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RESEARCH ARTICLE

Correlation between body composition parameters and cardiac workload by rate pressure product among young, healthy medical students

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ABSTRACT

Background: Obesity has become a major global problem leading to diabetes, hypertension, and metabolic syndrome. **Aims and Objectives:** The aim of this study was to assess the association between body fat percentage (BF%) and cardiac workload by rate pressure product (RPP) in healthy young adults. **Materials and Methods:** A cross-sectional study was conducted among 200 young healthy medical students of the age group of aged between 17 and 22 years in a medical college. BF% along with body water, bone mass, body mass index (BMI), visceral fat, basal metabolic rate (BMR), and muscle mass was measured using a commercially available digital weight scale incorporating a bioelectric impedance analysis new double electrode technology. RPP was assessed by systolic blood pressure (SBP) and heart rate (HR). Statistical analysis was done using unpaired *t*-test for comparison of variables such as body water, bone mass, BMI, visceral fat, BMR, muscle mass, SBP, diastolic blood pressure, HR, and RPP. Correlation between RPP and BF% was done by Karl Pearson's correlation. $P = 0.05$ or less was considered as statistically significant. **Results:** There was positive statistically significant relationship between BF% and RPP. There was increase in BF, visceral fat, and RPP in males when compared to females. **Conclusion:** There exists a positive association between BF% and RPP. RPP acts as early predictor of cardiovascular disease risk. Hence, early prevention can be undertaken to prevent the disease burden at young age.

KEY WORDS: Body Fat Percentage; Rate Pressure Product; Obesity; Basal Metabolic Rate

INTRODUCTION

Cardiovascular disease (CVD) is the leading global cause of death, accounting for more than 17.3 million deaths per year.[1] Obesity is considered to be a major cardiovascular risk factor accounting for raised blood pressure, glucose intolerance, Type II diabetes, and dyslipidemia. Stress, sedentary lifestyle, intake of junk food, and genetic predisposition are the predisposing factors of obesity.[2] Worldwide, it is found that 2.8 million people die each year for being overweight or obese and an estimated 35.8 million of global disability-adjusted life years are caused by overweight or obesity.[3]

Adipocytes have an important role in pathogenesis and complications of obesity.[4,5] Excessive adiposity has been strongly associated with first non-ST segment myocardial infarction at a very young age.[6] It is known that physiological, anthropometric, and body composition parameter predict the mortality in patients with CVD.[7-9]

It is observed that students, especially studying medicine, have a lot of time pressures, wherein they are spending a lot of their daily time attending hospital postings, practicals, and theory classes; therefore, they are getting very less time for

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doing exercises. Furthermore, they indulge up eating a lot of junk food due to time constraints. Junk food is a term used for food containing large amount of calories from fat and sugar with least from protein, fiber, and vitamins.[10] All these reasons make them vulnerable for obesity.

The rate pressure product (RPP) is an increasingly used surrogate measure of myocardial oxygen demand and cardiac workload. It is systolic blood pressure (SBP) multiplied by heart rate (HR).[11] It was found that SBP and HR are the two factors whose early changes can be noticed and controlled.[12] Hence, the present study was undertaken to evaluate the role of physiological and body composition parameters in cardiovascular risk assessment by RPP.

Several studies have shown a strong correlation between anthropometric indices and RPP.[13,14] However, to the best of our knowledge, no studies have addressed the association of physiological and body composition parameters with RPP in the healthy young medical students. Hence, the present study intended to find the correlation of physiological, body composition parameters with RPP as predictor of CVD risk in healthy young medical students. Moreover, the study also intended to compare the influence of these parameters on RPP between males and females.

MATERIALS AND METHODS

Study Design and Setting

The present 6 months cross-sectional study (March 2017–September 2017) was conducted at the department of physiology among the 1st year medical students. A total of 200 students aged between 17 and 22 years who volunteered for the study were included using the universal sampling method. The nature and purpose of the study was briefed to each participant and a written informed consent was obtained. Subjects with a history of any cardiac diseases, Type I diabetes, smoking, tobacco chewing or any substance abuse, on any medication causing obesity, and subjects with any endocrinal diseases were excluded from the study. The study was initiated after obtaining the approval from the institutional ethics committee for human subjects research. Demographic data and relevant medical history of all the subjects were recorded. A predesigned proforma was used to record the relevant information from the subjects.

Measurements

Physiological parameters

Body weight was measured to the nearest 0.10 kg, with participants lightly dressed using a portable digital weighing scale. Body height was measured to the nearest millimeter in bare or stocking feet with subjects standing upright against a stadiometer.

Body fat percentage (BF%) measurement

BF% was measured using a commercially available digital weight scale incorporating a bioelectric impedance analysis (BIA) new double electrode technology (BLUEWEIGH smart body composition analyzer).[15,16] The device measures human body bioelectrical impedance to calculate the composition based on physiological electroconduction. BIA is considered one of the most reliable and accessible methods of screening BF. It works using a small electric signal that is circulated through the body and measures the impedance or resistance to the signal as it travels through the water that is found in muscle and fat. Once the data are combined with age, height, and a few other details, the BF% can be calculated. BF% will be measured to the nearest 0.1%. The reproducibility of the BF measurement will be assessed by repeating the measurements twice on subjects on the same day. BF% normal ranges are taken from earlier report.[17] Body weight, BF content, body muscle weight, body water content, body bone mass, visceral fat, basal metabolic rate (BMR), and body mass index (BMI) parameters were measured. Subjects will be refrained from food and drink for at least 6 h and voided urine before the measurement session.[18]

Recording of RPP

The blood pressure (systolic blood pressure [SBP] and diastolic blood pressure [DBP] in mmHg) and electrocardiogram were recorded in the supine position after giving rest for 5 min. Three readings were taken with 1 min of interval between each measurement and best of three was considered for blood pressure. HR was calculated by 1500/R-R interval. The RPP was calculated by multiplying SBP by HR (mmHg/min)[12] or by formula SBP × HR/1000.[2]

Statistical Analysis

SPSS software was used to analyze the data. The results were expressed as mean ± standard deviation (SD). Comparison of physiological and body composition parameters between males and females was done using an unpaired *t*-test. Correlation of RPP with physiological and body composition parameters was determined using Karl Pearson's correlation. $P \leq 0.05$ is considered as statistically significant.

RESULTS

In this cross-sectional study, 200 young 1st year medical students were studied 100 each male and female. The results were expressed as mean ± SD. Body water, bone mass, visceral fat, BMR, muscle mass, SBP, DBP, and RPP were high in males as compared to females. However, body water, BF, bone mass, BMR, muscle mass, SBP, DBP, and RPP were significantly different between males and females [Table 1].

Physiological parameters and body composition parameters including BMI, visceral fat, muscle mass, BF, and bone mass were correlated significantly with RPP [Table 2].

Physiological parameters were significantly correlated with RPP in both the genders. Body composition parameters such as BF%, body water, visceral fat, SBP, DBP, and HR were significantly correlated with RPP among males, whereas BF%, body water, BMI, visceral fat, and BMR in females [Table 3].

DISCUSSION

Although studies found the importance of RPP in assessing cardiovascular risk, still few cross-sectional studies in Indian context might be helpful to describe the risk factor profile in a population, providing information of the relationship between different variables. Hence, the present cross-sectional study intended to find the correlation of physiological and body composition parameters with RPP as predictor of CVD risk in healthy young medical students aged 17–22 years.

The study found that BF%, bone mass, BMI, visceral fat, muscle mass, blood pressure (SBP and DBP), and HR were significantly correlated with RPP in either gender. A similar study conducted by Jena *et al.*[9] reported that BMI ($r = 0.540$; $P = 0.00$), waist–hip ratio ($r = 0.599$; $P = 0.00$), and waist-hip circumference ($r = 0.339$; $P = 0.00$), were significantly correlated with RPP. The study indicates that increase in RPP can be considered as an early predictor cardiovascular and metabolic disease risk. This also indicates that subjects who increase in the physiological and body composition parameters above normal limits may develop adverse cardiac effects and increase the risk of CVD. Hence, attention needs to be taken toward the health and early measures for prevention of cardiac complications.

In our study, significant gender differences were found in physiological parameters and body composition parameters (body water, fat, muscle mass, BMR, and body mass). While a study conducted by Al Dokhi and Habib[15] reported significant difference of muscle mass, BF mass, and BF between either genders. Our study also found that BF, bone mass, BMI, visceral fat, muscle mass, blood pressure (SBP and DBP), and HR were significantly correlated with RPP in either gender individually. This indicates that men and women have equal chances of attaining obesity and cardiac risk. Our findings are consistent with other studies.[15]

Although there are various accurate and reliable techniques available for the evaluation of body composition in clinical and

Table 1: Comparison of physiological and body composition parameters in both the genders

Variables	Male	Female	*P*-value
	Mean±SD	Mean±SD	
Body water (%)	56.83±4.79	51.00±4.66	0.0001*
BF (%)	14.89±7.44	27.11±9.65	0.0001*
Bone mass (Kg)	2.63±0.53	2.16±0.39	0.0001*
BMI	22.79±4.64	22.98±4.46	0.7714
Visceral fat	4.74±3.72	4.19±2.56	0.2247
BMR (Kcal)	1640.63±276.21	1548.84±173.48	0.0054*
Muscle mass (Kg)	51.54±6.23	38.03±4.26	0.0001*
SBP (mmHg)	119.76±7.46	113.44±10.62	0.0001*
DBP (mmHg)	81.79±6.31	78.32±7.41	0.0005*
HR (BPM)	79.99±11.03	79.67±8.82	0.8210
RPP	9.67±1.31	9.13±1.37	0.0047*

*$P<0.05$, BMI: Body mass index, BMR: Basal metabolic rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HR: Heart rate, RPP: Rate pressure product, BF: Body fat, SD: Standard deviation, BPM: Beats per minute

Table 2: Correlation of physiological and body composition parameters with RPP

Variables	RPP	
	r-value	*P*-value
Body water (%)	−0.1352	0.0564
BF (%)	0.1384	0.0500*
Bone mass (Kg)	0.1472	0.0375*
BMI	0.2397	0.0006*
Visceral fat	0.2667	0.0001*
BMR (Kcal)	0.0238	0.73
Muscle mass (Kg)	0.2327	0.0009*
SBP (mmHg)	0.5437	0.0001*
DBP (mmHg)	0.5950	0.0001*
HR (BPM)	0.8099	0.0001*

*$P<0.05$, BMI: Body mass index, BMR: Basal metabolic rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HR: Heart rate, RPP: Rate pressure product, BF: Body fat, BPM: Beats per minute

Table 3: Correlation of physiological and body composition parameters with RPP in both the genders

Variables	Male		Female	
	r-value	*P*-value	*r*-value	*P*-value
Body water (%)	−0.2540	0.0108*	−0.3232	0.0010*
BF (%)	0.2991	0.0025*	0.3358	0.0006*
Bone mass (Kg)	0.0491	0.6275	0.0908	0.3692
BMI	0.1412	0.1611	0.3569	0.0003*
Visceral fat	0.2150	0.0317*	0.3250	0.0010*
BMR (Kcal)	−0.1603	0.1111	0.2036	0.0421*
Muscle mass (Kg)	0.1102	0.2750	0.1534	0.1275
SBP (mmHg)	0.4852	0.0001*	0.5483	0.0001*
DBP (mmHg)	0.4701	0.0001*	0.6624	0.0001*
HR (BPM)	0.7841	0.0001*	0.8862	0.0001*

*$P<0.05$, BMI: Body mass index, BMR: Basal metabolic rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HR: Heart rate, RPP: Rate pressure product, BF: Body fat, BPM: Beats per minute

research level, those are costly, remote to the general public, and not practicable to use among large sample size.[15,19] However, BIA has attained wide acceptance because it is portable, easy to perform, inexpensive, safe, and observer independent.[20]

RPP is not only serves as a major determinant of myocardial oxygen consumption but also an important indicator of ventricular function.[21] RPP range between 7.00 and 9.00 has been considered as under resting condition and any value >10 clearly specify the risk of cardiovascular risk.[21] Fortunately, in our study, all the medical subjects had normal RPP values, indicating good ventricular function and their care toward the health.

The study has few limitations that need to be acknowledged. First, the sample size was small; hence, studies on a large sample size are required to validate our findings. Second, the study was a single-center study; therefore, the results cannot be generalized. Finally, cross-sectional study design may not possibly infer a causal relationship.

CONCLUSION

Overall, RPP acts as early predictor of CVD risk. Hence, early prevention can be undertaken to prevent the disease burden at young age. Moreover, this study adds to the existing literature of cardiovascular risk in young, healthy adults and also creates awareness of health issues associated with obesity. Early diagnosis and, hence, prevention of risk factors can be done by proper measures as nutrition, exercise, and stress relief techniques. This study may emphasize on the obligation to develop deliberate actions against the obesity rising prevalence even at such young ages.

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