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Research Article

CORRELATION OF BLOOD PRESSURE CHANGES IN RESPONSE TO SUSTAINED ISOMETRIC EXERCISE WITH RESPECT TO BODY MASS INDEX IN ADULTS OF HASSAN, KARNATAKA

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ABSTRACT

Objectives: The prevalence of obesity is increasing among Indians. Body mass index (BMI) marker of obesity might affect the pressure response to exercise. The present study was undertaken to correlate the blood pressure response to isometric exercise with BMI among males and females.

Method: This cross-sectional study comprised 100 male and 100 female subjects 20–40 years old depending on the set inclusion and exclusion criteria. Anthropometric parameters weight, height measured, and blood pressure recorded before exercise. Then subjects were asked to execute isometric hand grip strength at 30% of their maximum voluntary contraction and blood pressure was recorded before the release hand grip. Data were analyzed by the mean and standard deviation of systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP). An unpaired t-test was to compare blood pressure parameter changes in isometric exercise between males and females. Pearson's coefficient of correlation test was used to correlate blood pressure response with BMI in males and females. Statistical significance was fixed at a $p<0.05$.

Result: In both males and females, SBP, DBP, and MAP were increased after exercise. There is a significant positive correlation between DBP response to isometric exercise with BMI among males and females.

Conclusion: This knowledge about the variation of blood pressure response to isometric exercise with BMI is essential for the physicians to educate overweight and obese individuals to adopt a healthy lifestyle to prevent future cardiovascular morbidity.

Keywords: Systolic blood pressure, Diastolic blood pressure, Isometric exercise, Gender, Body mass index.

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INTRODUCTION

In Indians, the overweight and obesity prevalence has been increasing faster compared to the world average. Obesity is a very common preventable risk factor for non-communicable diseases such as diabetes, hypertension, and cardiovascular diseases [1].

A piece of adequate knowledge of the advantages of exercising frequently can motivate individuals to exercise regularly [2]. Physical inactivity and sedentary lifestyles are becoming more common in both developed and developing countries. It is a globally known fact that being less physically fit increases obesity, and as a result, the risk of cardiovascular disease morbidity and death is high. Regular exercise and physical activity not only lower the risk of hypertension but also decrease the occurrence of cardiac events [3]. Isometric exercise, also called static exercise, involves contracting the skeletal muscles without changing the length of the muscle. The cardiovascular responses produced by static exercise are significantly different than those of dynamic exercise. Blood pressure and HR increase after isometric exercise. The augmented BP and HR during isometric exercises are because of augmented peripheral resistance and augmented muscle sympathetic nerve activity (MSNA). These changes meet the additional demand by amplifying blood flow to muscle [3,4]. Body mass index (BMI) is one of many characteristics such as age, gender, activity type, and training that can influence the sympathetic and pressure response to physical exercise and it should have a high impact on cardiovascular health as obesity is the most common risk factor [3,4].

It has been shown in a few studies that training with isometric handgrip exercise for a few weeks has shown a reduction in both systolic and diastolic blood pressure (DBP) in healthy adults, pre-hypertensives, and hypertensives. Hence, isometric hand grip (IHG) strength can be prescribed for the management of hypertension in addition to pharmacotherapy. IHG may be a very simple variety of exercise that requires less adjustment in routine and time of the day. This could facilitate easing a number of barriers to exercise and increase patient adherence [3-6].

In the literature search, numerous studies have been conducted on cardiovascular response to isometric handgrip test, but the studies on the correlation of blood pressure changes in response to isometric exercise with BMI were very few in India. Because of conflicting results in previous studies, this study was taken up with the objective of correlation of blood pressure changes in response to isometric exercise with BMI in males and females, which helps to identify if there is any sympathetic dysfunction in overweight and obese individuals who will be likely to develop hypertension and cardiovascular diseases.

METHODS

This cross-sectional observational study was carried out in the Department of Physiology, Hassan Institute of Medical Sciences for 3 months. Approval from the institutional ethics committee (IEC No. 31, Dated June 8 2015) was taken. A total of 200 untrained normotensive subjects, 100 male and 100 female subjects aged 20–40 years, in and around Hassan District, Karnataka, were included in the study by simple random sampling method. Those with a history of hypertension, cardiovascular disease, or neuromuscular disorder, and those who were on medications that are likely to affect blood pressure were excluded from the study. Then, the objectives and protocol of the study were explained to all the subjects.

Body height was recorded by asking the subject to stand against a wall without footwear, using a measuring tape in centimeters. Body weight was measured using a weighing machine with light indoor clothing. BMI was calculated based on the Quetelet index, BMI=Weight (in kgs)/ Height^2 (in m). The baseline blood pressure (systolic blood pressure [SBP] and DBP) was recorded using a stethoscope and mercury sphygmomanometer in both groups. Mean arterial pressure (MAP) was calculated using the formula MAP=DBP+1/3 of pulse pressure. Hand grip strength is measured using a handgrip dynamometer (made by Jagson India). Handgrip strength was assessed in subjects sat in seated position test with the elbow by their side with right angles flexion, and a wrist to a neutral position with support beneath the dynamometer was provided. After practicing in this position, the subjects were requested to compress or squeeze the handgrip strength dynamometer with their full strength. The total static force, the dominant hand can exert around a dynamometer can be noted to measure hand grip strength. The average across three trials of grip strength was taken. After resting for 5 min, the subjects were instructed to do an isometric handgrip exercise with their dominant hand at 30% of their maximal voluntary contraction (MVC) for around 5 min or until exhaustion [7-10]. During the test, subjects were asked to breathe normally. The non-dominant arm's blood pressure was measured before the grip was released.

Statistical analysis

Data were entered in a Microsoft Excel spreadsheet, and statistical analysis was done using SPSS. Descriptive statistics such as mean and standard deviation (mean±SD) of all the blood pressure parameters (SBP, DBP, and MAP) were worked out, that is resting value and before the release of hand grip pressure, for both male and female groups. Then, the difference in the blood pressure before the release of grip strength release and mean resting value was calculated (blood pressure response to IHG). An unpaired t-test was applied to compare blood pressure changes between males and females. Pearson's correlation test was applied to correlate between BMI and blood pressure response to hand grip strength. $p<0.05$ was taken as statistically significant.

Table 1: Anthropometric parameters of the subjects

Parameter	Male	Female	p-value
Age	31.71±6.08	31.69±6.06	0.9814 NS
Height	159.17±4.54	157±5.91	0.0582 NS
Weight	69.65±7.91	56.52±6.98	0.0001*
BMI	24.657±2.74	22.985±2.45	0.0001*

BMI: Body mass index. Data presented in mean±standard deviation, *p≤0.05 considered significant

RESULTS

The present study was conducted on 100 male and 100 female subjects with a mean age of 31.71±6.08 years in males and 31.69±6.06 years in females (Table 1). Hand grip strength and endurance time are significantly higher in males when compared to females. A significant increase in basal and changes with the IHG test in SBP, DBP, and MAP was observed in males compared to females. Later on, correlating BMI in both males and females with blood pressure response showed significant positive correlation between BMI and difference in DBP in the IHG test both in males and females (Table 2).

DISCUSSION

This study showed hand grip strength in males is more and highly significant when compared to the females. Similar findings were observed by Das and Dutt [11] and Manjuanth *et al.* [12] Possible reasons explained by these studies are males have high bone mineral density and more muscle mass and also the effect of testosterone hormone on the muscle. Endurance time is more in males than females at 30% of MVC (Table 3). With respect to endurance time Manjuanth [12], Das and Dutt [11] observed contradictory findings of significantly longer endurance time in females compared to males.

This study showed an increase in SBP, DBP, and MAP after exercise in males which is significant compared to females. Similar findings were observed in a few studies [13-16]. Jones *et al*. conducted a study on 37 healthy adults in that before and during IHG, cold pressor, and mental arithmetic laboratory stressor tests; they recorded skeletal MSNA directly and took measurements of plasma catecholamines, heart rate, blood pressure, perceived stress were measured. They ascertained catecholamine, MSNA, and cardiovascular parameters were not consistently different between genders. Larger MSNA responses were observed in males for the IHG expressed as absolute unit changes; this response was partially explained by greater contraction force [17].

Ettinger *et al*. in their study on the influence of gender on sympathetic response to static exercise found that, an attenuated increase in blood pressure and muscle sympathetic activity determined by microneurography in women compared to men. They concluded less sympathetic outflow in women compared to men during non-ischemic static exercise [18].

Immediately after the beginning of isometric exercise, the mechanoreceptors activated due to increased muscle tension and to maintain muscle tension recruitment of new motor units occurs. This

Table 2: Correlation between BMI and blood pressure changes in response to isometric exercise

Anthropometric indices	Basal SBP r (p-value)	SBP response to IHG test r (p-value)	Basal DBP r (p-value)	DBP response to the IHG test r (p-value)
BMI in males	0.184	0.113	0.0988	0.213
	0.0668	0.263	0.328	0.033*
BMI in females	0.108	0.16	0.1045	0.197
	0.284	0.111	0.301	0.049*

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BMI: Body mass index, IHG: Isometric hand grip. P≤0.05 considered significant

Table 3: Comparison of SBP response, and DBP response between males and females

Parameter	Male	Female	p-value
Basal SBP	123.28±6.22	116.92±9.05	0.0001*
SBP response to IHG test	16.32±4.60	14.92±4.11	0.0243*
Basal DBP	80.56±5.19	76.83±6.25	0.0001*
DBP response to the IHG test	15.72±3.8	14.18±3.27	0.002*
Basal MAP	94.8±4.6	90.21±6.53	0.0001*
Difference in MAP in the IHG test	16.12±4.18	14.38±6.12	0.019*

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, IHG: Isometric hand grip. Data presented in mean±standard deviation, *p≤0.05 considered significant

leads to an increase in the central nervous system's excitatory state and results in a possible sympathetic outflow increase and a possible parasympathetic outflow decrease, which explains the mechanism of heart rate and blood pressure responses [19].

In this present study, a significant positive correlation was observed between DBP response to isometric exercise and BMI in both males and females. There is a non-significant positive correlation between SBP response and BMI.

In one study, researchers observed a significant positive correlation between DBP, MAP with BMI [20], which is similar to the present study. Aparna *et al*. observed that DBP is negatively correlated with BMI ≥25 kg/m^2 which contradicts our results [21].

CONCLUSION

This study shows that blood pressure response to isometric exercise is significantly higher in males as compared to females. Non-significant positive correlation between blood pressure parameters response and BMI was observed. An increase in BMI may be associated with a significant increase in the DBP response and a non-significant increase in SBP to isometric exercise; hence, this knowledge is essential for physicians to educate overweight and obese individuals to adopt healthy lifestyles to maintain normal BMI and to prevent future cardiovascular morbidity.

The large sample size and quantifying the change in blood pressure parameters with 1 kg/m^2 increase in BMI which will provide better knowledge variation of blood pressure with BMI are the limitations of this study.

AUTHORS CONTRIBUTION

All the authors have contributed to the preparation of the final manuscript.

CONFLICTS OF INTERESTS

No conflict of interest.

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None.

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