported, legs uncrossed and feet flat on the floor. Brachial blood pressure and Heart rate was recorded in this position with the arm supported at heart level as per the American Heart Association guidelines.^[8] For each of the participants, blood pressure and heart rate was recorded twice with an interval of 5 minutes between the two recordings using oscillometric method using automated OMRON blood pressure monitor.^[9] For each of the two parameters average of the 2 data was considered as the final recording and rate pressure product was calculated.

STATISTICAL ANALYSIS

Data was entered in Microsoft excel and was analyzed using GraphPad Prism version 7. Normality of the data was measured using Shapiro Wilk normality test and the data collected was found to be not normally distributed. The rate pressure product values were analysed between obese and non-obese women using non-parametric Mann Whitney test. The test was carried out at 5% significance. Confidence interval (CI) of 95% was chosen. P value $<$ 0.05 was considered to be statistically significant.

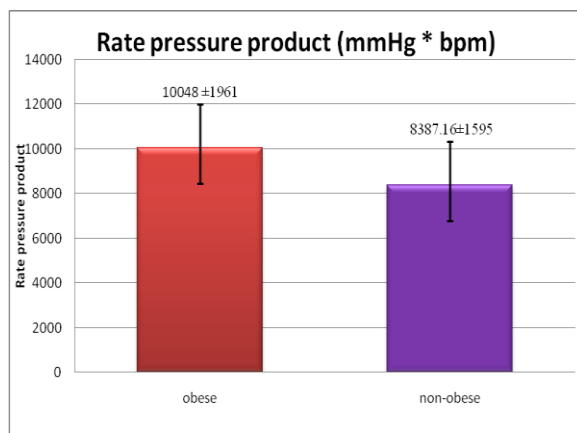
RESULTS

The mean and standard deviation of baseline data (age, height, weight and BMI) in obese and non-obese women is shown in table 1.

Table 1 Mean and standard deviation of baseline data in obese and non-obese women.

	Obese (Mean ± SD)	Non-obese (Mean± SD)
Age (years)	35.97 ± 3.03	35.13 ± 3.3
Weight (kg)	68.61 ± 8.44	50.77 ± 5.80
Height (cms)	154.4 ± 19.46	154.9 ± 5.71
BMI (kg/m ²)	30.41 ± 3.84	21.09 ± 1.38

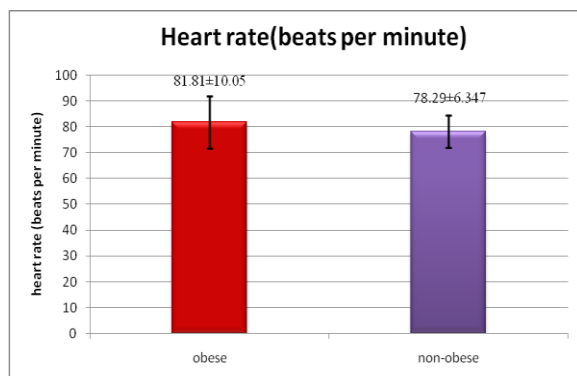
Each participant was assessed for heart rate and blood pressure under resting conditions and rate pressure product was calculated as the product of heart rate (Beats per minute) and systolic blood pressure (mmHg).



Graph1.Comparison of mean Rate Pressure Product in obese and non-obese women

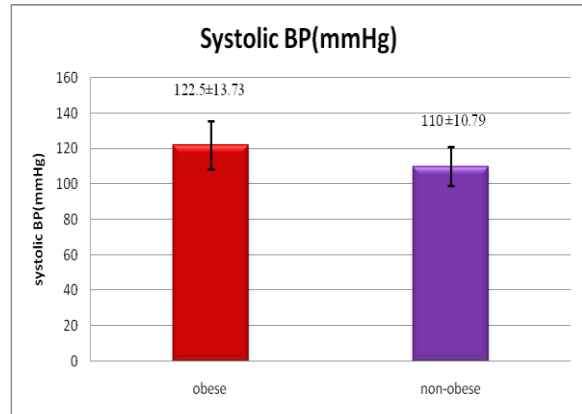
Statistically significant difference (with a p value of 0.0004) was found between the resting rate pressure product of the two groups (obese and non-obese).

Further analysis of heart rate and systolic blood pressure was done between each group.



Graph 2: Comparison of resting heart rate in obese and non-obese women

P value = 0.1306 i.e. > 0.05 (not significant)



Graph 3 Comparison of Systolic blood pressure at rest in obese and non-obese women

P value is 0.0004 i.e. < 0.05 (significant)

Obese women have higher rate pressure product at rest (P < 0.05) as compared to non-obese women. This is predominantly due to their higher systolic blood pressure rather than heart rate difference because heart rate elevation is little in obese group as compared to non-obese group.

DISCUSSION

Based on the results of our study we can say that, at rest, hearts of obese women consume more oxygen than that of non-obese women. This is in agreement with the study by Rajalaxmi et al and Parkhad et al. who also found that in young women, obesity is a significant predictor of increased myocardial oxygen consumption and decreased cardiac efficiency. [10, 11]

Obesity produces an increase in total blood volume and cardiac output that is caused by the increase in metabolic demand induced by excess body weight. Thus, at any given level of activity, the cardiac workload is greater for obese subjects. The increased cardiac output is attributable mostly to increased stroke volume which is reflected in the increase in systolic blood pressure of the obese subjects. [12]

On the other hand, obesity causes sympathovagal imbalance. The increase in sympathetic and decrease in parasympathetic tone on the heart is responsible for elevated resting heart rate and blood pressure. This results in higher rate pressure product in obese population

which in turn increases their myocardial oxygen consumption. [13]

Estrogen levels in women start rising during second decade of life and reach a plateau in third decade and start declining during the late fourth decade of life. Estrogen increases myocardial oxygen consumption by increased fatty acid oxidation. Increased fatty acid uptake and fatty acid oxidation by the heart increases myocardial oxygen uptake, because more oxygen is required to generate adenosine triphosphate (ATP) from fatty acid than by glucose metabolism. As fatty acid oxidation is less oxygen efficient than glucose oxidation there is an increased myocardial oxygen consumption in women. [14]

Fredrick Gobel in his study extends the evaluation of hemodynamic predictors of myocardial oxygen consumption, from normal subjects to patients with ischemic heart disease. The rate pressure product is known as a marker of myocardial oxygen requirement and elevation of the rate pressure product coexists with silent myocardial ischemia. Elevation of the rate pressure product at rest may reflect a consistent cardiac load which may inversely cause cardiac impairment. Determination of cardiac oxygen consumption becomes important also while monitoring the level of exercise performed while training an athlete or in monitoring the level of exercise to be done by various groups of persons like obese, cardiac patients and diabetic patients and also in normal persons who are health conscious. Whoever it may be, exercise should be done within limits otherwise it will lead to adverse effects on the body. In fact, if the cardiac muscle is over-worked beyond 'limit', it may lead to the development of angina. That 'limit' can be determined by calculating rate pressure product. [6] When the resting rate pressure product is itself elevated the window range available before this 'limit' rate pressure product is reached on exertion also reduces and angina threshold is reached faster. Thus assessment of rate pressure product in obese subjects helps us to understand the

cardiovascular risk in these subjects. This will better guide us in clinical decision making during our management by helping us in determining not only an appropriate but also a safe range of intensity of exercise during exercise prescription.

Studies on effect of aerobic exercise on cardiac functionality revealed that exercise training helps to reduce the resting heart rate and blood pressure. Regular exercise training increases parasympathetic tone which may contribute to the reduction in mortality associated with cardiovascular diseases. [15] It should be noted that even 2-mm Hg reduction in resting systolic blood pressure observed has been associated with reductions in mortality of 4% from coronary heart disease, 6% from stroke, and 3% from all causes. [16] Myocardial oxygen consumption and myocardial fatty acid utilization has been shown to decrease after weight loss in obese persons.

CONCLUSION

In conclusion the present study provides evidence that obesity in women is associated with elevated resting rate pressure product. This indicates that there is increased myocardial oxygen consumption suggesting larger hemodynamic stress to the heart.

Abbreviations

BMI- Body Mass Index
RPP- Rate Pressure Product
SBP- Systolic Blood Pressure
HR- Heart Rate

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