

Original Research Article

Does gender affect the response of blood pressure to isotonic hand grip exercise in prehypertensives?

Saravanan Murugan¹, Sushil Kumar Singh², Wasim Sheikh³

¹Associate Professor & Principal In-charge, The Sarvajanic College of Physiotherapy, Badatwadi, Chhada-Ole, Rampura, Surat – 395003, Gujarat, India

²Head of Department, Department of Physiology, Pramukhswami Medical College, Anand Sojitra Road, Karamsad – 388325, Gujarat, India

³Associate Professor, Department of Physiology, Pramukhswami Medical College, Anand Sojitra Road, Karamsad – 388325, Gujarat, India

***Corresponding author**

Saravanan M

Email: saravananmurugan77@gmail.com

Abstract: This study aims to determine gender differences in response of blood pressure (BP) to isotonic handgrip exercise (IHG) in prehypertensive adolescents. In addition, it also aims to determine differences in recovery patterns of BP and pulse rate (PR) between genders. 60 volunteers with prehypertension (male–30; female–30) participated in this study. Resting systolic (SBP) and diastolic blood pressure (DBP) and PR of participants were recorded on arrival after 5 minutes of rest. This was followed by IHG for 20 minutes and BP, PR variables were recorded. Measurements were again recorded into the follow up period after 60 minutes. Independent t-test ($p < 0.05$) was used to compare means of SBP, DBP, PR, mean arterial pressure (MAP) and Pulse pressure (PP) between male and female participants at rest, after 20 minutes of IHG exercise and 60 minutes post exercise. Male participants had higher resting SBP and PP as compared to their female counterparts, whereas resting values of DBP, PR and MAP were higher in females. Significant differences were observed between genders in DBP ($p=0.012$), PR ($p=0.024$), MAP ($p=0.033$) and PP ($p=0.022$) 20 minutes after IHG exercise except SBP ($p=0.723$). Similarly 60 minutes post exercise, male and female participants showed significant differences in DBP ($p=0.009$), PR ($p=0.002$), MAP ($p=0.011$) and PP ($p=0.028$) except SBP ($p=0.507$). Decline of SBP, DBP, MAP and PP were higher in males whereas decline in PR was high in females. These results suggest existence of gender differences in BP response to isotonic hand grip exercise in prehypertensives.

Keywords: Prehypertensives, Isotonic handgrip exercise, Blood pressure, Pulse rate, Recovery pattern, Gender differences.

INTRODUCTION

Longitudinal data obtained from the Framingham study has indicated that Systolic Blood Pressure (SBP) values between 120-139 mm Hg or Diastolic Blood Pressure (DBP) values between 80-89 mm Hg or both, are associated with a more than two fold increase in relative risk of cardiovascular disease as compared with those with normal SBP levels below 120 mm Hg [1]. The Seventh Report of the Joint National Committee (JNC-7) introduced a new term “prehypertension” and it broadened the range of prehypertension to 120-139/80-89 mmHg [2].

Since pre hypertensives are not candidates for drug therapy owing to their BP levels [3], they should be firmly and unambiguously advised to adopt healthy

lifestyles [4-6]. This could reduce their BP, decrease the rate of progression of BP to hypertensive levels with age, or prevent HT entirely.

Physical exercise is one of the essential elements for controlling blood pressure. Recent evidence suggest that acute dynamic exercise result in transient changes in physiological variables that lead to reduction in blood pressure for 12 to 16 hours following the exercise act [7-9]. Isotonic handgrip (IHG) exercise is a simple, cheap and feasible form of physical exercise which can be performed at the person’s convenience at any time or place using simple equipment like handgrip dynamometer. Very few studies are available, focusing on the effects of IHG exercise on BP in Prehypertensives or hypertensives [10].

Despite the pattern of cardiovascular response to most forms of exercise remaining similar in both genders, the magnitude of response need not be same in some variables. Various studies in the past have focused on observing the differences in these responses between genders in normal healthy individuals [11-13]. A thorough literature review showed lack of scientific data of the BP responses to IHG exercise in Prehypertensives.

The purpose of this study therefore, is to determine gender differences in SBP, DBP, Pulse rate (PR), Mean Arterial Pressure (MAP) and Pulse Pressure (PP) during rest, after 20 minutes of IHG exercise and 60 minutes post exercise in prehypertensive adolescents.

MATERIALS AND METHODS

This study included random selection of 60 college students (30 males and 30 females) diagnosed with prehypertension (BP range 120–139/80–89 mmHg) [14]. Untrained participants of all socio economic class and falling under the normal Body Mass Index (BMI) range were included. Participants were excluded if they were smokers or present with any chronic illness or chronic usage of medical drugs. Pregnant females were also excluded. A written informed consent was obtained from all participants prior to their participation in the study. Prior approval was obtained from the Human Research Ethics Committee (HREC) of Pramukh Swami Medical College, Karamsad.

Maximal voluntary contraction (MVC) of hand grip strength of the participants was measured prior to the experimental session. 30% MVC was set and used as an appropriate magnitude of contraction during experiment [15]. The participants were refrained from the intake of any stimulant (drugs, coffee) for a period of at least 30 minutes before the measurement. The participants were also asked to empty the bladder before the measurement and relax quietly in sitting position for a period of at least 5 minutes prior to measurement of BP.

SBP, DBP and PR were measured in the left arm in sitting position with arm and back support, uncrossed legs and feet on the floor using the Omron HEM711 DLX Automatic BP instrument (Accuracy, BP: ± 4 mm Hg, Pulse: ± 5 , validated by Association for the Advancement of Medical Instrumentation, AAMI and European Society of Hypertension) [16]. The average of the three consecutive readings was used for statistical analysis. PP was calculated as SBP – DBP and MAP was calculated from the average values of SBP and DBP using the formula, $MAP = DBP + 1/3(PP)$ respectively.

Participants were asked to perform IHG exercise of the dominant hand at 30% of MVC for a period of 20 minutes at a cadence of 2 seconds of contraction / 3 seconds of release. (Rate of contraction: 12/min) [15]. After completion of 20 minutes of IHG exercise, BP and PR were measured and recorded as immediate post exercise measurements. The same sequence of procedures was followed after 60 minutes of exercise and the measurements recorded as post exercise 60 minutes.

Descriptive statistics of mean and standard deviation for continuous variables and independent t-test was used to analyze differences in BP and PR variables between genders with level of significance set at $p < 0.05$.

RESULTS & DISCUSSION

This study was conducted to determine the differences in response of blood pressure and pulse rate to isotonic hand grip exercise in male and female prehypertensives. Mean values of physical characteristics of the participants are shown in Table 1. There was statistically significant difference in all variables except for age, with higher mean values of height, weight and BMI in males than females (Table 1).

Results indicate statistically significant differences in resting values of SBP ($t=1.937$, $p=0.05$), DBP ($t=-3.396$, $p=0.001$), PR ($t=-3.868$, $p=0.000$), MAP ($t=-2.447$, $p=0.017$) and PP ($t=4.122$, $p=0.000$) between genders (Table 2) with DBP, PR and MAP higher in females than males.

Studies by F. A. Maruf *et al.*; [17] and UcheDimkpa *et al.*; [11] showed higher pre exercise SBP and DBP in males than in females with a higher pre exercise HR in females than in males. Srikanth *et al.*; [18] in their study found resting values of SBP, DBP, PR and MAP higher in males than females, in both seated and supine position. Katti Mani [19] found SBP, DBP and PR higher in male subjects before exercise.

Female participants in the present study had higher DBP, PR and MAP and lower SBP and PP than males. Studies in the past had focused on determining the BP and heart rate responses to different forms of exercises and the population studied were normal healthy individuals [11, 13, 17, 19, 20]. A few studies even used isometric hand grip exercise as a measure to determine the response of BP in comparatively normal healthy subjects [18, 21-23]. Philip J Millar [24] presented with a narrative review of Isometric hand grip effects on Hypertension. After a thorough literature search, it was found that this is the first study to

determine the gender differences in blood pressure after isotonic hand grip exercise among prehypertensives.

Table 1: Physical characteristics of male and female participants

Variable	Mean ± SD		t value	p value
	Male (n=30)	Female (n=30)		
Age (in years)	20.50 ±1.07	20.13 ±1.04	0.006	0.998
Height (in cms)	164.63 ±4.31	156.76 ±4.01	7.309	0.000
Weight (in Kgs)	60.83 ±4.48	54.61 ±5.02	5.059	0.000
Body Mass Index (BMI) (Kg/m ²)	22.42 ±1.14	21.72 ±1.07	2.439	0.018
SD – Standard Deviation				

Table 2: Resting values of SBP, DBP, PR, MAP and PP in male and female participants

Variable	Mean ± SD		t value	p value
	Male (n=30)	Female (n=30)		
SBP (mmHg)	123.30 ±1.803	122.13 ±2.76	1.937	0.058
DBP(mmHg)	79.97 ±2.73	82.80 ±3.66	-3.396	0.001
PR	78.63 ±5.63	85.07 ±7.15	-3.868	0.000
MAP	94.41 ±2.11	95.91 ±2.60	-2.447	0.017
PP	43.33 ±2.67	39.33 ±4.59	4.122	0.000
SD – Standard Deviation; SBP-Systolic Blood Pressure; DBP – Diastolic Blood Pressure; PR – Pulse Rate; MAP – Mean Arterial Pressure; PP – Pulse Pressure				

Table 3: SBP, DBP, PR, MAP and PP values in male and female participants after 20 minutes of Isotonic Hand Grip exercise

Variable	Mean ± SD		t value	p value
	Male (n=30)	Female (n=30)		
SBP(mmHg)	123.37 ± 4.61	122.80 ± 4.80	-0.356	0.723
DBP(mmHg)	79.70 ± 5.19	82.33 ± 5.62	-2.600	0.012
PR	80.83 ± 4.97	84.70 ± 7.66	-2.318	0.024
MAP	94.25 ± 4.40	95.82 ± 4.70	-2.180	0.033
PP	43.67 ± 5.03	40.47 ± 5.46	2.360	0.022
SD – Standard Deviation; SBP-Systolic Blood Pressure; DBP – Diastolic Blood Pressure; PR – Pulse Rate; MAP – Mean Arterial Pressure; PP – Pulse Pressure				

When mean values of variables were compared after 20 minutes of IHG exercise, significant differences were observed between genders in all variables except SBP which showed no significance

(Table 3). Female participants showed higher mean values of DBP, PR and MAP than male. PP values were higher in male participants.

Table 4: SBP, DBP, PR, MAP and PP in male and female participants 60 minutes after Isotonic Hand Grip exercise

Variable	Mean ± SD		t value	p value
	Male (n=30)	Female (n=30)		
SBP(mmHg)	117.20 ± 2.39	117.70 ± 3.32	-0.668	0.507
DBP(mmHg)	77.70 ± 5.30	81.53 ± 5.75	-2.683	0.009
PR	75.93 ± 5.17	80.80 ± 6.55	-3.193	0.002
MAP	90.86 ± 3.74	93.58 ± 4.22	-2.639	0.011
PP	39.50 ± 5.46	36.17 ± 5.94	2.259	0.028
SD – Standard Deviation; SBP-Systolic Blood Pressure; DBP – Diastolic Blood Pressure; PR – Pulse Rate; MAP – Mean Arterial Pressure; PP – Pulse Pressure				

Table 4 shows comparison of mean values of variables 60 minutes after IHG exercise. Significant differences were observed between genders in all variables except SBP which showed no significance. Female participants showed higher mean values of

DBP, PR and MAP than male. PP values were higher in male participants.

F. A. Maruf *et al.*; [17] studied the influence of sex on SBP and Heart Rate (HR) in healthy adults during exercise using Bruce protocol. SBP and HR

were measured post exercise and during 3 minutes and 4 minutes into recovery. They found no difference in post exercise SBP and HR response after exercise and concluded that the differences observed after 3 and 4 minutes into recovery became non-existent after adjusting for BMI, exercise duration and resting SBP and HR. Results from study by Srikanth *et al.*; [18] showed differences in SBP, DBP, HR and MAP with a parallel increase in both genders after isometric hand grip exercise. They concluded that men had significantly greater values than women.

When the BP and PR variables were measured and analyzed at 60 minutes post IHG exercise, the mean values had decreased below the baseline resting values. This decline in SBP, DBP, MAP and PP was high in males than in females. Difference (Δ) in SBP at 60 minutes post IHG to resting values was -6.1 in males and -4.43 in females; for DBP the difference was -2.27 in males and -1.27 in females; for MAP the difference was -3.55 in males and -2.33 in females; for PP the difference was -3.83 and -3.16 in males and females respectively. Decline in PR values was high in females (Δ =-4.27) than in males (Δ =-2.7). In contrast to the study by F. A. Maruf [17], this study measured post exercise BP and PR during 60 minutes into recovery and found significant decline in the variables below resting values.

CONCLUSION

This study indicated the existence of gender differences in resting values of BP and PR in prehypertensive adolescents. While SBP remained unaffected by gender immediately after IHG exercise and 60 minutes into recovery period, DBP, PR, MAP and PP showed differences between both genders. The results also indicates the possible positive effects of IHG exercise in reducing BP, thus suggesting 20 minutes of IHG exercise as an alternative to other forms of exercise in reducing BP among prehypertensives.

REFERENCES

1. Vasan RS, Larson MG, Leip EP, Kannel WB, Levy D; Assessment of frequency of progression to hypertension in non-hypertensive participants in the Framingham Heart Study: a cohort study. *Lancet*. 2001;358(9294):1682-6.
2. Jones DW, Hall JE; Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure and evidence from new hypertension trials. *Hypertension*. 2004;43(1):1-3.
3. Martin JF, Martin LN, Cipullo JP; Pharmacologic treatment for prehypertension: to treat or not to treat? Recent patents on cardiovascular drug discovery. 2009;4(2):133-41.
4. Karanja NM, Obarzanek E, Lin PH, McCullough ML, Phillips KM, Swain JF, *et al.*; Descriptive characteristics of the dietary patterns used in the Dietary Approaches to Stop Hypertension Trial. DASH Collaborative Research Group. *Journal of the American Dietetic Association*. 1999;99(8 Suppl):S19-27.
5. Elmer PJ, Obarzanek E, Vollmer WM, Simons-Morton D, Stevens VJ, Young DR, *et al.*; Effects of comprehensive lifestyle modification on diet, weight, physical fitness, and blood pressure control: 18-month results of a randomized trial. *Annals of internal medicine*. 2006;144(7):485-95.
6. Funk KL, Elmer PJ, Stevens VJ, Harsha DW, Craddick SR, Lin PH, *et al.*; PREMIER--a trial of lifestyle interventions for blood pressure control: intervention design and rationale. *Health promotion practice*. 2008;9(3):271-80.
7. Fagard R, Vanhees L; Twenty-four hour blood pressure after exercise in patients with coronary artery disease. *Journal of human hypertension*. 2000;14(4):231-4.
8. Hamer M, Taylor A, Steptoe A; The effect of acute aerobic exercise on stress related blood pressure responses: a systematic review and meta-analysis. *Biological psychology*. 2006;71(2):183-90.
9. Pescatello LS, Kulikowich JM; The aftereffects of dynamic exercise on ambulatory blood pressure. *Medicine and science in sports and exercise*. 2001;33(11):1855-61.
10. Green DJ, Bilsborough W, Naylor LH, Reed C, Wright J, O'Driscoll G, *et al.*; Comparison of forearm blood flow responses to incremental handgrip and cycle ergometer exercise: relative contribution of nitric oxide. *The Journal of physiology*. 2005;562(Pt 2):617-28.
11. Uche Dimkpa AU, Daniel Oshi; Assessment of sex differences in Systolic Blood Pressure responses to exercise in healthy, non-athletic young adults. *Journal of Exercise Physiology Online*. 2008;11(2):18-25.
12. Daida H, Allison TG, Squires RW, Miller TD, Gau GT; Peak exercise blood pressure stratified by age and gender in apparently healthy subjects. *Mayo Clin Proc*. 1996;71(5):445-52.
13. Dimkpa U UA, Oshi D; Determination of systolic blood pressure recovery time after exercise in apparently healthy, normotensive nonathletic adults and the effects of age, gender and exercise intensity. *International journal of exercise science*. 2009;2:115-30.
14. NM. K; Kaplan's Clinical Hypertension. 9th ed; Lippincott Williams & Wilkins; 2006.
15. Brian A. Batman Jch UAL, Michael B. Smith, Qing X. Yang, Lawrence I. Sinoway; Sympathetic nerve activity during prolonged rhythmic forearm exercise. *The American Physiological Society* 1994;1077-81.
16. Grim CE, Grim CM; Omron HEM-711 DLX home Blood pressure monitor passes the European

- Society of Hypertension International Validation Protocol. Blood pressure monitoring. 2008;13(4):225-6.
17. Maruf UNO FA, Dim PA, Alada ARA; Absence of sex differences in systolic blood pressure and heart rate responses to exercise in healthy young adults. Niger J Physiol Sci. 2012;27:95-100.
 18. Srikanth S NDPB; Gender differences in cardiovascular responses to isometric exercise. IJRRMS. 2013;3(4).
 19. Kattimani YR; Gender Comparison of Heart Rate Variability Response to Exercise in Male and Female Medical Students. International Journal of Scientific Study. 2015;3(1):48-53.
 20. M. Syamala Devi KSSSD, M. Usha Rani, D. Taraka Lakshmi, Nazia Farah; Study of Blood Pressure and Heart Rate Responses to Exercise in Young Adults. Sch J App Med Sci. 2015;3(5D):2064-7.
 21. McGowan CL, Visocchi A, Faulkner M, Verduyn R, Rakobowchuk M, Levy AS, *et al.*; Isometric handgrip training improves local flow-mediated dilation in medicated hypertensives. European journal of applied physiology. 2007;99(3):227-34.
 22. Mortimer J, McKune AJ; Effect of short-term isometric handgrip training on blood pressure in middle-aged females. Cardiovascular journal of Africa. 2011;22(5):257-60.
 23. Howden JTL R, Brown SJ, Swaine IL; The effects of isometric exercise training on resting blood pressure and orthostatic tolerance in humans. Exp Physiol. 2002;87(4):507-15.
 24. Philip J. Millar APaNM; Isometric Handgrip Effects on Hypertension. Current Hypertension Reviews. 2009;5:54-60.