

Sex Differences in Cardiovascular Response to Handgrip Exercise among Apparently Healthy Young Adult Nigerians

Research Article

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Abstract

Background: Sustained handgrip is one of the standardized non-invasive test involved in assessment of cardiac autonomic functions.

Objective: This study aimed at determining the sex differences in cardiovascular response to sustained handgrip among apparently healthy young adult Nigerians.

Materials and Method: 148 (74 females and 74 males, age and sex matched) apparently healthy young adults aged between 18-40years participated in this study. The Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Pulse Rate (PR) of the subjects were recorded before and during sustained handgrip exercise in sitting position with sphygmomanometer cuff attached to the dominant arm. The maximum voluntary contraction (MVC) of the subject was determined from the non-dominant arm by the use of a handgrip dynamometer. The handgrip was maintained at 30% of the maximum voluntary contraction for as long as possible (up to maximum period of 5 minutes). Blood pressure was monitored every minute until the maximum values were obtained. Mean Arterial Pressure (MAP), Pulse Pressure (PP) and Rate Pressure Product (RPP) were calculated from SBP, DBP and PR. Data were analyzed using descriptive and inferential statistics. The student t-test was used to determine the difference between two groups and p value < 0.05 was considered statistically significant.

Results: The males had a higher resting SBP, DBP, MAP, PP and RPP than females with significant sex difference in PP (t=3.719, p-value < 0.001) and SBP (t=3.382, p-value=0.001). Significant sex differences were observed in maximum values of SBP (t=8.982, p-value < 0.001), DBP (t=2.512, p-value=0.013), MAP (t=3.155, p-value = 0.002), RPP (t=1.984, p-value=0.049) and PP (t=2.283, p-value=0.024) during sustained handgrip exercise. The resting heart rate at rest and during sustained handgrip exercise were higher in females. Significant sex differences were also observed in change in cardiovascular responses to sustained handgrip with regards to SBP (t= 2.225, p-value = 0.028), DBP (t= 2.414, p-value = 0.017) and MAP (t=2.400, p=0.018).

Conclusion: This study showed that sex significantly influenced haemodynamic responses to sustained handgrip exercise.

Keywords: Cardiovascular response; Young adults; Handgrip; Sex differences

Introduction

Handgrip exercise is a form of physiological isometric exercise used in eliciting cardiovascular response in basic and clinical settings [1-3]. It was once used as a test for unmasking hypertension and in offsprings of hypertensive parents [4]. Sustained handgrip exercise is one of the series of tests involved in assessing cardiac autonomic function (CAF) [5,6]. It is a form of static exercise used to investigate cardiovascular responses to stress. It dominantly assesses the sympathetic function of the cardiac autonomic innervations [4,7]. Sustained handgrip causes an increase in sympathetic activity with simultaneous parasympathetic withdrawal which have being demonstrated in young normotensive offspring of hypertensive parents [8-10]. Sustained handgrip increased systolic blood pressure as a result

of increased cardiac output while raised diastolic blood pressure is due to increased peripheral resistance during the exercise [1]. Young athletes showed lower sympathetic and hemodynamic response to the isometric exercise than non-athletes [11]. Cardiovascular response to exercise in non athletes has been used as major criteria in exercise prescription for both the patients and healthy population [12-15]. This study evaluated the sex difference in cardiovascular response to sustained handgrip among apparently healthy young adult Nigerians.

Materials and Methods

This study was conducted in the Department of Physiological Sciences Obafemi Awolowo University Ile-Ife, Nigeria. One hundred and forty eight (148) young adults (74 males and

74 females) age and sex matched who were between 18-40 years of age participated in this study. The participants were selected using purposive sampling technique. The procedure were explained to each participant and informed consents were obtained. Ethical clearance was obtained from Ethics and Research Committee of Obafemi Awolowo University Teaching Hospital Complex, Ile-Ife, Nigeria. Detailed medical history was taken and thorough clinical examination was done to exclude those with systemic diseases. The materials used for this study include: digital sphygmomanometer (Lumiscope), Littmann Cardiology III Stethoscope, Smedley digital hand dynamometer (Model 12-0286), Tiger head alkaline batteries-AAA, stop watch and calculator. The maximum voluntary contraction (MVC) of the subject was determined from the non-dominant arm by the use of a digital handgrip dynamometer. The handgrip was maintained at 30% of the maximum voluntary contraction for as long as possible up to maximum period of 5 minutes. The Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Pulse Rate (PR) of the subjects were recorded every minute in sitting position with sphygmomanometer cuff attached to the dominant arm. Measurement continued until the individual could no longer sustained the handgrip. Mean Arterial Pressure (MAP), Pulse Pressure (PP) and Rate Pressure Product (RPP) were calculated from SBP, DBP and PR. Data was analysed using student t-test to determine the difference between two groups (male and female) and p value < 0.05 was considered statistically significant.

Results

A total of One hundred and forty eight (148) young adults with mean age of 22.27± 4.40 years completed the study protocol. The age group distribution was as shown in Table 1. The mean of weight (kg), height (m), body mass index (kg/m²) and body surface area (m²) were 59.91±10.15, 1.66±0.09, 21.82±3.38 and 1.66±0.16 respectively. The mean of weight (kg), height (m), body mass index (kg/m²) and body surface area (m²) for males and females respectively were 62.64 ±8.68 and 57.17 ± 10.83, 1.70 ± 0.08 and 1.61 ± 0.66, 21.54 ± 2.60 and 22.10 ± 4.01 and 1.72 ± 0.14 and 1.59 ± 0.16 with significant sex differences in weight

(t=3.391, p=0.001), height (t=8.109, p<0.001) and body surface area (t=5.096, p<0.001). The mean of resting SBP(mmHg), DBP(mmHg), PR(beats per minutes), MAP(mmHg), RPP and PP(mmHg) for the study population were 116.04 ± 9.86, 68.39 ± 8.03, 71.09 ± 10.58, 84.27 ± 7.90, 8254.97 ± 1454.70 and 47.65 ± 7.60 respectively while the mean of the maximum values during sustained handgrip exercise were 137.55 ± 18.07, 88.80 ± 17.56, 105.05 ± 16.84, 12460.23 ± 2562.19 and 48.76 ± 11.32 for SBP, DBP, PR, MAP and RPP respectively has shown in Table 2.

The mean of resting SBP(mmHg), DBP(mmHg), PR(beats per minutes), MAP(mmHg), RPP and PP(mmHg) in males and females respectively were 118.69 ± 9.27 and 113.39 ± 9.78, 68.81 ± 7.65 and 67.97 ± 1.14, 70.09 ± 11.22 and 72.09 ± 1.15, 85.44 ± 7.37 and 83.11 ± 8.30, 8320.24 ± 1466.56 and 8189.70 ± 1449.79 and 49.88 ± 7.75 and 45.42 ± 6.81 with significant gender differences in SBP (t= 3.382, p-value = 0.001) and PP (t= 3.719, p-value < 0.001) as shown in Table 3. The mean of the maximum cardiovascular variables during sustained handgrip exercise for SBP (mmHg), DBP (mmHg), PR (beats per minutes), MAP (mmHg), RPP and PP (mmHg) in males and females respectively were 143.19 ± 19.66 and 131.92 ± 14.36, 92.34 ± 18.96 and 85.26 ± 15.12, 89.85 ± 13.63 and 91.14 ± 13.11, 109.29 ± 18.58 and 100.81 ± 13.75, 12873.96 ± 2682.92 and 12046.50 ± 2382.12, 50.85 ± 10.21 and 46.66 ± 12.03. There were significant gender differences in SBP (t= 3.982, p-value < 0.001), DBP (t= 2.512, p-value = 0.013), MAP (t=3.155, p=0.002), RPP (t=1.984, p=0.049) and PP (t=2.283, p=0.024) as shown in Table 4.

The mean of the change in cardiovascular variables for SBP(mmHg), DBP(mmHg), PR(beats per minutes), MAP(mmHg), RPP and PP(mmHg) in males and females respectively were 23.53±19.66 and 17.28±14.01, 24.50±16.67 and 18.53±13.23, 19.85±11.68 and 19.04±12.70, 23.85±18.03 and 17.70±12.70, 4553±2525.87 and 3856.80±2181.88, 0.97±10.63 and 1.24±11.22. There were significant gender differences in SBP (t= 2.225, p-value = 0.028), DBP (t= 2.414, p-value = 0.017) and MAP (t=2.400, p=0.018) as shown in Table 5.

Table 1: Age and sex distributions of the participants.

Age group (years)	Gender		Total
	Male (n=74)	Female (n=74)	
18-20	30	30	60
21-30	41	41	82
31-40	3	3	6
	74	74	148

Table 2: Cardiovascular parameters at rest and during sustained handgrip.

Cardiovascular Parameters	Mean ± SD	
	Resting Values	Maximum Values
SBP(mmHg)	116.04 ± 9.86	137.55 ± 18.07
DBP(mmHg)	68.39 ± 8.03	88.80 ± 17.46
PR(bpm)	71.09 ± 10.58	90.49 ± 13.34
MAP(mmHg)	84.27 ± 7.91	105.05 ± 16.84
RPP	8254.97 ± 1454.70	12460.23 ± 2562.19
PP(mmHg)	47.65 ± 6.60	48.76 ± 11.32

SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; PR: Pulse Rate; MAP: Mean Arterial Pressure; RPP: Rate Pressure Product; PP: Pulse Pressure.

Table 3: Gender differences in resting cardiovascular parameters.

Cardiovascular Parameters	Mean \pm SD		t	p-value
	Male	Female		
SBP(mmHg)	118.69 \pm 9.27	113.39 \pm 9.78	3.382	0.001*
DBP(mmHg)	68.81 \pm 7.65	67.97 \pm 8.42	0.633	0.527
PR(bpm)	70.09 \pm 11.21	72.09 \pm 9.88	-1.151	0.252
MAP(mmHg)	85.44 \pm 7.37	83.11 \pm 8.30	1.801	0.074
RPP	8320.24 \pm 1466.55	8189.70 \pm 1449.79	0.545	0.587
PP(mmHg)	49.88 \pm 7.75	45.42 \pm 6.81	3.719	<0.001*

*-Statistical significant at p-value < 0.05, SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; PR: Pulse Rate; MAP: Mean Arterial Pressure; RPP: Rate Pressure Product; PP: Pulse Pressure

Table 4: Gender differences in maximum values of cardiovascular parameters during sustained handgrip.

Cardiovascular Parameters	Mean \pm SD		t	p-value
	Male	Female		
SBP(mmHg)	143.19 \pm 19.66	131.92 \pm 14.36	3.982	<0.001*
DBP(mmHg)	92.34 \pm 18.96	85.26 \pm 15.12	2.512	0.013*
PR	89.85 \pm 13.63	91.14 \pm 13.11	-0.584	0.56
MAP(mmHg)	109.29 \pm 18.58	100.81 \pm 13.75	3.155	0.002*
RPP	12873.96 \pm 2682.91	12046.50 \pm 2382.12	1.984	0.049*
PP(mmHg)	50.85 \pm 10.21	46.66 \pm 12.03	2.283	0.024*

*- Statistical significant at p-value < 0.05, SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; PR: Pulse Rate; MAP: Mean Arterial Pressure; RPP: Rate Pressure Product; PP: Pulse Pressure

Table 5: Gender differences in change in cardiovascular parameters (Maximum – Resting values).

Cardiovascular Parameters	Mean \pm SD		t	p-value
	Male	Female		
SBP(mmHg)	23.53 \pm 19.66	17.28 \pm 14.01	2.225	0.028*
DBP(mmHg)	24.50 \pm 16.67	18.53 \pm 13.23	2.414	0.017*
PR(bpm)	19.85 \pm 11.68	19.04 \pm 12.70	0.374	0.709
MAP(mmHg)	23.85 \pm 18.03	17.70 \pm 12.70	2.4	0.018*
RPP	4553 \pm 2525.87	3856.80 \pm 2181.88	1.796	0.075
PP(mmHg)	0.97 \pm 10.63	1.24 \pm 11.22	-0.15	0.881

*- Statistical significant at p-value < 0.05, SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; PR: Pulse Rate; MAP: Mean Arterial Pressure; RPP: Rate Pressure Product; PP: Pulse Pressure

Discussion

This study investigated the gender differences in cardiovascular response to sustained handgrip among apparently healthy young adult Nigerians. The mean weight, height and body surface area were higher in males than females while the mean BMI of female participants was higher than that of male which was in support of earlier reports among young adults [16] but contrary to what was earlier reported among adolescent by Bhavsar et al. [1]. This may be due to the fact that Bhavsar et al. [1] studied adolescent between the ages of 17-19years who were just developing secondary sexual characteristics.

The mean resting SBP, DBP, HR and MAP was similar to what has being reported in earlier studies among young adults of the same age range [17,18]. The resting SBP and DBP among the study population was higher in males than females which is similar to what was reported by Asafa and Ogunlade in 2015 using 702 subjects of the same age range [17] but contrary to report from a study conducted among adults of age 35 to 70 years in northern part of Nigeria by Sharaye et al. [19], in which the resting SBP and DBP were higher in females than males [19]. This is probably due to reversed gender dichotomy with increasing age. The resting PR was higher in females than male which is in consistent with the report of earlier studies among apparently healthy adults

within the age range of 25-54years and 18-74years by Ewing et al. and Ndayisaba et al. respectively [20,21] but contradicts what was reported by Rajasekhar et al. [22] in which the resting HR in males was higher than that of females. The resting heart rate of females higher than that of males because males have high vagal tone. The resting SBP, DBP and MAP were higher in males than females, these findings were supported by Ewing et al in 1974 and Rajasekhar et al. [22] among other studies [1,17,20,22-24]. PP and RPP were also higher in males than females. Significant gender differences were noticed in resting SBP and PP (Table 3) which was in contrast with what was reported in some studies [20,22].

There was an increase in all the cardiovascular parameters during the sustained isometric handgrip exercise which is in support of earlier study done by Bhavsar et al. [1]. This may be due to the stressor effect exerted by the sustained isometric handgrip exercise. There was an increase in SBP and DBP of the study population during sustained handgrip exercise which can be explained on the basis of the activation of sympathetic adrenergic system as indicated by an increase in the plasma catecholamine level [25]. The increased muscle tension caused activation of mechanoreceptors which increased the excitatory state of the central nervous system. Sympathetic discharge and suppression of parasympathetic activity culminating in an increase in blood pressure [22]. Significant gender differences were observed in SBP, DBP, PP, MAP and RPP during sustained handgrip exercise with higher values in males. These findings were consistent with the outcome of previous studies on cardiovascular responses to isometric exercise [1,24].

There were positive changes in cardiovascular responses to sustained handgrip in both sexes, with all the responses higher in males than in females except the PP changes. These marked sex differences can probably be explained by the low differential sympatho-adrenal responses to isometric response to isometric exercise in males and females [26].

Conclusion

This study showed that gender has significant influence in the cardiovascular and haemodynamic responses to isometric handgrip exercise.

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