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Original Article

Evaluating Brisk Walking, Deep Breathing, and Stress Disclosure for Blood Pressure Reduction in Individuals with Prehypertension and Stress

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ABSTRACT

Background: Prehypertension often coincides with elevated stress levels, exacerbating the condition, and emphasizing the early self-management approach. **Aim:** Evaluate brisk walking, deep breathing, and stress disclosure for blood pressure reduction and perceived stress in individuals with prehypertension and stress. **Methods:** A parallel-group randomized controlled trial was conducted at Minia University Hospital, Egypt, involving 120 individuals aged ≥ 18 years with prehypertension and moderate to high perceived stress levels, randomly assigning them to either control (n=60) or study (n=60) groups. Data collected through structured interview questionnaires [Bio-socio-demographic and Perceived Stress Scale (PSS)], blood pressure (BP), and PSS were re-measured after 2 and 4 weeks. **Results:** Both groups had similar bio-socio-demographics. Significant reductions in BP and PSS were observed in the study group ($p < 0.001$). Study group mean systolic BP changes were -3.4 mmHg (2 weeks) and -7.7 mmHg (4 weeks), with decreases in Diastolic BP (-2.4 and -3.03) and perceived stress scores (-3.43 and -5.73), respectively, while controls had mean Systolic BP changes of -0.83 mmHg (2 weeks) and -1.77 mmHg (4 weeks), with slight reduction in Diastolic BP (-0.63 and -1.6) and slight stress score increases at +0.63 (2 weeks) then reductions at -1.72 (4 weeks). Systolic and diastolic BP changes had strong positive correlations with PSS changes in the study group. **Conclusion**: Brisk walking, deep breathing, and stress disclosure interventions significantly reduced BP and PSS score in individuals with prehypertension and stress. **Recommendation**: Incorporate interventions into care plans. Further research is needed on long-term effects and underlying mechanisms.

Keywords: Blood pressure reduction, Brisk walking, Deep breathing, Perceived stress, Prehypertension, stress.

Introduction:

Prehypertension, a state that is typified by slightly raised blood pressure, is a significant public health issue which impacts a large portion of the global population. As a stage preceding hypertension, prehypertension is a crucial risk factor for cardiovascular diseases as well as stroke **(Balouchi et al., 2022)**. According to the World Health Federation (2023), an estimated 20.5 million people died from cardiovascular diseases. Notably, there is a strong association between increased perceived stress and the presence of prehypertension in adults **(Chadha et al., 2023)**. The progression from prehypertension to hypertension not only heightens the risk of these conditions but also places a significant strain on healthcare systems across the world **(Al-Zahrani et al., 2021)**. Consequently, early intervention strategies that target individuals with prehypertension and stress are of utmost importance.

Non-pharmacological interventions, such as lifestyle modifications, have been recognized as effective strategies for blood pressure (BP) management. Among these, brisk walking, deep breathing, and stress disclosure have shown promise in reducing BP and perceived stress.

Brisk walking, a form of moderate-intensity aerobic exercise, has been associated with significant reductions in BP. The equivalent of at least 150 minutes (two hours and 30 minutes) per week of brisk walking is an easily recommended plan **(Yu, Chang, Wu, Guo, & Xie, 2021)**.

Deep breathing exercises have been shown to have a positive impact on BP and stress. According to a scoping review, deep breathing exercises can significantly lower systolic blood pressure (SBP) as well as diastolic blood pressure (DBP) in patient's hypertensive over 12 weeks, enhance baroreflex sensitivity, and boost heart rate variability (HRV) in both prehypertensive and hypertensive individuals **(Herawati, Mat Ludin, Ishak, & Farah, 2023)**. On the other hand, deep breathing have been demonstrated to trigger the body's relaxation reaction, resulting in decreases in heart rate and BP **(Cahyati & Februanti, 2023)**.

Stress disclosure, the act of verbal expressing **(Munawar & Choudhry, 2021)** or expressive writing **(Mohamed et al., 2023)** about one's stressors, has been linked to improved psychological well-being and stress management.

Despite the promising evidence, most existing studies have examined these interventions in isolation. The potential synergistic effects of combining brisk walking, deep breathing, and stress disclosure remain largely unexplored. Furthermore, much of the current research has focused on individuals with established hypertension, with less attention given to those in the prehypertension stage. This represents a significant gap in the literature, as early intervention in individuals with prehypertension could prevent the progression to hypertension and decrease the risk of cardiovascular diseases.

In response to this research gap, the current study was conducted to contribute to the existing body of knowledge and inform the development of effective, integrative intervention strategies for individuals with prehypertension and stress.

Significance of the study

Prehypertension, considered a precursor to hypertension, is associated with increased perception of stress over time, and consequently an increased risk of developing hypertension **(Spruill et al., 2019)**.

Additionally, a systematic review of the incidence as well as risk factors of prehypertension in Africa present that in adults, the incidence of prehypertension varied from 32.9% to 56.8% **(Malik et al., 2022)**. In Egypt, **Fares and Soliman (2022)** reported that 21.0 percent of the study personnel had hypertension, while 15.31% had high normal BP, which is connected with a 2–3-fold raise in the risk of enhancing hypertension.

These findings provide insights into the prevalence of prehypertension and hypertension in Egypt, highlighting the significant burden of these conditions in the adult population.

Aim of the study

This study aimed to evaluate brisk walking, deep breathing, and stress disclosure for blood pressure reduction in individuals with prehypertension and stress.

Research hypothesis:

H1: Brisk Walking, Deep Breathing, and Stress Disclosure are expected to reduce Blood Pressure in Individuals with Prehypertension and Stress.

Methods:

Research design:

The current study used a Randomized control trial (an experimental design).

Setting:

The current study was conducted in medical inpatient and outpatient units at Minia University Hospital, Egypt.

Sample:

A parallel-group randomized controlled trial was conducted using a simple random sample with a 1:1 allocation ratio among Pre-hypertensive participants. The study recruited a total of 120 participants, with 60 in each group (control and study). Eligible participants were randomly assigned into either the control group (continuing their usual daily activities) or the study group (participants underwent combined programs of brisk walking, deep breathing, and stress disclosure).

Inclusion Criteria:

Those that fit the following requirements for inclusion will be sought out: The following groups of people should be considered: 1) individuals over the age of 18, 2) prehypertensive patients, 3) those who follow physical activity guidelines, and 4) people with moderate to high perceived stress levels as measured by the Perceived Stress Scale (PSS).

Exclusion criteria include individuals with 1) hypertension or on antihypertensive treatment, 2) musculoskeletal limitations (e.g., bone and joint diseases or spinal or limb surgery, or fractures within the last three months), or inability to engage in regular physical activity, 3) Have already developed a cardiovascular disease, 4) confirmed psychological disorder (e.g., depression, anxiety), 5) significant organ illness or malfunction involving the heart, liver, or kidneys, 6) chronic respiratory disease, or 7) uncontrolled active systemic infection.

Calculation of **sample size:**

The sample size was decided using G*Power software with the next parameters:1) effect size: 0.5,

2) significance level (alpha): 0.05, 3) power: 80%. Then it was adjusted for a 10% dropout rate, and a total of 120 participants (60 in each group) were recruited.

Data collection tools:

Two questionnaires were utilized:

1) **Bio-Sociodemographic questionnaire**: A structured questionnaire designed to gather information on demographic characteristics of participants (as age, marital status) as well as relevant medical data (e.g., BP, body mass index).

2) Perceived Stress Scale: The PSS is a widely utilized psychological instrument for evaluating the degree to which personnel perceive situations in their life as stressful. This scale consists of 10 items, each designed to evaluate different aspects of perceived stress. Participants rate their answer on a Likert-type scale, with options ranging from zero to four, where 0 indicates "Never" and 4 indicates "Very Often." For 4 positively items (4, 5, 7, and 8), responses are reversed before summing across all items. The total score can range from zero to forty, with higher scores meaning higher levels of perceived stress. Following the scoring system recommended for the PSS, participants are categorized into different levels of perceived stress: low stress (zero to thirteen), moderate stress (fourteen to twenty-six), and high perceived stress (twenty-seven to forty). Participants with moderate or high-stress levels (scores ranging from 14 to 40) were included in the study **(Ali et al., 2021; Anwer, Manzar, Alghadir, Salahuddin, & Abdul Hameed, 2020)**.

Reliability of the Arabic version of the PSS: The Arabic version of the PSS has undergone rigorous validation studies, affirming its reliability and validity. Research in Jordan with 90 participants revealed satisfactory reliability and validity, with a Cronbach's alpha coefficient of 0.80 and an intra-correlation coefficient of 0.90 for test-retest reliability **(Algaralleh, Altwalbeh, & Alzayyat, 2019)**. Similarly, studies on university students **(Alhalaiqa et al., 2021)** and pregnant/postpartum women **(Khalil et al., 2022)**demonstrated factorial validity and measurement invariance, supporting the Arabic version of the PSS as a reliable measure of stress perception.

Data collection procedure:

Data was collected at three time points: before the study, and at two-week and four-week intervals post-intervention. Two questionnaires (Bio-sociodemographic and perceived stress scale), in Arabic understandable words, were administered via interviews before the intervention.

Blood pressure was measured by Digital sphygmomanometer: (Omron, made in Japan) by a nurse with no knowledge of the study groups. Before each measurement, participants were asked to rest for 5 minutes to ensure a stable physiological state. Blood pressure was primarily measured in the right arm unless the initial reading indicated a higher value in the left arm. During measurements, the participant’s arm was positioned at heart level, and the cuff was securely fitted 2.5 cm above the elbow. Each participant's BP was measured three times at 1-2-minute intervals, and the average was calculated.

Prehypertension was defined as systolic BP

120-139 mmHg and/or diastolic BP 80-89 mmHg, while hypertension was defined as systolic BP equal or more 140 mmHg or diastolic BP equal or more 90 mmHg **(Norris & Beech, 2021)**. Body weight and height measurements (kg/m2) were used to compute the body mass index (BMI), which was then divided into four categories: underweight (BMI less 18.5), normal weight (BMI from 18.5 to 24.9), overweight (BMI from 25to 29.9), and obese (BMI equal or more 30) **(Kela & Nkengbeza, 2022)**.

Ethical consideration:

The study received approval from the Research Ethics Committee of the Faculty of Nursing at Minia University, Egypt (Approval No: REC2022111). The objectives and significance of the study were thoroughly communicated to each participant. Subsequently, informed consent, both orally and in writing, was obtained from participants who agreed to participate. Participants were assured that their participation was voluntary, and they had the right to withdraw from the study at any time. To ensure confidentiality and anonymity, all data were coded appropriately.

Pilot study:

A pilot study was undertaken with ten percent of the total sample (consisting of six personnel from the study group as well as six from the control group) to evaluate the clarity and applicability of the instrument and identify any potential challenges that might arise during the study. Based on the results from the pilot study, adjustments were made to the final version of the study instruments and study procedure steps. Notably, participants include in the pilot study were not included from the study to prevent duplication of data and ensure the integrity of the results.

Study fieldwork

Study Field work included four phases as following: preparatory, participant enrolment, implementation, and evaluation.

In the preparation phase, In the preparatory phase, extensive literature review was conducted to inform the development of data collection tools. Textbooks, academic journals, periodicals, and online resources were utilized to ensure a comprehensive understanding of the research topic. Additionally, logistical arrangements were established by visiting Minia University Hospital's medical units to create recruiting strategies and secure official authority from the appropriate authorities.

During the **participant enrollment phase**, eligible participants were individually interviewed at the outpatient clinic reception or inpatient medical unit to identify those meeting the study's inclusion criteria. Over two months, researchers visited Minia University Hospital four days a week to facilitate participant recruitment. Following a thorough discussion of the study's aim and procedures, informed consent was taken from willing participants. Subsequently, participants were randomly allocated to either the control or study group on a 1:1 basis. A flowchart depicting the enrollment process is presented in Figure 1. The study was conducted from May 2023 to September 2023.

During **the implementation phase**, interventions were administered based on participant allocation. The control group continued their usual daily activities, while the study group engaged in a program comprising brisk walking, deep breathing, and stress disclosure:

1. Brisk walking: Participants walked briskly for thirty minutes, 5 days a week for four weeks. Brisk walking was operationally defined as walking at a consistent walking pace that elevates heart rate and breathing rate, yet remains sustainable for the duration of the activity **(Mak & Wong-Yu, 2021)**. Participants were instructed to walk at a pace that felt moderately challenging but still allowed for conversation. Participants were encouraged to incorporate this exercise regimen into their daily routine, preferably at a time of day when they felt most energetic and stress-free. To measure compliance with the intervention, participants were provided with an activity tracker chart that was evaluated at each subsequent visit.
2. Deep breathing: Participants in the study group underwent training in deep breathing exercises, involving deep inspiration and slow expiration for 5 seconds each, at a rate of 6 breaths per minute **(Jafari et al., 2020)**. They performed these exercises twice daily for 10 minutes, at least five days a week, over four weeks.
3. Stress Disclosure: Daily stress disclosure, through verbal expression (to a trusted one or with any type of voice recorder) or expressive writing (writing on paper), was integrated into the intervention. Participants openly expressed and reflected upon their stressors, emotions, and thoughts related to stressful experiences. Guidelines were provided to ensure consistent engagement, and compliance was assessed through written entries or audio recordings.

In the **outcome evaluation phase**, reductions in BP and perceived stress scores were assessed as primary and secondary outcomes, respectively. The control group remained unexposed to the intervention materials related to the study group, ensuring the integrity of the study's outcomes.

Statistical Analyses

The statistical analyses were performed utilizing SPSS 25 software. The normality of the data distribution was measured using the Kolmogorov-Smirnov test. The mean values of the two groups were compared using both paired t-tests and independent t-tests. The connection between categorical variables was assessed using the chi-square test. It's crucial to note that when one of the variables is binary (binomial), the application of Pearson correlation may not be appropriate. In such instances, for the correlation between a binary variable and a continuous variable, alternative methods such as point-biserial correlation or rank-biserial correlation were conducted. A P-value of low 0.05 was mean statistically significant.

Results:

Table (1) summarizes the socio-demographic characteristics of 60 participants in the study and control groups. The age, gender, marital status, educational level, and income distribution were similar between the two groups without any statistically significant differences. Mean age was comparable, with 37.98 years (SD=13.83) in the study group and 38.30 years (SD=14.07) in the control group. Gender distribution was even, with 50% male and 50% female participants in both groups. The majority of participants were married (75% in the study group, 71.67% in the control group), had attained at least a secondary education (15% elementary, 15% secondary in the study group; 13.33% elementary, 20% secondary in the control group), and reported sufficient income (76.67% in the study group, 78.33% in the control group).

Table (2) demonstrates that the clinical data distribution among study and control group participants showed similar patterns without any statistically significant differences even in the hospital setting (inpatient and outpatient settings). BMI categories had comparable percentages, with the majority falling into the normal weight range (40% study, 41.67% control). Current smokers comprised 16.67% in the study group and 18.33% in the control group, however, the highest proportions reported never smoking (78.33% study, 81.67% control). Around 68.33% and 66.67% reported≥ 6 hours daily sleep duration and 21.67% and 20% reported DM in the study and control groups, respectively. Family history of hypertension also had similar distributions (58.33% study, 56.67% control).

Table (3) shows a notable decrease in SBP in the study group from baseline to post-4 weeks ($p<0.001$), with a substantial increase in the number of participants achieving pressures below 120 mmHg (0 to 38) and a decrease in those with pressures between 120-125 mmHg (34 to 16). Conversely, the control group exhibited a non-significant increase in the number of participants with systolic pressure below 120 mmHg (0 to 7) from baseline to post-4 weeks, however, the mean SBP trended significantly. Importantly, statistical tests showed significant differences in the study group only across different time points, with highly significant p-values ($p<0.001$) between baseline and post-2 weeks and baseline and post-4 weeks, and a significant p-value ($p=0.031$) between post-2 and 4 weeks.

Similarly, the study group presented a significant decrease in participants with DBP < 80 mmHg from baseline to post-4 weeks (14 to 40), with a corresponding decline in those with 80 to 89 mmHg ($p<0.0001$). Conversely, the control group's count of participants with BP < 80 mmHg remained stable, peaking at post-4 weeks (16 to 17) with a P-value of 0.999, although the mean DBP trended significantly. Additionally, the study group exhibited a significant decrease in low-stress levels compared to controls from baseline to post-4 weeks ($p<0.0001$), with significant differences only observed in the study group, notably between baseline and post-4 weeks ($p<0.001$) and baseline and post-2 weeks ($P=0.003$).

Table (4) illustrates a significant increase in the participants of the study group with low-stress levels from baseline to post-4 weeks (0 to 16), with a corresponding decrease in high-stress levels (15 to 0) giving $p<0.0001$. Conversely, in the control group, low-stress levels remained steady, reaching the highest count at post-4 weeks (0 to 2) at P-value= 0.656, however, the mean perceived stress trended significantly. The study group demonstrated a significant decrease in low-stress levels compared to the control group from baseline to post-4 weeks (p<0.0001). Additionally, statistical tests showed significant differences in the study group only across different time points, with highly significant p-values (p<0.001) between baseline and post-4 weeks and significant differences between baseline and post-2 weeks (P=0.003) and between post-2 and 4 weeks ((P=0.046).

Table (5) shows significant reductions in SBP in the study group after 2 weeks and after 4 weeks compared to controls (p < 0.001). Mean changes were -3.4 mmHg and -7.7 mmHg at 2 and 4 weeks, respectively, in the study group, contrasting with -0.83 mmHg and -1.77 mmHg in controls. Perceived stress scores decreased significantly in the study group at both time points (p < 0.001), with mean changes of -3.43 and -5.73 at 2 and 4 weeks, respectively, while controls showed slight increases at + 0 .63±0.49 after 2 weeks and slight reduction at -1.72±0.45 after 4 weeks.

In Table (6), the study group analysis revealed a weak negative correlation between age and SBP change (r = -0.265, p = 0.041), whereas marital status exhibited a moderately moderate negative correlation (r = -0.335, p = 0.009). Conversely, in the control group, diabetes mellitus (DM) showed a moderate negative correlation with changes in perceived stress scores (r = -0.425, p = 0.001), indicating a significant association. Importantly, a significant moderate negative correlation between DBP and 2 variables (age and family history of hypertension) in the control group. No other variables exhibited significant correlations with changes in SBP or perceived stress in either group. Notably, a significant positive correlation was observed between changes in perceived stress scores and changes in both SBP and DBP in the study group (r > 0.80, p < 0.0001).

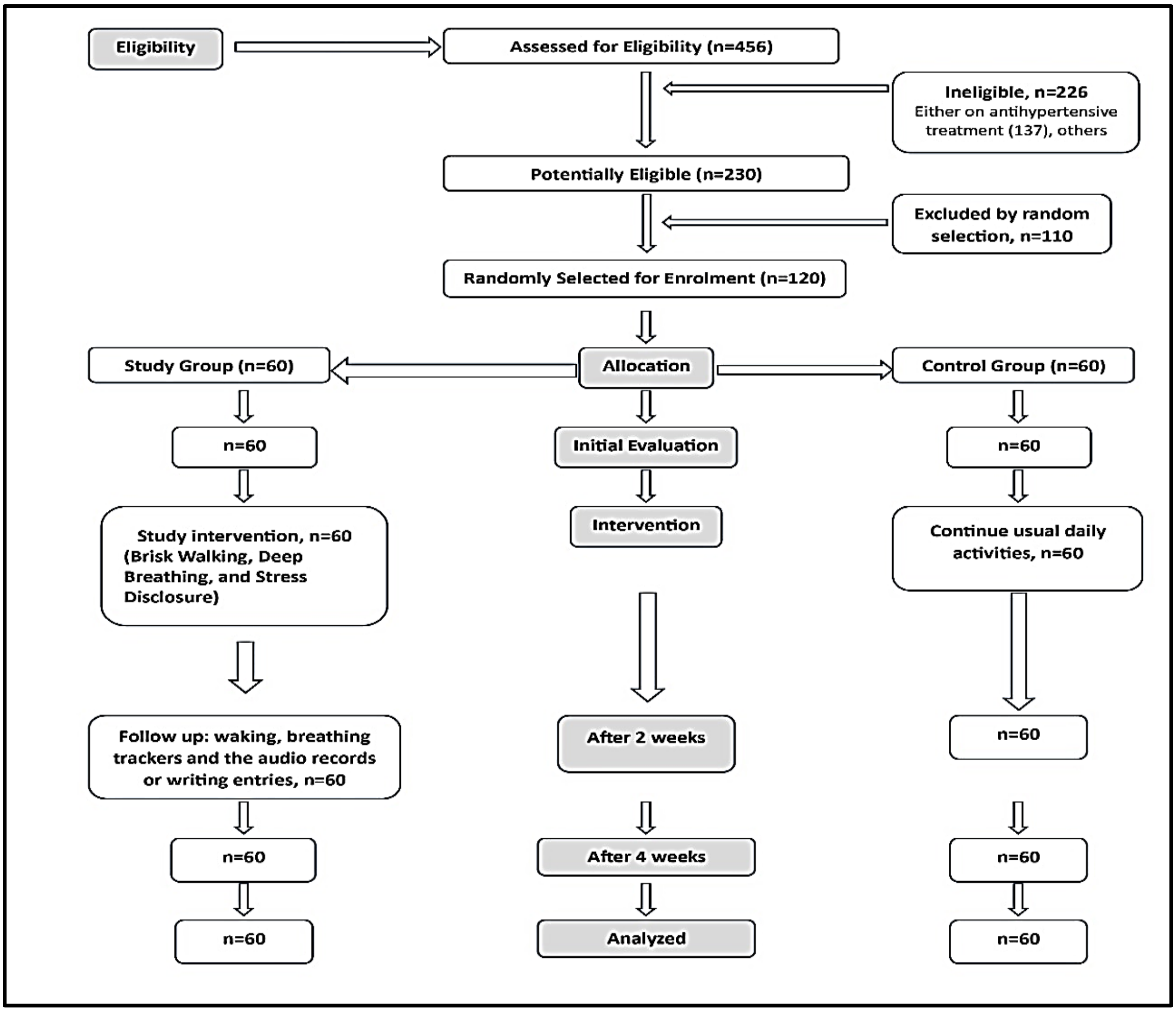

Fig 1 Study Flowchart

Table (1): Distribution of the studied participants according to their socio-demographic characteristics (n=120):

Variables	Study Group (n=60)		Control Group (n=60)		Test of Sig.	P - Value
	No	%	No	%		
Age (yrs)						
18 - <30	23	38.33%	23	38.33%	X^2= 0.5	0.779
30 -<50	23	38.33%	20	33.33%		
≥ 50	14	23.33%	17	28.33%		
Mean ± SD	37.98 ± 13.83		38.30 ±14.07		t=0.124	0.901
Gender						
Male	30	50%	31	51.67%	X^2=0.033	0.855
Female	30	50%	29	48.33%		
Marital status						
single	12	20%	14	23.33%	X^2=0.199	0.905
Married	45	75%	43	71.67%		
widowed	3	5%	3	5%		
Educational Level						
illiterate	6	10%	9	15%	X^2=3.108	0.553
read and write	12	20%	6	10%		
elementary	9	15%	8	13.33%		
secondary	9	15%	12	20%		
bachelor or higher	24	40%	25	41.67%		
Income						
not enough	6	10%	5	8.33%	X^2=0.102	0.95
enough	46	76.67%	47	78.33%		
enough and save	8	13.33%	8	13.33%		

Table (2): Distribution of the studied participants according to their clinical data (n=120):

Variables	Study Group (n=60)		Control Group (n=60)		Test of Sig.	P - Value
	No	%	No	%		
Hospital Sitting						
Inpatient	30	50%	29	48.33%	X^2=0.033	0.855
Outpatient	30	50%	31	51.67%		
Body Mass Index (Kg/m^2)						
Under-weight: 18.5 - 24.9	24	40%	25	41.67%	X^2=0.43	0.934
Normal weight: 25- 29.9	23	38.33%	20	33.33%		
Overweight: 30-34.9	4	6.67%	4	6.67%		
Obese: ≥ 35	9	15%	11	18.33%		
Mean ± SD	27.55 ± 6.27		27.94 ± 6.81		t=0.322	0.748
Smoking		0%		0%		
Never	47	78.33%	49	81.67%	fisher=2.72	0.355
Past history	3	5%	0	0%		
Current smoker	10	16.67%	11	18.33%		
Daily sleep duration						
< 6 hours	19	31.67%	20	33.33%	X^2=0.0377	0.846
≥ 6 hours	41	68.33%	40	66.67%		
Diabetes mellites						
Yes	13	21.67%	12	20%	X^2=0.051	0.822
No	47	78.33%	48	80%		
Family history of Hypertension						
Yes	35	58.33%	34	56.67%	X^2=0.0338	0.854
No	25	41.67%	26	43.33%		

Table (3): Distribution of the studied participants according to their levels of blood pressure throughout intervention periods of the study(n=120):

	Study group (n=60)				Control group (n=60)			
	Baseline	Post 2wks	Post 4wks	Test (p-value)	Baseline	Post 2wks	Post 4wks	Test (p-value)
Systolic pressure								
<120	0	25	38	59.624 P <0.0001**	0	1	7	9.799 P =0.279
120-125	34	14	16		33	32	27	
126-130	17	15	5		17	19	18	
130-135	4	6	1		4	3	5	
136-139	5	0	0		6	5	3	
Mean ± SD	125.8±5.7	122.4±5.8	118.0±5.7	F=1661.9 P<0.0001	126.1±6.0	125.3±5.4	124.4±5.1	F= 47.8 P<0.001
Baseline, Post 2weeks				X^2= 35.17 P<0.0001**				X^2= 0.642 P=0.958
Post 2 weeks & post 4 weeks				X^2= 10.048 P=0.039*				X^2= 5.019 P=0.2854
Baseline, Post 4 weeks				X^2= 53.187 P<0.0001**				X^2= 7.177 P=0.1269
Diastolic pressure								
<80	14	39	40	29.864 P <0.0001**	16	16	17	0.0612 P =0.999
80-85	34	16	17		33	33	32	
86-89	12	5	3		11	11	11	
Mean ± SD	80.6±5.7	78.13±5.8	77.5±5.9	F=733.8 P<0.0001	81.5±5.2	80.6±5.3	79.9±5.3	F= 677.8 P<0.001
Baseline, Post 2weeks				X^2= 21.15 P<0.0001**				X^2=0.00 P=1.00
Post 2 weeks & post 4 weeks				X^2= 0.543 P=0.762				X^2= 0.046 P=0.978
Baseline, Post 4 weeks				X^2= 23.59 P<0.0001**				X^2= 0.046 P=0.978

***Significant at p <0.05 **High significant at p <0.001 X: Chi-square f: Repeated-Measures ANOVA**

Table (4): Distribution of the studied participants according to their levels of Perceived stress throughout intervention periods of the study (n=120):

	Study group (n=60)				Control group (n=60)			
Perceived stress	Baseline	Post 2wks	Post 4wks	Test (p-value)	Baseline	Post 2wks	Post 4wks	Test (p-value)
Low	0	7	16	31.599 P< 0.0001	0	0	2	X^2= 2.436 P= 0.656
Moderate	45	49	44		46	46	48	
High	15	4	0		14	14	10	
Mean ± SD	22.3±4.5	18.87±4.5	16.6±4.5	F=1724.3 P<0.001	22.2±4.5	22.9±4.5	20.5±4.5	F=439.7 P <0.001
Baseline, Post 2weeks				X^2= 11.4 P=0.0034*				X^2=0.00 P=1.00
Post 2 weeks & post 4 weeks				X^2= 6.2 P=0.0457				X^2= 1.6 P=0.437
Baseline & Post 4 weeks				X^2=27.5 p<0.0001**				X^2= 1.7 P=0.437

***Significant at p <0.05 **High significant at p <0.001 X: Chi square f: Repeated-Measures ANOVA**

Table (5): comparison of changes in blood pressure and perceived stress after 2 weeks and 4 weeks of the intervention period (n=120):

items	Study Group Mean ± SD	Control Group Mean ± SD	T	p-value
Change in Systolic Blood Pressure				
Post 2 weeks	-3.4±0.5	-0.83±0.92	18.889	< 0.001**
Post 4 weeks	-7.7±1.3	-1.77±1.4	23.818	< 0.001**
Change in Diastolic Blood Pressure				
Post 2 weeks	-2.4±0.49	-0.63±0.49	20.003	< 0.001**
Post 4 weeks	-3.03±0.71	-1.6±0.49	12.577	< 0.001**
Change in Perceived Stress score				
Post 2 weeks	-3.43±0.51	+ 0 .63±0.49	45.191	< 0.001**
Post 4 weeks	-5.73±0.84	-1.72±0.45	32.547	< 0.001**

$**$High significant at p <0.001 t: student t-test

Table (6): Correlation between socio-demographic characteristics and clinical data of the studied participants with their change in Blood Pressure and perceived stress post 4 weeks

variables		Change in Systolic Blood Pressure		Change in Diastolic Blood Pressure		Change in Perceived Stress score	
		Study Group	Control Group	Study Group	Control Group	Study Group	
Socio-demographics							
Age (yrs)	*r*	-0.265*	0.113	-0.210	-0.259*	-0.199	-0.146
	P-value	0.041	0.389	0.108	0.046	0.128	0.267
Gender	*r*	-0.063	-0.247	0.000	0.044	-0.063	0.090
	P-value	0.634	0.057	1.000	0.739	0.634	0.494
Marital status	*r*	-0.335**	0.021	-0.219	-0.211	-0.243	-0.245
	P-value	0.009	0.872	0.093	0.106	0.061	0.059
Educational Level	*r*	0.134	-0.140	-0.018	0.139	0.011	0.019
	P-value	0.306	0.285	0.891	0.288	0.932	0.884
Income	*r*	-0.011	-0.138	-0.052	-0.067	-0.019	-0.092
	P-value	0.932	0.293	0.692	0.610	0.883	0.485
Clinical Data							
Body Mass Index (Kg/m^2)	*r*	-0.236	-0.208	0.002	0.071	-0.039	-0.133
	P-value	0.070	0.110	0.985	0.588	0.770	0.311
Smoking	*r*	-0.018	0.065	0.046	0.097	-0.039	0.017
	P-value	0.889	0.670	0.727	0.462	0.767	0.897
Daily sleep duration	*r*	-0.009	-.049	-0.149	0.049	-0.181	-0.008
	P-value	0.948	0.711	0.257	0.712	0.537	0.949
DM	*r*	-0.192	0.054	0.032	-0.052	-0.171	-0.425**
	P-value	0.141	0.681	0.806	0.649	0.190	0.001
Family history of Hypertension	*r*	0.020	0.143	-0.129	-0.301*	-0.039	0.173
	P-value	0.879	0.275	0.327	0.019	0.797	0.185
Stress							
Change in Perceived Stress score	*r*	0.893**	0.215	0.836**	-095		
	P-value	<0.0001	0.099	<0.0001	0.472		
Change in Diastolic blood pressure	*r*	0.808**	-0.178				
	P-value	<0.0001	0.173				

Interpretation of r: Weak (0.1-0.24); Intermediate (0.25-0.7); Strong (0.75-0.99) *Significant at p <0.05 **High significant at p <0.001

Discussion

The study aimed to fill a gap in the literature concerning non-pharmacological interventions for BP and stress reduction among individuals with prehypertension and moderate to high perceived stress.

Previous research has suggested various strategies to decrease BP and stress, including lifestyle modifications and stress management techniques. However, there remains a noticeable gap in studies focusing specifically on individuals with prehypertension and stress, indicating a need for further investigation into tailored interventions for this population. Furthermore, the combined effect of brisk walking, deep breathing, and stress disclosure has not been thoroughly investigated in this context, making this study unique in its approach.

Related to the socio-demographic characteristics of participants, the study results indicated that the study and control groups were well-matched in terms of age, gender, marital status, educational level, and income distribution. These findings are consistent with last research, suggesting that the sample is representative of individuals with prehypertension and moderate to high perceived stress levels. Previous studies have emphasized the importance of considering socio-demographic factors when assessing intervention effectiveness on BP reduction and stress management. Age, gender, marital status, and educational level have been shown to influence hypertension prevalence and management, as well as stress levels and coping mechanisms **(Boima et al., 2023; Palagiri, Bala, Pandve, Polamuri, & Katkuri, 2023; Sarkar et al., 2019)**. Therefore, the homogeneity of our sample in these aspects enhances the internal validity of the study and strengthens the generalizability of the findings.

Similarly, for the clinical characteristics, the study findings demonstrate that BMI, smoking status, sleep duration, DM, and family history of hypertension were similar between the study and control groups. These clinical factors are known to influence BP levels and stress management outcomes **(Adeke, Chori, Neupane, Sharman, & Odili, 2022; Sarkar et al., 2019)**. The comparable distribution of BMI categories suggests that obesity was not a confounding factor in increased BP in our study. Likewise, the consistent proportions of current smokers and non-smokers indicate that smoking status did not significantly influence the outcomes of the interventions. Additionally, the similar percentages of participants reporting adequate sleep duration in both groups suggest a balanced relationship between sleep duration and stress levels. The comparable prevalence of DM and family history of hypertension between groups further strengthens the study's validity, as these factors can impact BP regulation and stress response.

Moving on to the changes in SBP levels observed over the intervention periods, the current study findings align with previous research demonstrating the efficacy of lifestyle modifications in lowering BP and improving stress levels among individuals with prehypertension and also other studies for those with accompanied by stress.

Indeed, numerous studies have demonstrated the efficacy of various lifestyle modification strategies in reducing SBP. For instance, a review titled "Comprehensive impact of lifestyle reform, adherence, as well as related factors on hypertension control: A review" highlights the significance of preserving healthy lifestyle choices, including BMI, food, smoking, drinking, excreting salt, and engaging in sedentary behavior. These changes have the potential to decrease blood pressure by 3.5 mm Hg and lessen the risk of cardiovascular disease over a minimum 3-month period **(Ojangba et al., 2023)**.

In another study involving patients with resistant hypertension, a four month program of modification the lifestyle involving dietary counselling, behavioural management of weight , as well as exercise resulted in significant decreasing in the clinic also ambulatory SBP (–10.2 to –14.9 mmHg) and DBP (4.7 to –7.2 mmHg) **(Blumenthal et al., 2021)**.

Additionally, there are recent studies that targeted stress to reduce BP. For example, a study at Brown University found that participants who underwent a nine-week Mindfulness-Based BP Reduction program demonstrated significant enhancement in self-regulation skills as well as significantly decreased BP readings. Particularly, participants with stage 2 uncontrolled hypertension experienced a mean 15.1-mmHg decreased in SBP and a 7.5 mmHg decreased in DBP after one year of follow-up **(Loucks et al., 2019)**.

These studies highlight the potential of lifestyle modifications in managing BP. However, the effectiveness of these strategies can vary in the period of intervention and reduction in BP. The results of the current study are promising in that it showed a greater reduction in SBP in a relatively short period and with easily applicable approaches.

The significant reductions in SBP observed in the study group highlight the effectiveness of the combined interventions. From the scientific side, brisk walking, deep breathing, and stress disclosure likely synergistically contributed to these reductions by promoting relaxation, enhancing cardiovascular fitness, and providing emotional support.

Conversely, the control group exhibited only marginal changes in SBP, emphasizing the limited effectiveness of routine daily activities in mitigating BP levels among individuals with prehypertension. These results underscore the potential of non-pharmacological interventions as adjunctive therapies for individuals with prehypertension and stress.

Similarly, the changes in perceived stress levels observed over the intervention periods align with last studies emphasizing the bidirectional relation between stress as well as hypertension. The significant reduction in perceived stress levels in the study group suggests that the combination of interventions was effective in alleviating stress symptoms among individuals with prehypertension.

Conversely, the control group exhibited relatively stable stress levels throughout the intervention period, highlighting the limited impact of routine daily activities on stress management in this population. These findings underscore the potential of multifaceted interventions in addressing both physiological and psychological aspects of prehypertension.

Lastly, the correlation analysis results provide valuable insights into the complex relationships between demographic variables, stress, and BP in individuals with prehypertension. A weak negative correlation between age and changes in SBP change observed in the study group and changes in DBP in the control group. These align with previous studies suggesting that advancing age is associated with higher BP levels **(Cheng et al., 2022; Li et al., 2023; Rahimi et al., 2021)**. While the correlation is modest, it underscores the need for targeted interventions to mitigate age-related increases in BP among individuals with prehypertension and raises the question of how the current study approach could be tailored to different age groups to manage BP effectively.

Moreover, the moderately strong negative correlation between marital status and SBP change in the study group is intriguing. Previous research has proposed that social support and marital satisfaction may influence BP regulation **(Harding et al., 2022; Ramezankhani, Azizi, & Hadaegh, 2019)**. The negative correlation suggests that unmarried individuals may experience greater BP reductions, possibly due to differences in stress levels or lifestyle factors between married and unmarried individuals.

Conversely, in the control group, the moderate negative correlation between DM and changes in perceived stress scores is noteworthy. Individuals with diabetes often experience higher stress levels due to the demands of managing their condition, which could contribute to the observed negative correlation. This finding highlights the importance of addressing stress management strategies as part of diabetes care to improve overall well-being.

To the best of knowledge of the study's researchers, while there are numerous studies on the relationship between DM and stress, the specific correlation between DM and changes in perceived stress scores in prehypertensive patients is not well-documented. However, some studies have shown that stress can influence metabolic control in DM patients. For example, a study found that the problem-focused coping method and age were negatively correlated with perceived stress, while the emotion-focused coping method and perceived stress were positively correlated with BMI, number of accompanying chronic diseases, insulin use period, and waist circumference **(Bakan & Inci, 2021)**. Another study showed that depression and anxiety, which can be related to perceived stress, are common psychiatric complications affecting patients with DM **(Woon et al., 2020)**. Further research is required to explore the specific relation between DM as well as changes in perceived stress scores in prehypertensive patients.

Additionally, the current study revealed a significant moderate negative correlation between DBP and family history of hypertension) in the control group. To underscore that, previous studies showed that family history is an impact factor in hypertension **(Kanchan et al., 2023; Queiroz et al., 2022)**. Furthermore, research has connected a familial history of hypertension to additional heart disease and stroke risk factors, such as excessive body fat, high cholesterol, and heightened sensitivity to the effects of salt on blood pressure **(Ambaw Kassie et al., 2023)**.

Intriguingly, the study group exhibited a significant and robust positive correlation between changes in perceived stress scores and changes in SBP. However, to the best of the researchers' knowledge, there are no specific studies or meta-analyses that demonstrate a correlation between changes in perceived stress scores and changes in SBP in prehypertensive patients.

To underscore this point, a study conducted by **Tanna and Khatri (2021)** in the International Journal of Recent Innovations in Medicine and

Clinical Research found a moderate correlation between PSS scores and SBP. This finding underscores the interconnectedness of psychological and physiological factors in BP regulation, emphasizing the importance of incorporating stress management strategies in BP management.

Limitations of the study:

Despite the promising findings, it is essential to acknowledge the limitations of our study, including the relatively short duration of the intervention period and the single-centre design. Additionally, the reliance on self-reported measures of perceived stress.

Conclusion

This study contributes to the existing literature by providing promising findings on the effectiveness of brisk walking, deep breathing, and stress disclosure interventions in reducing BP and perceived stress levels among individuals with prehypertension and stress. The findings underscore the potential of multifaceted interventions in the early mitigation of hypertension in its preceding stage in this population. However, further research is needed to elucidate the underlying mechanisms and long-term effects of these interventions.

Recommendations

Healthcare practitioners should consider incorporating brisk walking, deep breathing, and stress disclosure interventions into routine care plans for individuals with prehypertension and stress to optimize BP management and overall well-being. Future research should explore the long-term effects of these interventions in larger and more diverse populations to validate their efficacy and inform clinical practice. Additionally, further investigation into the mechanisms underlying the observed reductions in BP and stress levels is warranted to optimize intervention strategies and improve cardiovascular outcomes. Moreover, the reliance on self-reported measures of perceived stress may introduce bias and limit the accuracy of the results. Therefore, future studies should consider incorporating objective measures of stress to enhance the robustness of findings.

Conflict of interest:

None

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