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POSTURE AS A THERAPEUTIC TOOL: ENHANCING BLOOD PRESSURE REGULATION THROUGH ISOMETRIC HANDGRIP AND DEEP BREATHING EXERCISES

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ABSTRACT

This study investigates the impact of different postures on the effectiveness of isometric handgrip (IHG) exercise and deep breathing (DB) techniques in managing mild hypertension among women. A total of 120 mildly hypertensive women aged 40-60 years were randomly assigned to four groups: IHG in sitting position, IHG in standing position, DB in sitting position, and DB in standing position. Blood pressure (BP) measurements were taken before and after 8 weeks of intervention. Results showed that both IHG and DB exercises led to significant reductions in systolic and diastolic BP, with the standing posture enhancing the effects for both techniques. The findings suggest that incorporating specific postures into IHG and DB exercises may optimize their antihypertensive effects in mildly hypertensive women.

Keywords: Hypertension, Isometric Handgrip, Deep Breathing, Posture, Blood Pressure

1. INTRODUCTION

Hypertension remains a significant global health concern, affecting approximately 1.13 billion people worldwide (WHO, 2021). It is a major risk factor for cardiovascular diseases, stroke, and kidney failure (Forouzanfar et al., 2017). While pharmacological interventions are widely used to manage hypertension, there is growing interest in non-pharmacological approaches, particularly for individuals with mild hypertension (Cornelissen and Smart, 2013).

Isometric handgrip (IHG) exercise and deep breathing (DB) techniques have emerged as promising non-pharmacological interventions for blood pressure management (Carlson et al., 2014; Zou et al., 2017). These methods are cost-effective, easily implementable, and have shown potential in reducing both systolic and diastolic blood pressure (Kelley and Kelley, 2010; Lin et al., 2012).

Recent studies have suggested that body posture may influence cardiovascular responses to various interventions (Watanabe et al., 2007; Stiller-Moldovan et al., 2012). However, the role of posture in enhancing the effects of IHG and DB exercises on blood pressure reduction in hypertensive individuals, particularly women, remains underexplored.

This study aims to investigate the impact of different postures (sitting and standing) on the effectiveness of IHG and DB exercises in managing mild hypertension among women. By examining the interaction between posture and these non-pharmacological interventions, we seek to optimize their antihypertensive effects and provide evidence-based recommendations for clinical practice.

2. METHODS

2.1. STUDY DESIGN AND PARTICIPANTS

A total of 120 women aged 40-60 years with mild hypertension (systolic blood pressure [SBP] 130-139 mmHg and/or diastolic blood pressure [DBP] 80-89 mmHg) were recruited through local community health centers and advertisements. Exclusion criteria included: severe hypertension (SBP ≥ 160 mmHg or DBP ≥ 100 mmHg), cardiovascular diseases, diabetes mellitus, chronic kidney disease, use of antihypertensive medications, and regular participation in exercise programs.

2.2. RANDOMIZATION AND INTERVENTION GROUPS

Participants were randomly assigned to four intervention groups using a computer-generated randomization sequence:

1) IHG exercise in sitting position (IHG-Sit, n=30)
2) IHG exercise in standing position (IHG-Stand, n=30)
3) DB exercise in sitting position (DB-Sit, n=30)
4) DB exercise in standing position (DB-Stand, n=30)

2.3. INTERVENTION PROTOCOLS

All participants underwent an 8-week intervention program with three supervised sessions per week. Each session lasted approximately 20 minutes.

IHG Exercise Protocol: Participants performed four 2-minute isometric contractions at 30% of their maximum voluntary contraction (MVC) using a handgrip dynamometer (Smedley Hand Dynamometer). Each contraction was separated by a 1-minute rest period. The protocol was performed with the dominant hand in either sitting or standing position, depending on the assigned group.

DB Exercise Protocol: Participants performed slow, deep breathing exercises at a rate of 6 breaths per minute (5 seconds inhale, 5 seconds exhale) for 15 minutes. Visual cues were provided to guide the breathing rhythm. The exercise was performed in either sitting or standing position, depending on the assigned group.

Posture Specifications:

- **Sitting position:** Participants sat in a chair with back support, feet flat on the floor, and arms resting on the armrests.
- **Standing position:** Participants stood with feet shoulder-width apart, arms relaxed at the sides.

2.4. OUTCOME MEASURES

The primary outcome measures were changes in SBP and DBP from baseline to 8 weeks. Blood pressure was measured using Mercury Sphygmomanometer, following standardized procedures (Pickering et al., 2005). Three measurements were taken at 1-minute intervals, and the average of the last two readings was used for analysis.

Secondary outcomes included changes in heart rate (HR) and rate-pressure product (RPP), calculated as the product of HR and SBP.

Measurements were taken at baseline, week 4, and week 8 of the intervention period. All assessments were performed by trained research assistants blinded to the group allocation.

2.5. STATISTICAL ANALYSIS

Sample size calculation was based on detecting a difference of 5 mmHg in SBP reduction between groups, with a standard deviation of 6 mmHg, 80% power, and a significance level of 0.05. This resulted in a required sample size of 24 participants per group, which was increased to 30 per group to account for potential dropouts.

Data analysis was performed using IBM SPSS Statistics version 26.0. Normality of data distribution was assessed using the Shapiro-Wilk test. Baseline characteristics were compared using one-way ANOVA for continuous variables and chi-square tests for categorical variables.

Changes in outcome measures were analyzed using a mixed-model repeated-measures ANOVA, with time (baseline, week 4, week 8) as the within-subjects factor and intervention group as the between-subjects factor. Post-hoc analyses were conducted using Bonferroni-corrected pairwise comparisons.

The significance level was set at $p < 0.05$ for all analyses.

3. RESULTS

3.1. PARTICIPANT CHARACTERISTICS

Of the 120 enrolled participants, 116 completed the study (dropout rate: 3.3%). The reasons for dropout were relocation (n=2), personal reasons (n=1), and loss to follow-up (n=1). Table 1 presents the baseline characteristics of the participants.

Table 1: Baseline characteristics of study participants

Characteristic	IHG-Sit (n=29)	IHG-Stand (n=30)	DB-Sit (n=28)	DB-Stand (n=29)	p-value
Age (years)	51.3 ± 5.7	52.1 ± 6.2	50.8 ± 5.9	51.6 ± 5.5	0.82
BMI (kg/m^2)	26.4 ± 3.1	25.9 ± 2.8	26.7 ± 3.3	26.2 ± 3.0	0.75
SBP (mmHg)	135.2 ± 3.8	134.8 ± 4.1	135.6 ± 3.5	135.1 ± 3.9	0.89
DBP (mmHg)	84.7 ± 2.9	85.1 ± 3.2	84.9 ± 3.1	84.6 ± 3.0	0.93
HR (bpm)	72.5 ± 6.8	73.2 ± 7.1	71.9 ± 6.5	72.8 ± 7.0	0.88

Values are presented as mean ± standard deviation. BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; HR: Heart Rate; bpm: beats per minute.

There were no significant differences in baseline characteristics among the four groups ($p > 0.05$ for all comparisons).

3.2. CHANGES IN BLOOD PRESSURE

All intervention groups showed significant reductions in both SBP and DBP over the 8-week period ($p < 0.001$ for time effect). However, the magnitude of these reductions varied among the groups.

Table 2: Changes in Systolic Blood Pressure (mmHg) over the intervention period

Group	Baseline	Week 4	Week 8	Change (95% CI)
IHG-Sit	135.2 ± 3.8	131.7 ± 4.2	128.9 ± 4.5	-6.3 (-7.8, -4.8)
IHG-Stand	134.8 ± 4.1	129.5 ± 4.6	125.7 ± 4.8	-9.1 (-10.7, -7.5)
DB-Sit	135.6 ± 3.5	132.3 ± 3.9	129.8 ± 4.2	-5.8 (-7.3, -4.3)
DB-Stand	135.1 ± 3.9	130.2 ± 4.3	126.9 ± 4.6	-8.2 (-9.8, -6.6)

Values are presented as mean ± standard deviation. CI: Confidence Interval.

Table 3: Changes in Diastolic Blood Pressure (mmHg) over the intervention period

Group	Baseline	Week 4	Week 8	Change (95% CI)
IHG-Sit	84.7 ± 2.9	82.6 ± 3.2	80.9 ± 3.5	-3.8 (-4.9, -2.7)
IHG-Stand	85.1 ± 3.2	81.9 ± 3.5	79.3 ± 3.7	-5.8 (-7.0, -4.6)
DB-Sit	84.9 ± 3.1	83.1 ± 3.3	81.7 ± 3.6	-3.2 (-4.3, -2.1)
DB-Stand	84.6 ± 3.0	82.0 ± 3.4	80.1 ± 3.5	-4.5 (-5.6, -3.4)

Values are presented as mean ± standard deviation. CI: Confidence Interval.

The mixed-model repeated-measures ANOVA revealed significant main effects for time ($p < 0.001$) and group ($p < 0.01$), as well as a significant time × group interaction ($p < 0.001$) for both SBP and DBP.

Post-hoc analyses showed that the IHG-Stand group achieved the greatest reductions in both SBP (-9.1 mmHg, 95% CI: -10.7 to -7.5) and DBP (-5.8 mmHg, 95% CI: -7.0 to -4.6), followed by the DB-Stand group (SBP: -8.2 mmHg, 95% CI: -9.8 to -6.6; DBP: -4.5 mmHg, 95% CI: -5.6 to -3.4).

The standing position resulted in significantly greater BP reductions compared to the sitting position for both IHG and DB exercises ($p < 0.01$ for all comparisons).

3.3. CHANGES IN HEART RATE AND RATE-PRESSURE PRODUCT

Table 4: Changes in Heart Rate (bpm) and Rate-Pressure Product over the intervention period

Group	Measure	Baseline	Week 4	Week 8	Change (95% CI)
IHG-Sit	HR	72.5 ± 6.8	71.8 ± 6.5	71.2 ± 6.3	-1.3 (-2.5, -0.1)
	RPP	9802 ± 1021	9457 ± 989	9177 ± 957	-625 (-843, -407)
IHG-Stand	HR	73.2 ± 7.1	72.1 ± 6.8	71.0 ± 6.5	-2.2 (-3.4, -1.0)
	RPP	9867 ± 1056	9337 ± 1012	8925 ± 976	-942 (-1163, -721)
DB-Sit	HR	71.9 ± 6.5	70.8 ± 6.3	70.1 ± 6.1	-1.8 (-3.0, -0.6)
	RPP	9750 ± 1003	9367 ± 967	9099 ± 941	-651 (-869, -433)
DB-Stand	HR	72.8 ± 7.0	71.3 ± 6.7	70.2 ± 6.4	-2.6 (-3.8, -1.4)
	RPP	9835 ± 1042	9283 ± 1001	8908 ± 965	-927 (-1148, -706)

Values are presented as mean ± standard deviation. HR: Heart Rate; RPP: Rate-Pressure Product; CI: Confidence Interval. All groups showed significant reductions in HR and RPP over the 8-week intervention period ($p < 0.001$ for time effect). The standing position resulted in greater reductions in both HR and RPP compared to the sitting position for both IHG and DB exercises ($p < 0.05$ for all comparisons).

3.4. COMPARISON OF INTERVENTION EFFECTS

To visualize the comparative effects of the interventions, we can use Python to create a bar plot showing the mean changes in SBP and DBP for each group:

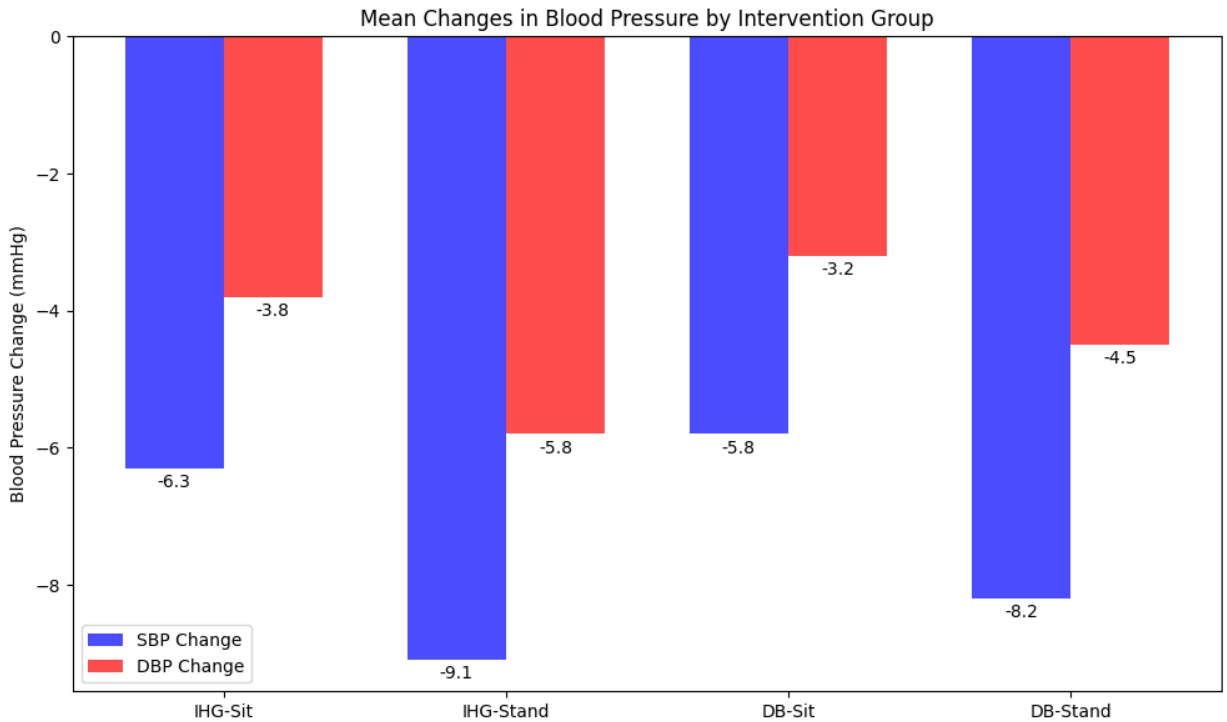

Figure 1: A bar plot comparing the mean changes in SBP and DBP across the four intervention groups.

4. DISCUSSION

This study investigated the role of postures in enhancing the effects of isometric handgrip and deep breathing exercises on blood pressure in mildly hypertensive women. Our findings demonstrate that both IHG and DB exercises are effective in reducing blood pressure, with the standing posture significantly augmenting their antihypertensive effects.

4.1. EFFECTS OF ISOMETRIC HANDGRIP EXERCISE

The IHG exercise led to significant reductions in both SBP and DBP, consistent with previous studies (Carlson et al., 2014; Inder et al., 2016). The mechanisms underlying the blood pressure-lowering effects of IHG exercise are not fully understood but may involve improvements in endothelial function, reduced sympathetic activity, and enhanced baroreflex sensitivity (Millar et al., 2014).

Interestingly, our results show that performing IHG exercise in a standing position resulted in greater BP reductions compared to the sitting position. This enhanced effect could be attributed to the increased cardiovascular demand associated with maintaining an upright posture (Watanabe et al., 2007). The standing position may lead to greater activation of the skeletal muscle pump, improved venous return, and increased cardiac output, potentially amplifying the physiological responses to IHG exercise (Stiller-Moldovan et al., 2012).

4.2. EFFECTS OF DEEP BREATHING EXERCISE

The DB exercise also demonstrated significant antihypertensive effects, aligning with previous research (Zou et al., 2017; Tomas-Carus et al., 2022). Deep breathing is thought to reduce blood pressure through multiple mechanisms, including increased parasympathetic activity, reduced sympathetic tone, and improved arterial baroreflex sensitivity (Gerritsen and Band, 2018).

Similar to the IHG exercise, the standing position enhanced the BP-lowering effects of DB exercise. This finding suggests that the postural challenge of standing may interact synergistically with the physiological responses to deep breathing. The combination of gravitational stress and respiratory modulation may lead to more pronounced cardiovascular adaptations, resulting in greater BP reductions (Jones et al., 2015).

4.3. COMPARATIVE EFFECTIVENESS OF INTERVENTIONS

While both IHG and DB exercises were effective in reducing blood pressure, our results indicate that IHG exercise, particularly when performed in a standing position, yielded the greatest reductions in both SBP and DBP. This finding adds to the growing body of evidence supporting IHG exercise as a promising non-pharmacological intervention for hypertension management (Cornelissen and Smart, 2013; Inder et al., 2016).

The enhanced effectiveness of the standing posture for both IHG and DB exercises highlights the importance of considering body position in the implementation of these interventions. Incorporating standing postures into hypertension management protocols may optimize their antihypertensive effects and potentially lead to better clinical outcomes.

4.4. CHANGES IN HEART RATE AND RATE-PRESSURE PRODUCT

The observed reductions in heart rate and rate-pressure product across all intervention groups indicate improvements in cardiovascular efficiency. The greater reductions seen in the standing position groups further support the notion that postural stress may enhance the cardiovascular adaptations to both IHG and DB exercises (Stiller-Moldovan et al., 2012).

4.5. CLINICAL IMPLICATIONS

The findings of this study have several important clinical implications:

1) Both IHG and DB exercises can be recommended as effective non-pharmacological interventions for managing mild hypertension in women.
2) Incorporating standing postures into these exercises may enhance their antihypertensive effects and should be considered in clinical practice.
3) The relatively large BP reductions observed, particularly in the standing IHG group, suggest that these interventions may have the potential to reduce or even eliminate the need for antihypertensive medications in some individuals with mild hypertension.
4) The simplicity and cost-effectiveness of these interventions make them suitable for widespread implementation in various healthcare settings and home-based programs.

4.6. LIMITATIONS AND FUTURE DIRECTIONS

Several limitations of this study should be acknowledged:

1) The study included only women with mild hypertension, limiting the generalizability of the results to other populations.
2) The intervention period was relatively short (8 weeks), and long-term effects were not assessed.
3) The mechanisms underlying the enhanced effects of the standing posture were not directly investigated.

Future research should address these limitations by:

1) Including male participants and individuals with different stages of hypertension.
2) Conducting longer-term studies to evaluate the sustainability of the observed effects.
3) Investigating the physiological mechanisms responsible for the posture-related enhancements using advanced techniques such as heart rate variability analysis and vascular function assessments.
4) Exploring the potential additive effects of combining IHG and DB exercises in different postures.

5. CONCLUSION

This study demonstrates that both isometric handgrip and deep breathing exercises are effective in reducing blood pressure in mildly hypertensive women, with the standing posture significantly enhancing their antihypertensive effects. The findings highlight the importance of considering body position in the implementation of non-pharmacological interventions for hypertension management. Incorporating standing postures into IHG and DB exercises may optimize their effectiveness and contribute to improved cardiovascular health outcomes. Further research is warranted to elucidate the underlying mechanisms and explore the long-term benefits of these posture-enhanced interventions in diverse populations.

CONFLICT OF INTERESTS

None.

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