Innovations

Effect of Isometric Handgrip Exercise on Blood Pressure in Post-Menopausal Women

[1] **Dr. Bujji Karre**, [2] **Dr. Konakanchi Suresh**

[1] Assistant professor, Department of Physiology, Konaseema institute of medical sciences and research foundation (KIMS & RF), Amalapuram, AP

[2] Assistant Professor, Department of physiology Sri Madhusudan Sai Institute of Medical Sciences and Research, Kalaburagi, Karnataka

Corresponding Author: **Dr. Bujji Karre**

Abstract

Aims: *The study aimed to record the effects of short term Isometric handgrip exercise training on blood pressure in postmenopausal women.* ***Settings and Design:*** *This community based observational study was done among labour workers, The sample size was calculated using an online software tool, with a confidence interval of 95%, leaving a margin of 5% error, amongst 80 participants.* ***Subjects and methods:*** *Participants were divided into two groups, each comprising of 40 individuals: Group 1 (Control subjects): 40 healthy adult women aged between 20 to 30 years. Group 2(study subjects): 40 postmenopausal women aged between 45 to 65 years. Isometric handgrip exercises were performed for three minutes per day at 30% of maximum voluntary contraction, over a nine days period within a three-week test phase. The effects of short-term isometric handgrip training on blood pressure were recorded at the end of the first, second, and third weeks. Resting systolic and diastolic blood pressure were measured before the intervention began, and all parameters were recorded immediately after the isometric handgrip training. The results were compared between the two groups using statistical analysis,* ***Results:*** *Significant changes in systolic blood pressure (SBP) at rest, before exercise, and after exercise were observed during the first and third weeks of isometric handgrip (IHG) training in both the control and study subjects. Diastolic blood pressure (DBP) at rest, before exercise, and after exercise also showed a significant reduction when compared the first and third weeks of training following IHG exercise.* ***Conclusion:*** *The result indicates a decrease in blood pressure with statistically significant p-values of SBP -0.04, DBP- 0.03, and PP (pulse pressure)- 0.00 at the end of the third week. As many women are obese and also present with cardiovascular conditions during their post-menopausal period a correction can be brought about by mainly healthy life style modification and introducing minimal exercise in their daily physical activities.*

Keywords: *Isometric hand grip training (IHG), Blood pressure (BP), Post menopause, Maximum voluntary contraction. maximum isometric tension (Tmax)*

Introduction:

Isometric or static exercise involves the contraction of skeletal muscles without a change in muscle length for example, lifting or pushing heavy weights or contracting muscles against fixed objects[1]. These exercises are considered important components of a comprehensive fitness program[2]. The American College of Sports Medicine (ACSM) suggests that appropriately prescribed and well-supervised static exercises have favorable effects on cardiovascular function, psychosocial well-being, and endurance[3]. Based on this, we designed a study involving postmenopausal women, as they often experience obesity and cardiovascular complications during the postmenopausal period.

Menopause marks the end of ovarian function, leading to permanent cessation of menstruation. This phase is associated with hormonal changes resulting from ovarian atrophy. Estrogen plays a cardio protective role by increasing high-density lipoprotein (HDL) levels and reducing low-density lipoprotein (LDL) and triglyceride levels [4]. Consequently, a deficiency in estrogen can contribute to the development of atherosclerosis, ischemic heart disease, and myocardial infarction.

Estrogen deficiency also affects the integrity of blood vessel walls, increasing the likelihood of plaque buildup and blood clot formation[5]. Additionally, reduced estrogen levels lead to elevated fibrinogen levels, a protein that promotes blood clot formation (thrombosis). These intravascular clots can obstruct coronary arteries, resulting in heart attacks, or block cerebral vessels, leading to strokes [6].Therefore, estrogen deficiency is considered a significant risk factor for cardiovascular issues in postmenopausal women[5].

Hypertension becomes increasingly prevalent among women as they age. Cardiovascular changes associated with postmen pause can be effectively managed through lifestyle interventions, particularly regular physical activity and a balanced diet. To support cardiovascular health, women are encouraged to engage in at least 150 minutes of moderate physical activity per week[7]. The present study aims to evaluate the effectiveness of isometric exercise in controlling the blood pressure in postmenopausal women.

Methods:

The present study was conducted among labour workers, after obtaining approval from the Institutional Ethics Committee (IEC/SVIMS/2014/04) and informed consent from all participants. "The sample size was calculated using an online software tool with a confidence interval of 95%, a margin of error of 5%, and a population size of 80." A total of 80 subjects were recruited and divided into two groups, each consisting of 40 individuals: Group 1 (Control subjects): 40 healthy women aged between 20 to 30 years. Group 2 (Study subjects): 40 postmenopausal women aged between 45 to 65 years.

Inclusion Criteria: Healthy adult women (Control subjects), Postmenopausal women. Exclusion Criteria: Individuals with diabetes mellitus, Smokers and alcohol consumers, Athletes, Individuals with chronic liver disease, renal disorders, or Cushing's syndrome, Women who have undergone hysterectomy, those receiving hormone replacement therapy[8].Resting blood pressure for all participants was measured using the auscultator method with a mercury sphygmomanometer. Participants were instructed to avoid stimulants (such as coffee or medications) for at least 30 minutes prior to the BP measurement. They were also asked to empty their bladder and sit quietly in a relaxed position for at least five minutes before the reading was taken [9].Pulse pressure (PP) and mean arterial pressure (MAP) were calculated from the values of SBP and DBP using the standard formula.

PP = SBP – DBP, MAP = DBP – 1/3(PP) [8].

After recording the participants' baseline blood pressure parameters, they were asked to perform the isometric handgrip exercise. Each subject was instructed to hold a handgrip spring dynamometer in their dominant (right/left) hand and grasp it firmly. They were then asked to compress the handles of the dynamometer using maximum effort for 2–3 seconds to one minute. This procedure was repeated three times, with a one-minute rest between each attempt to prevent fatigue.

The highest value recorded among the three attempts was considered the maximum voluntary contraction (MVC) for each participant. The average of the three readings was considered as the maximum isometric tension (Tmax). Pulse rate and blood pressure were measured on left hand one minute after the exercise. The percentage rise in diastolic blood pressure (%RDBP) due to isometric exercise was calculated based on the pre-exercise reading. Body Mass Index (BMI) was calculated using Quetelet's index: BMI = weight (kg) / height (m^2).Basal Metabolic Rate (BMR) was estimated using the Roza and Shizgal formula for women: BMR = 447.593 + (9.247 × weight in kg) + (3.098 × height in cm) – (4.330 × age in years).The results were analyzed statistically to determine their significance [10].

$$t = \frac{d}{\sqrt{s2/n}}$$

Where d=∑d/n: d=x-y

S2 = ∑ (d-d) 2/n-1

n = sample size [11].

Results:

The test results for BMI indicate a significant difference between postmenopausal women (cases) and the control group (p-0.000). In contrast, the BMR values show no significant difference between the two groups (p- 0.82) (Table 1)

Table 1: Mean, SD, P value of BMI and BMR in study and control subjects

Variable	Groups	Mean	SD	P value
BMI	Study subjects	25.19	4.55	0.000
	Controls	21.41	3.42	
BMR	Study subjects	1318.45	142.89	0.82
	Controls	1324.29	80.49	

BMI: Body mass index, BMR: Basal metabolic rate, SD: Standard deviation,

As shown in Table 2, the mean, standard deviation (SD), and p-values for SBP in the study subjects (p - 0.00) and control subjects (p-0.06) at the end of the first week indicate a significant difference in SBP before and after exercise in the study subjects. In the second week, the mean, SD, and p-values for SBP in the study subjects (p-0.95) and control subjects (p-0.30) show no significant difference in SBP before and after exercise. By the third week (Table 3), the mean, SD, and p-values for SBP in the study subjects (p- 0.04) and control subjects (p - 0.00) suggest a significant difference in SBP before and after exercise in both groups.
At the end of the first week (Table 2), the mean, SD, and p-values for diastolic blood pressure (DBP) in the study subjects (p-0.26) and control subjects (p-0.92) before and after exercise indicate no significant difference in DBP. In the second week, the mean, SD, and p-values for DBP in the study group (p-0.00) and control group (p-0.00) suggest a significant difference in DBP before and after exercise. By the third week (Table 3), the mean, SD, and p-values for DBP in the study subjects (p-0.03) and control subjects (p-0.02) also indicate a significant difference in DBP before and after exercise.

Table 2. First week - Mean, SD, P values of SBP, DBP, PP, MAP in study and control subjects before and after exercise

Explanatory variable	Study subjects			Control subjects		
	Pre exercise Mean ± SD	Post Exercise Mean ± SD	p-value	Pre exercise Mean ± SD	Post exercise Mean ± SD	p-value
SBP(mmHg)	118.26±22.59	116.0±21.22	0.001	109.83±17.57	107.23±17.38	0.06
DBP(mmHg)	75.59±14.48	78.21±10.08	0.262	72.63±11.00	72.55±10.23	0.92
PP(mmHg)	40.34±15.58	36.69±16.01	0.01	37.28±10.97	36.72±10.36	0.08
MAP(mmHg)	90.71±14.29	90.28±12.76	0.647	85.11±12.41	84.37±11.52	0.29

SBP (Systolic blood pressure), DBP (Diastolic blood pressure), PP (Pulse pressure) and MAP (mean arterial pressure), SD (Standard deviation) P<0.05-Significant, P>0.05-non significant

At the end of the first week (Table 2), the mean, SD, and p-values for pulse pressure (PP) in the study subjects (p-0.00) and control subjects (p-0.08) before and after exercise indicate a significant difference in the study subjects, but no significant difference in the control subjects. In the second week, the mean, SD, and p-values for PP in the study subjects (p-0.00) and control subjects (p-0.00) show a significant difference in both groups before and after exercise. By the third week (Table 3), the mean, SD, and p-values for PP in the study subjects (p-0.00) and control subjects (p-0.03) also indicate a significant difference in both groups before and after exercise.
At the end of the first week (Table 2), the mean, SD, and p-values for MAP in the study subjects (p-0.64) and control subjects (p-0.29) before and after exercise indicate no significant difference in either group. In the second week, the mean, SD, and p-values for MAP in the study subjects (p-0.04) and control subjects (p-0.03) suggest a significant difference in both groups before and after exercise. By the third week (Table 3), the mean, SD, and p-values for MAP in the study subjects (p-0.19) and control subjects (p-0.00) show no significant difference in the study subjects but a significant difference in the control subjects.

Table 3. Third week - Mean, SD, P values of SBP, DBP, PP, MAP in study and control subjects before and after exercise

Explanatory variable	**Study subjects**			**Control subjects**		
	Pre exercise mean ± SD	Post exercise mean ± SD	p-value	Pre exercise mean ± SD	Post exercise mean ± SD	p-value
SBP(mmHg)	116.29±20.03	114.79±18.08	0.04	102.22±8.33	99.99±6.72	0.00
DBP(mmHg)	76.49±9.51	78.20±8.67	0.036	68.05±7.47	67.05±6.87	0.02
PP(mmHg)	39.65±13.63	36.43±13.29	0.000	34.06±5.56	32.89±5.43	0.03
MAP(mmHg)	89.05±12.91	89.99±11.13	0.19	79.39±7.29	78.02±6.56	0.00

SBP (Systolic blood pressure), DBP(Diastolic blood pressure), PP (Pulse pressure) and MAP (mean arterial pressure) SD(Standard deviation) P<0.05-Significant, P>0.05-non significant

Statistical Analysis: Data are presented as mean ± standard deviation. A paired t-test was used to compare systolic blood pressure, diastolic blood pressure, pulse pressure, and mean arterial pressure before and after exercise at the end of each week. All statistical analyses were performed using SPSS software. A p-value of less than 0.05 was considered statistically significant

Discussion:
BMI has a strong correlation with both systolic and diastolic blood pressure [12]. Individuals with a higher BMI are more likely to exhibit elevated blood pressure levels[13]. According to Doll et al., hypertension associated with obesity may result from insufficient vasodilatation despite increased blood volume and cardiac output both of which are typical physiological responses to greater body mass. Overweight and obesity have been recognized as significant risk factors for elevated blood pressure in both men and women, with a particularly strong association observed for DBP[14]. As a result, prehypertension and hypertension are more frequently observed in individuals who are overweight or obese.
The present study reveals a significant difference in BMI between the control group and postmenopausal women. BMI values tend to be slightly higher in postmenopausal women, likely due to age-related and hormonal changes associated with decreased estrogen levels[15]. The primary form of estrogen in the female body, 17-beta-estradiol, plays a key role in lipid metabolism it increases HDL and triglyceride levels, while decreasing LDL levels and reducing fat accumulation. In the present study, all postmenopausal women were physically active and had normal nutritional status[16]. BMR is influenced by body composition specifically fat-free mass (FFM), fat mass as well as gender, age, physical activity, and nutritional status[16].BMR significantly declines with age in sedentary populations, decreasing by approximately 1–2% per decade after the age of 20[17-18].BMR, which accounts for about 50–70% of total energy expenditure (TEE), is estimated to decline by around 150 calories per decade after the age of 20. This reduction is largely attributed to a loss of muscle mass which is highly metabolically active and an increase in fat mass, which is relatively metabolically inactive. The decline in BMR tends to accelerate after the age of 40 in men and after 50 in women. A significant change in SBP was observed at rest, before exercise, and after exercise during the first and third weeks of isometric handgrip (IHG) training in both the control and study groups. Similar reductions in SBP following IHG training were reported by Rinku Garg et al. (2014) and Philip J. Millar et al. after 10 weeks of intervention.
When comparing DBP between the first and third weeks of training, a significant reduction in DBP was also noted following IHG exercise. These findings are consistent with previous studies conducted by Rinku Garg (2014), Philip J. Millar (2009), and Joline Mortimer (2011), which also reported a decrease in DBP after IHG training[19,20,21,22]. However, regular exercise was found to reduce blood pressure, as demonstrated by the results after ten weeks of training. The underlying mechanism has been explained by Mostoufi-Moab et al., who showed that regular exercise leads to increased capillary and mitochondrial density, activation of oxidative enzymes, and enhanced oxygen extraction in skeletal muscles. Improved vascular flow, combined with the trained muscles' enhanced ability to sustain aerobic

metabolism, results in lower interstitial concentrations of metabolites. This reduces stimulation of metaboreceptors, leading to a diminished sympathetic response and, consequently, a smaller rise in blood pressure.

Regular isometric exercise training has been associated with a reduced risk of developing hypertension in the future[23].Multiple studies have demonstrated that such training diminishes chemoreceptor reflex activity, which plays a key role in activating sympathetic nerve responses. This reduction in sympathetic activity leads to a gradual lowering of resting blood pressure over time[24].Moreover, isometric exercise has been shown to improve local, endothelium-dependent vasodilation, even among individuals receiving medication for hypertension[25].Evidence also indicates that individuals engaged in occupations involving regular isometric activity tend to have a lower incidence of hypertension. Muscle sympathetic nerve activity decreases during exercise. Regular physical activity also enhances myocardial efficiency while reducing oxygen demand. Additionally, several authors have reported that the chemo reflex response, which contributes to sympathetic nerve activity, is attenuated during isometric handgrip exercise[26].The changes in SBP,DBP, PP, and MAP observed in the first week were not statistically significant, possibly due to the initial grading of exercise being insufficiently effective. By the end of the third week, changes in PP and MAP were evident; however, MAP values remained insignificant in the postmenopausal group, while they were significant in the control group. These findings suggest an inverse relationship between arterial blood pressure and vascular sympathetic reactivity, as assessed by the isometric handgrip (IHG) test. In menopausal women, fat mass typically increases relative to muscle mass. This change in body composition may reduce peripheral resistance, potentially contributing to decreases in DBP, PP, and MAP[8].

Conclusion:

Performing isometric handgrip exercises daily, even for a short duration, helps maintain healthy blood pressure levels. Though Isometric handgrip exercise was administered for shorter duration the results of this study show a significant reduction in SBP, DBP, and PP with statistically significant changes observed by the end of the third week. The corresponding p-values were: SBP – 0.04, DBP – 0.03, and PP – 0.00.

Limitation of the Study:

In this study, we administered isometric handgrip training for nine days over a three-week period. The duration of each maximum voluntary contraction was less than one minute, and both the number of training days and the duration of each session were relatively short. The study was conducted on labor workers rather than individuals with dyslipidemia. Including additional blood cholesterol investigations along with blood pressure parameters would have added more weight to the study

References:

1. *Pollock LM, Franklin BA, Balady GJ, Chaitman BL, Fleg JL, Fletcher B, et al. Resistance exercises in individuals with and without cardiovascular diseases. AHA Science Advisory. 2000; 101:828–33.*
2. *Mortimeter J, Mckune AJ. Effect of short-term isometric handgrip training on blood pressure in middle-aged females. Cardiovasc J Afr. 2010; 21:1–4.*
3. *American College of Sports Medicine. Position Stand: The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. Med Sci Sports Exerc. 1990;22:265–74.*
4. *Howkins and Bourne, Padubidri V.G., Daftary. Shaw's Text book of Gynaecology.16thed.NewDelhi:Reed Elsevier India Pvt limited;2011.P.65-69. tinyurl.com.*
5. *Koh KK. Effects of estrogen on the vascular wall: vasomotor function and inflammation. Cardiovasc Res. 2002; 55(4):714-26. 10.1016/s0008-6363(02) 00487-x.*
6. *R.C. Tostes, D. Nigro, Z.B. Fortes and M.H.C. Carvalho Effects of estrogen on the vascular system Braz J Med Biol Res, September 2003, Volume 36(9) 1143-1158. 10.1590/s0100-879x2003000900002*
7. *Carol mattson porth, Essentials of pathophysiology concepts of altered health states .2nded. lippincott Williams and Wilkins;2007.p.366. pdfcoffee.com.*
8. *Shaikh WA, Patel M, Shah HD, Nimbalkar AS, Patel N, Singh SK. Arterial blood pressure is inversely associated with vascular sympathetic reactivity (isometric handgrip exercise) in Gujarati Indian adolescents. Indian J Physiol Pharmacol. 2014; 58(3):271-4. pubmed.ncbi.nlm.nih.gov.*
9. *Millar PJ, Macdonald MJ, Bray SR, Mccartney N. Isometric handgrip exercise improves acute neurocardiac regulation. Eur J Appl Physiol. 2009;107(5):509-15.*
10. *Roza AM, Shizgal HM. The Harris Benedict equation reevaluated: resting energy requirements and the body cell mass. Am J ClinNutr. 1984;40(1):168-82.*
11. *W. Wayne, Daniel and chod, L. cross. Biostatistics : a foundation for analysis in the health sciences. 10th ed.ISBN : 978-1-118-30279-8; PP.236-260.*
12. *N. K. Mungreiphy,[1] Satwanti Kapoor,[1] and Rashmi Sinha[2]. .Association between BMI, Blood Pressure, and Age: Study among Tangkhul Naga Tribal Males of Northeast India. Journal of Anthropology: Volume 2011 (2011), Article ID 748147, 6 pages.*

13. *Kannel WB. Risk stratification in hypertension: new insights from the Framingham Study. Am J Hypertens. 2000;13(1 Pt 2):3S-10S.10.1016/s0895-7061(99)00252-6*
14. *Doll S, Paccaud F, Bovet P, Burnier M, Wietlisbach V. Body mass index, abdominal adiposity and blood pressure: consistency of their association across developing and developed countries. Int J Obes Relat Metab Disord. 2002;26(1):48-57.*
15. *Weder AB. Membrane sodium transport. In: Izzo JL, Black HR, editors. Hypertension Primer. Dallas TX: American Heart Association; 1993. pp. 36–7.*
16. *16.Wang Z, Heshka S, Wang J, et al. Metabolically active portion of fat-free mass: a cellular body composition level modeling analysis. Am J Physiol Endocrinol Metab. 2007;292(1):E49-53.*
17. *Fukagawa NK, Bandini LG, Young JB. Effect of age on body composition and resting metabolic rate. Am J Physiol. 1990;259(2 Pt 1):E233-8.*
18. *Keys A, Taylor HL, Grande F. Basal metabolism and age of adult man. MetabClin Exp. 1973;22(4):579-87.*
19. *Yanovski JA, Yanovski SZ, Sovik KN, Nguyen TT, O'neil PM, Sebring NG. A prospective study of holiday weight gain. N Engl J Med. 2000;342(12):861-7.*
20. *Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. JAMA. 2012;307(5):491-7.*
21. *Williamson DF. Descriptive epidemiology of body weight and weight change in U.S. adults. Ann Intern Med. 1993;119(7 Pt 2):646-9.*
22. *Roberts SB, Dallal GE. Energy requirements and aging. Public Health Nutr. 2005;8(7A):1028-36.*
23. *Mostoufi-moab S, Widmaier EJ, Cornett JA, Gray K, Sinoway LI. Forearm training reduces the exercise pressor reflex during ischemic rhythmic handgrip. J Appl Physiol. 1998;84(1):277-83.*
24. *24.Somers VK, Leo KC, Shields R, Clary M, Mark AL. Forearm endurance training attenuates sympathetic nerve response to isometric handgrip in normal humans. J Appl Physiol. 1992;72(3):1039-43.*
25. *Pollock ML, Franklin BA, Balady GJ, et al. AHA Science Advisory. Resistance exercise in individuals with and without cardiovascular disease: benefits, rationale, safety, and prescription: An advisory from the Committee on Exercise, Rehabilitation, and Prevention, Council on Clinical Cardiology, American Heart Association; Position paper endorsed by the American College of Sports Medicine. Circulation. 2000;101(7):828-33.*
26. *Buck C, Donner AP. Isometric occupational exercise and the incidence of hypertension. J Occup Med. 1985;27(5):370-2.*