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ORIGINAL ARTICLE

Breathing Exercise and High-Intensity Bodyweight Interval Training Intervention Among Hypertensive Individuals: Study Protocol and The Preliminary Finding

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ABSTRAK

Senaman adalah bahagian penting dalam rawatan bukan farmakologi bagi individu dengan prahipertensi, hipertensi atau mereka yang menerima rawatan antihipertensi. Untuk kesihatan optimum, orang dewasa yang lebih tua harus melakukan 150-300 minit aktiviti aerobik ringan hingga sederhana atau 75-150 minit aktiviti aerobik berat setiap minggu mengikut saranan semasa. Kajian kawalan rawak selama 14 minggu telah dijalankan dengan 87 peserta yang berusia lebih daripada 30 tahun, mengalami hipertensi, indeks jisim badan (BMI) 18.5-24.99 kg/m^2, dan tidak aktif secara fizikal. Peserta telah dibahagikan kepada empat kumpulan; kawalan (n:24), latihan pernafasan (BE) (n:21), latihan interval berintensiti tinggi (HIIT) (n:20), dan Campuran (n:22). Kumpulan BE melakukan latihan pernafasan perlahan mengikut protokol 8 set selama 10 minit. Kumpulan HIIT mengikuti protokol senaman selama 40 minit. Kumpulan campuran melakukan kedua-duanya manakala kumpulan kawalan mengekalkan aktiviti harian. Penilaian awal dilakukan pada Minggu 0,

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dengan susulan pada Minggu 6, 10, dan 14. ANOVA berulang digunakan untuk membandingkan kumpulan dengan mengambil kira tahap signifikan alfa pada p = 0.05. Data awal diperoleh daripada 96 peserta, dengan usia purata 59.4 ± 9.1 tahun. Majoriti adalah wanita (87.5%), dengan indeks jisim badan purata 22.7 ± 1.6 kg/m², tekanan darah sistolik rehat 156 ± 14 dan tekanan darah diastolik 91 ± 10 mmHg. Penemuan awal ini menunjukkan tiada perbezaan yang signifikan dalam skor tekanan darah sistolik, kecergasan kardiorespiratori, kekuatan otot, tahap kortisol dan 'C-reactive protein' (CRP) dalam keempat-empat kumpulan. Seramai 21% peserta termasuk dalam kategori prahipertensi, 38% termasuk dalam tahap 1 hipertensi dan 42% termasuk dalam tahap 1 hipertensi. Kami meramalkan bahawa intervensi dengan senaman gabungan akan memberikan lebih banyak manfaat daripada intervensi lain.

Kata kunci: Hipertensi; latihan pernafasan; latihan jeda intensiti tinggi menggunakan berat badan

ABSTRACT

Exercise is an important part of non-pharmacological treatment for people with prehypertension, hypertension, or those on antihypertensive medication. For optimum health, older adults should engage in 150-300 minutes of light to moderate aerobic activity or 75-150 minutes of strenuous aerobic activity per week, according to current recommendations. A 14-week randomised controlled trial was conducted with 87 participants, whose age is greater than 30 years, suffering from hypertension, with a body mass index (BMI) 18.5-24.99 kg/m² and physical inactivity. Participants were assigned to four groups: control (n:24), breathing exercise (BE) (n:21), high-intensity interval training (HIIT) (n:20), and Mixed (n:22). The BE group practiced slow breathing exercises following an 8-sets protocol for 10 minutes. The HIIT group followed a 40-minutes exercise protocol. The mixed group performed both types of exercise, while the control group maintained their daily activities. Initial assessments were conducted at Week 0, with follow-ups at Weeks 6, 10, and 14. Repeated ANOVA was used to compare the groups, considering an alpha level of significance at p = 0.05. Preliminary data were obtained by 96 participants, with an average age of 59.4 ± 9.1 years. The majority were women (87.5%), with an average body mass index of 22.7 ± 1.6 kg/m², a resting systolic blood pressure of 156 ± 14 and a diastolic blood pressure of 91 ± 10 mmHg. These preliminary findings showed no significant differences in systolic blood pressure scores, cardiorespiratory fitness, muscle strength, cortisol levels or C-reactive protein among the four groups. As many as 21% of participants included in prehypertension category, 38% included stage 1 hypertension and 42% included stage 2 hypertension. We predict that interventions with combined exercise will provide greater benefits than other interventions.

Keyword: Breathing exercise; high-intensity bodyweight interval training; hypertension

INTRODUCTION

Hypertension, the most prevalent non-communicable disease, continues to pose an important health risk on a global scale (Bloch 2016; Chobanian et al. 2003; Mills et al. 2020). Its prevalence rate has increased globally by 5.2% over the past 10 years (Bloch 2016; Mills et al. 2020). From 25.8% in 2013 to 34.1% in 2018, the prevalence rate of hypertension has drastically increased in Indonesia (Riskesdas 2028). Approximately 40% of adults worldwide have elevated blood pressure (BP), which causes 9.4 million deaths annually, primarily from heart disease and stroke. Therefore, it is important to manage high blood pressure effectively to reduce cardiovascular morbidity and mortality due to this condition. Therapeutically, there are both pharmaceutical and non-pharmacological methods for managing high blood pressure (Daskalopoulou et al. 2015; Mancia et al. 2013). Lifestyle modification is one of the first line non-pharmacological treatments for hypertension in which regular aerobic exercise is shown to be a key intervention for both prevention and treatment of high blood pressure. (Hanssen et al. 2022).

Exercise is a crucial component of the non-pharmacological approach for those with prehypertension (Ash et al. 2017; Daskalopoulou et al. 2015; Mancia et al. 2013) and hypertension, and/or under antihypertensive medication (Börjesson et al 2016; Daskalopoulou et al. 2015; Mancia et al. 2013; Pescatello et al. 2015). According to Whelton et al. (2017), both high-intensity interval training (HIIT) or intermittent bursts of vigorous activity separated by rest intervals or low-intensity and moderate-intensity exercise have been used to lower blood pressure in various populations (Hussain et al. 2016). HIIT and moderate-intensity continuous training (MICT) exhibited comparable benefits on resting systolic blood pressure (SBP) and diastolic blood pressure (DBP) in patients with hypertension and prehypertension. When it comes to lowering SBP during daytime monitoring, HIIT is superior to MICT (Li et al. 2022; John et al. 2022). Systolic and diastolic blood pressure has been reduced by 3.8 ± 2.8 mmHg and 2.9 ± 2.2 mmHg respectively among participants who received HIIT intervention. Comparatively, participants who received MICT saw non-significant drops in diastolic blood pressure by 1.5 ± 3.10 mmHg (John et al. 2022). Harris (2023) stated that isometric exercise, which involves contracting muscles to hold the body in a motionless position, is best for lowering blood pressure at rest, according to results from 270 randomised clinical trials involving 15,827 participants. Additionally, according to current recommendations, older persons should perform at least 150-300 minutes of low-to-moderate level or 75-150 minutes of vigorous level aerobic activity per week to reap the biggest health benefits (Piercy et al. 2018). Aerobic exercise regimens must be carried out regularly to be successful, and older persons frequently have a low long-term commitment to such therapies (Rivera-torres et al. 2019). The most significant obstacles to MICT are tediousness and high time-consumption (Hoare et al. 2017; Othman et al. 2022). Based on those restrictions, exercise techniques that may be carried out more quickly, like HIIT, emerge as an intriguing alternative for older persons and may help with training compliance.

HIIT is becoming increasingly popular as an alternative to exercise for people with hypertension, in addition to effectively lowering blood pressure, there are many other benefits that can be obtained. Several studies stated that HIIT was superior to MICT in improving cardiorespiratory fitness in patients with cardiovascular disease (e.g. coronary heart disease, heart failure, hypertension) (Costa 2018; Delgado Floody et al. 2020; Liou et al. 2016; Weston et al. 2014). HIIT, performed in a group setting, has been reported to be more pleasurable and more improved in quality of life (QoL) than MICT (Molmen-Hansen et al. 2012; Wisloff et al. 2007). In particular, exercise is suggested as an important mediator to reduce long-term systemic inflammation, given that physical inactivity is associated with increased chronic systemic inflammation (CSI) and disease (You et al. 2013). Studies have shown that HIIT exercise can lead to the control or reduction of inflammatory factors if performed over a long period of time, although in the short and acute term, it may be different and increase inflammation (Zwetsloot et al. 2014), which is indicated by a decrease in C-reactive protein (CRP) (Collier et al. 2009; Lamina & Okoye 2012; Tjønna et al. 2008), IL-6 at rest (Mendham et al. 2014), and improved glycemic control (Andersen et al. 2014). It is still unclear about the effect of HIIT on cortisol levels, some claim HIIT increases cortisol levels (Zar et al. 2021), while others report that it lowers cortisol levels (Irandoust & Taheri 2019).

Another non-pharmacological approach is breathing exercises (BEs). Hypertensive people frequently exhibit shallow breathing, which causes the blood's level of carbon dioxide to increase and leads to respiratory acidosis. Proper breathing involves a wide, deep, and gradual inhale that involves using both nostrils. It should be stressed that exhaling through the lips should be slower and should take twice as long as inhaling. Regular BEs are known to improve cardiovascular and respiratory functions, lower sympathetic activity, reduce the body's response to stress and strain, and enhance both physical and mental health (Naik et al. 2018; Russo et al. 2017; Yau & Loke 2021; Zaccaro et al. 2018).

Slow breathing techniques can help strengthen the interaction between autonomic, cerebral, and psychological flexibility, linking parasympathetic activity and the central nervous system related to emotional control and well-being. Through vagal activity, slow breathing techniques seem to support the dominance of the parasympathetic autonomic system over the sympathetic system (Ma et al. 2017; Mangnon et al. 2021; Yau & Loke 2021). Vagal activity is enhanced by slow breathing, which lowers the resting heart rate and blood pressure. This has a positive impact on the vagal tone and a negative impact on sympathetic discharge. Recordings from the cardiac autonomic nerves show that neuronal activity rises in the sympathetic during inspiration and vagal fibres during expiration (Adhana et al. 2013; Gerritsen & Band 2018; Koeppen 2009; Laborde et al. 2021).

These responses are manifested in the rise and fall of heart rate during the respiration processes. Slow deep breathing potentially serves as an alternative choice because it can be done independently, and it is easier to practice than other non-pharmacological therapies. Furthermore, it does not require specific setup or equipment. Both HIIT and slow deep BE can be packaged together and administered at the community level. Previous systematic review reported, community-based intervention among hypertensive individuals was cost-effective and has potential to reduce the hypertension related healthcare burden (Wan Ibadullah et al. 2023). Community-based intervention would especially benefit the rural population. It is crucial to target this group of individuals who are residing in a rural area as they are often being neglected and at the same time they are also the group with higher risk for hypertension (Ismail et al. 2023).

Previous studies independently reported the positive effect of HIIT and BE modalities in reducing blood pressure. We designed this study to determine the effect of these two modalities when they were administered together. We present our study protocol and preliminary findings in this manuscript.

The objective of this study was to determine the effectiveness of a combined HIIT and BEs protocol in reducing blood pressure and improving the cardiorespiratory fitness of patients with hypertension. We hypothesised that this intervention would reduce blood pressure (SBP, DBP) and heart rate (primary outcomes), and improve physical fitness (cardiorespiratory fitness and muscle strength), psychological parameters (QoL, level of stress), and biochemical parameters (cortisol, interleukin-6, CRP) (secondary outcomes).

MATERIALS AND METHODS

Study Design

This study was planned to be a 10-week randomised controlled trial involving patients diagnosed with hypertension. Participants were continuously recruited from the Health Activity Center (Kartasura region, Central Java, Indonesia).

Ethical approval has been obtained from the Ethics Committee of Universiti Kebangsaan Malaysia (JEP-2019-461). It was also registered with the Thai Clinical Trials Registry (TCTR20230707003) (https://www.thaiclinicaltrials.org/show/TCTR20230707003).

Sample Size Calculation

A priori power analysis (Cohen 1988) using G*power 3.1 is being used to calculate the required sample size for this study. The sample size is being calculated through an F-test ANOVA repeated measure within-between interactions, with a type 1 error rate of 5% (alpha-level 0.05) and 95% power. F Effect size of 0.25 (medium effect size) was adopted for this study (Cohen 1988) as there was no similar study with effect size on the local population published currently. Assuming an attrition rate of 50 % for the HIIT training and BEs, the target sample size was n=92 participants.

G Power calculation protocol

F tests - ANOVA: Repeated measures, within-between interaction
Analysis: A priori: Compute required sample size

Input:
Effect size f = 0.25
α err prob = 0.05
Power (1-β err prob) = 0.95
Number of groups = 4
Number of measurements = 3
Corr among rep measures = 0.5
Nonsphericity correction = 1

Output:
Noncentrality parameter λ = 22.5000000
Critical F = 2.1805636
Numerator df = 6.0000000
Denominator df = 112
Total sample size = 60

Inclusion and Exclusion Criteria

The inclusion criteria were: (i) age greater than 30 years old; (ii) patients with diagnosed hypertension, i.e., SBP >130 mmHg and/or DBP >80 mmHg in any stage; (iii) body mass index (BMI) 18.5 - 24.99 kg/m^2; (iv) all the subjects will be considered not active according to the International Physical Activity Questionnaire (IPAQ), currently not participating in any type of regular exercise training for at least 3 months prior to being recruited for this study; and (v) patients who are ready to do the exercise (Participants will fill out the Physical Activity Readiness Questionnaire, PAR-Q).

The exclusion criteria were: (i) uncontrolled hypertension, chronic heart disease, diabetes, myocardial infarction, unstable angina, and renal disease, orthopaedic conditions that affect the ability to participate in exercise programs; (ii) currently receiving treatment with steroids, hormones, or cancer chemotherapy; (iii) history of exercise-induced asthma; and (iv) has physical disability.

The participants were screened according to the inclusion and exclusion criteria outlined above. All eligible participants were explained in detail regarding the study information, consent form, and collection of baseline data upon providing the study consent. Staggered recruitment was conducted, and this study was conducted in compliance with the Helsinki Declaration of 1975- revised in 1989, which stated that no vulnerable participants should be recruited. Prior to study initiation, all participants provided written consent None of the participants' personal information will be published or used for public purposes, and only the research team will have access to it.

Study Timeline

This study lasted for 12 months, and assessments were done at baseline, week 6, week 10, and week 14 of the intervention (Figure 1).

Baseline Screening and Randomisation

At the baseline stage, the participants were subjected to physiological, psychological, biochemical, and physical fitness assessments. The participants were randomly allocated to a 10-week intervention by random lottery method, whereby a slip of paper was drawn. They were randomly assigned into one of the following groups: (i) Group A (Control): participants carried out daily activities as usual; (ii) Group B (BE): participants practiced their ordinary activities and BEs only; (iii) Group C (HIIT exercise): participants performed HIIT only; and (iv) group D (HIIT and BE): participants performed both HIIT and BEs.

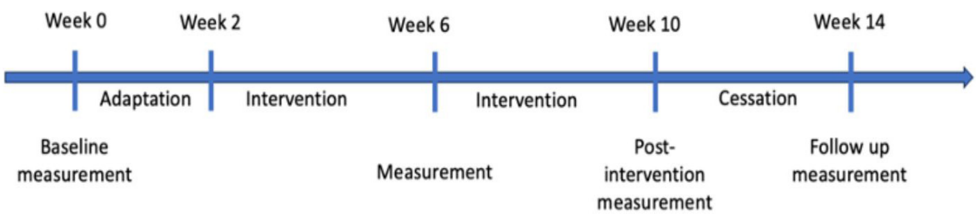

FIGURE 1: Study timeline

Intervention

As they were both aware of therapists of intervention received and provided, it was not possible for the participants or therapists to be blinded; however, outcome assessors were blindfolded to control for detection bias.

Breathing Exercise

The participants were required to sit or be in a semi-fowler position in a comfortable and quiet environment. They were advised to close their eyes and loosen their muscles to be more concentrated and relaxed. Next, they were asked to raise their hand to the abdomen and chest to feel each breathing pattern whether they were performing abdominal or thoracic breathing. Instruction was given to perform abdominal breathing. They were subsequently instructed to inhale slowly through their nostrils for about four seconds until the lungs were filled with air followed by slow exhalation to the maximum through their nostrils for about 6 seconds.

The participants were requested to do the BE repeatedly. Each cycle in the slow-breathing implementation procedure took about 10 seconds; 4 seconds of inspiration and 6 second expiration. One completed set was calculated by 6 times BEs per minute. The BE group participants received 8 set BEs with a 10 second break for 10 minutes, 2 times a day. The participants were instructed to conduct the BEs in the morning and evening and at about the same time of day. They were also reminded to record the exercise in the logbook and return it to researchers at the end of the intervention (Figure 2).

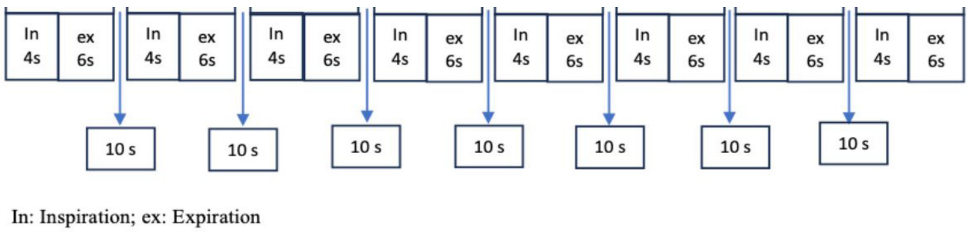

FIGURE 2: Breathing exercise protocol

HIIT Exercise

The participants were briefed by the researcher about the intervention procedure. The first two weeks were remarked as a familiarisation stage for the exercise. At this stage, participants were closely supervised to ensure correct execution. The participants proceeded with the exercise intervention in accordance with the module provided for 10 weeks. Researchers monitored the implementation of the exercise to ensure correct execution. The intensity of HIIT was determined by Rating of perceived exertion (RPE)(5-18) and the rest intensity will be 8-10 with the breathing control. Blood pressure, heart rate, and subjective complaints were checked before, during, and after exercise. The participants were not allowed to perform the exercise protocol if their blood pressure of pre-study 180/110 mmHg and the increase in the heart rate was more than 50% of the baseline. Exercise session indications for termination followed ACSM recommendations. Exercise protocol started with a 5-minute warm-up (dynamic stretching, walking, or jogging) followed by 40 minutes of HIIT programs. In the first 2 weeks, HIIT was performed with high-intensity exercise movements (RPE 15-16) for 20 seconds, followed by brisk walking in place at low to moderate intensity (RPE 10-11) while performing breathing control for 40 seconds. In weeks 3 to 10, the intensity was increased with 30 seconds of high-intensity exercise and 30 seconds of brisk walking at low to moderate intensity. All participants performed high-intensity exercise movements with eight bodyweight trainings, jumping jacks, squats, high knees, lunges, side lunges, butt kicks, lateral walks, and split squats, for 3 sets with 30 seconds intervals between sets. They were allowed a 5–10-minute cool-down period at the end of the session (Figure 3).

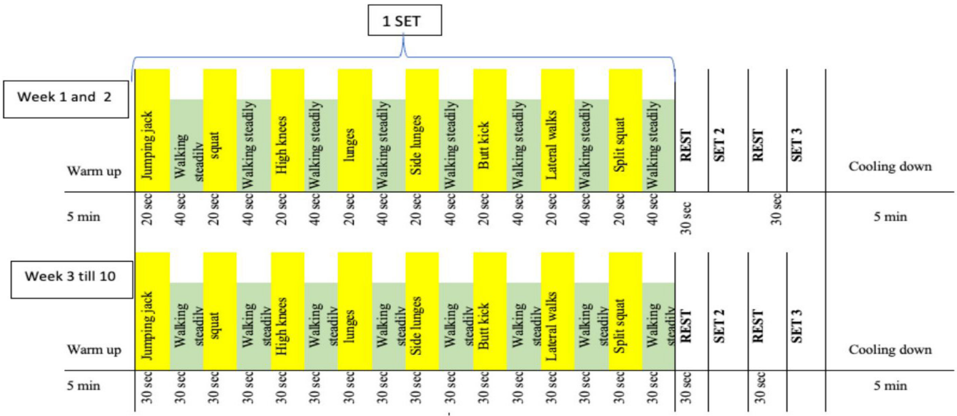

FIGURE 3: HIIT protocol

Data Collection

The primary and secondary outcome measures for this study are presented in Table 1. In preparation for all outcome measurements, the participants were required to adhere to all instructions and exercises involved in each group.

Follow-up

All participants returned for an outcome's measurement evaluation at weeks 5 and 10. The participants were instructed to refrain from any intervention for 4 weeks after the intervention was over. They were re-convened for outcome measurements at week 14 in order to assess the sustainability of the exercise intervention's effects.

Compliance and Adverse Effects Monitoring

The participants received daily checklists to track compliance with the activities. Under the direction of the researcher, the exercises were carried out three times per week by assembling several volunteers close together. The participants who missed the group exercise session were visited to make sure they performed the exercise independently. Participants were considered non-compliant if they missed more than 25% of exercise sessions. Additionally, the participants were requested to report on any side effects or complications, and the side effect sheet was used to document this information. Any adverse events due to Any occurrence of adverse events resulting from the trial intervention will be reported to the clinic and if necessary, treated by a physician from the research team.

Data Collection and Outcome Measurement
- Physiological Parameters (Blood Pressure and Heart Rate)

The participants were requested to rest

TABLE 1: Data collection table

Outcome measures	Measurement tools	Week 0	Week 6	Week 10	Week 14
Primary outcome					
Systolic blood pressure	Automatic Blood Pressure Monitor	√	√	√	√
Diastolic blood pressure	Automatic Blood Pressure Monitor	√	√	√	√
Heart rate	Automatic Blood Pressure Monitor	√	√	√	√
Secondary outcome					
a. Physical fitness					
Cardiorespiratory fitness	Six minutes walking test	√		√	√
Muscle strength	Handgrip Dynamometer	√		√	√
b. Psychological parameters					
Quality of life	Quality of life (WHOQOL)	√		√	√
DASS-14	DASS-14	√		√	√
c. Biochemical profiles					
Cortisol	An enzyme-linked immunosorbent assay (ELISA)	√		√	√
Interleukin-6	An enzyme-linked immunosorbent assay (ELISA)	√		√	√
C-reactive protein	Behring Nephelometer Analyzer System	√		√	√

DASS: Depression Anxiety Stress Scale

on a chair with feet flat on the ground and arms at heart level for a minimum of 5 minutes. Participants were instructed to not smoke and consume any caffeinated food or drinks before the measurement is being done.

The measurement was done using an automatic blood pressure device (Omron 8712). An appropriate size cuff was put on the upper arm 2-3 cm above the elbow. The air tube pointed in the direction of the lower arm and over the brachial artery. The cuff should be snug on the upper arm so that 2 fingers will fit between the cuffs. Three measurements of blood pressure and heart rate were recorded.

Physical Fitness Parameters
(i) Cardiorespiratory fitness

Six-minute Walking Test (6MWT) was employed to assess cardiorespiratory fitness. The standard distance was marked in a straight line with two cones (30 meters is ideal). A chair was placed halfway for participants to sit if necessary. The participants were briefed on the purpose of the test and the safety measures. The distance they completed within 6 minutes was recorded. A standard instruction was used, "For the next six minutes, kindly walk up and down the corridor while circling the cone. Try to walk as far as possible at your normal speed. When necessary, use your walking aid (if applicable). Tell me when you need to take a break and rest so we can sit down. I will walk behind you so as not to affect your normal walking speed. When you are ready, please begin". The stopwatch was started once the participants moved their feet to take a step. Standardised encouragement was given at 1, 3, and 5 minutes: "You're doing a good job" (minute 1), "You're halfway there" (minute 3), and "You have one more minute" (minute 5). Upon completion of the test, participants were asked to estimate their energy level using an RPE scale.

(ii) Muscle strength

According to the recommendations of the Institute of Medicine, hand grip strength was assessed using the hand grip strength test as a measure of muscle strength (Pate & Daniel 2013). The reliability and reproducibility of this device have been tested in previous studies (Buckinx et al. 2017; Mentiplay et al. 2015). The Sammons Preston Rolyan Hand-held Dynamometer, USA was used in this study, expressed in kilograms (kg). There were three tests performed on each hand, each followed by a 60-second break between assessments of the same hand. The participants stood upright with hips apart and both hands extended beside the thighs with palms facing the thighs. The participants were told to squeeze the grip continuously with full force for at least three seconds (Jaafar et al. 2023). Among the measurement results, the higher hand grip strength was recorded.

Psychological Parameters
(i) Quality of Life

The measurement of QoL was performed by using the WHOQOL-BREF in the Indonesian version (Gondodiputro et al. 2021; WHO 1996). There were 26 questions in the questionnaire, two of which were general questions related to the respondents' perceptions of their QoL, satisfaction in life, and health condition. There were four domains, with seven questions in the physical domain, six questions in the psychological domain, three questions in the social relationships domain, and eight questions in the environment domain. Each query was scored between 1 and 5. The total score for each domain was calculated using the transformation table and a scale from 0 to 100 (WHO 1996).

(ii) Stress Level

The Depression Anxiety Stress Scale (DASS) is a set of subjective scales established to measure the negative emotional states of depression, anxiety, and stress. The DASS-14 consists of five items relating to depression, six items relating to stress, and three items describing specific symptoms of anxiety. The depression scale looks at dysphoria, hopelessness, devaluation of life, self-reproach, lack of interest/ engagement, anhedonia, and inertia. The anxiety scale looks at autonomic arousal, striated muscle effects, situational anxiety, and subjective experience of anxiety effect. The stress scale is sensitive to the degree of nonspecific chronic arousal. The scale looks at difficulty to relax, nervous arousal, and ease of becoming upset/ agitated, irritable/over-reactive and impatient. On the modified DASS-14, the subscales showed good internal consistency, with Cronbach's alpha ranging from 0.73 (Anxiety) to 0.88 (Depression) (Wise et al. 2017). This is consistent with previous research on the DASS-21 (Nada et al. 2022; Sinclair et al. 2012) and although the 3-item Anxiety scale in our modified version had the lowest α, it was still acceptable for ongoing research in population groups. Three four-point Likert subscales are used in the DASS-14 to collect self-report data. The items on each subscale are designed to measure the emotional states of stress, anxiety, and depression. Each participant was asked to mark how much each statement related to them over the previous week. The item scores for each of the three subscales were added to get the final result.

Biochemical Analysis

Blood was drawn by a trained phlebotomist. It was then centrifuged, and the serum was transferred into three different Eppendorf tubes for further analysis. It was kept in -80°C freezer until the analysis.

Cortisol level & IL-6 Level

An enzyme-linked immunosorbent assay (ELISA) was used for cortisol and IL-6 levels determination. Kits were purchased from DRG Instrument GmbH, Germany, and Predictor ELISA kit, Genzyme Corporation, Cambridge, USA respectively. The instructions provided by the companies will be followed thoroughly.

C-Reactive Protein

CRP was measured using the Behring Nephelometer Analyser System (Behring Diagnostics Inc., Somerville, NJ). According to American Heart Association guidelines (Ruiz-Ramie et al. 2021), elevated levels of CRP >3.0 mg/L were defined as high risk.

Statistical Analysis

The analysis was performed according to the per-protocol approach. All statistical tests were carried out using SPSS 23.0 software. Prior to the analysis, data were tabulated and screened for any outliers, and missing values as well as the normality of the data were determined. The differences between groups at the baseline were determined by one-way ANOVA. Mixed design ANOVA was employed to determine the effectiveness of the intervention. The p-value was set at <0.05.

RESULTS

A total of 101 persons were identified as possible study participants, but five refused to participate (Figure 4).

Sample Characteristics

Approximately 87.50% of the 96 responders who participated in the study were female whereas only

12.50% were male. The samples' average age was 59.42 ± 9.14 years (range = 36-80 years). The average BMI of the respondents was 22.74 ± 1.56. Table 2 shows the average features of each category.

Baseline Value among All Group

The mean systolic blood pressure of group A was 152.79 ± 14.17 mmHg, 159.58 ± 15.40 mmHg for group B, 164.29 ± 24.65 mmHg for group C and 155.00 ± 11.29 mmHg for group D. Each group's diastolic blood pressure was 86.42 ± 7.95 mmHg, 92.71 ± 10.12 mmHg, 95.92 ± 10.66 mmHg and 88.04 ± 8.25 mmHg, respectively. Cardiorespiratory fitness was assessed using a six-minute walking test, with average results of 273.75 ± 63.30 m for group A, 310.83 ± 118.83 m for group B, 311.67 ± 127.61 m for group C, and 340.00 ± 66.85 m for group D. Muscle strength was tested using a hand dynamometer, and the results for each group were 16.70 ± 3.70 kg, 18.95 ± 7.86 kg, 16.87 ± 6.31 kg, and 17.36 ± 6.04 kg, respectively. Examination of stress levels in the respondents found that the average DASS-14 scores of each group were 4.58, 6.04, 7.83, and 3.87. This illustrates that the average respondent did not experience stress (DASS <14).

QoL as measured by WHOQOL obtained the following results: physical health domain of 54.46, 59.79, 55.42

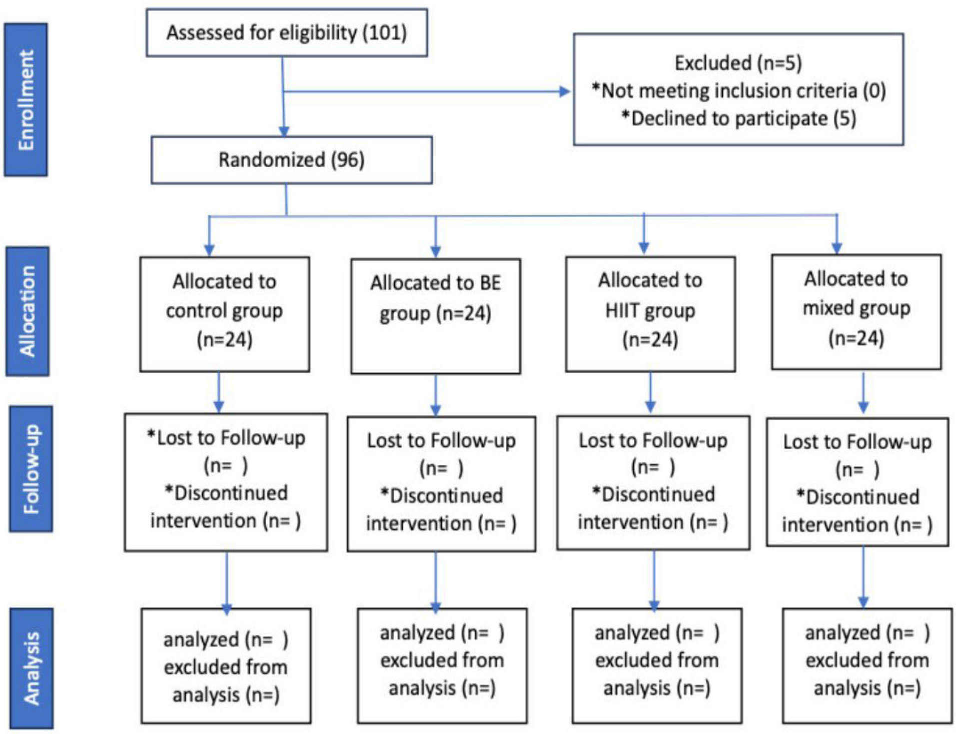

FIGURE 4: CONSORT diagram of the study protocol

TABLE 2: Demographic characteristics of participants Baseline values among all groups

Variable	Group A (n:24)	Group B (n:24)	Group C (n:24)	Group D (n:24)	Sig
Age	60.17 ± 10.73	59.00 ± 8,35	58.67 ± 10.56	59.83 ± 6.88	
Female	21 (87.5%)	19 (79.16%)	22 (91,67%)	22 (91.67%)	
IMT	22.67 ± 1.69	22.88 ± 1.84	23.01 ± 1.35	22.41 ± 1.33	
Classification of BP					
Pre-Hypertension	7 (29.17%)	4 (16.67%)	7 (29.17%)	2 (8.33%)	
Hypertension stage 1	9 (37.50%)	12 (50.00%)	5 (20.83%)	14 (58.33%)	
Hypertension stage 2	8 (33.33%)	8 (33.33%)	12 (50.00%)	8 (33.33%)	
Primary outcome					
Systolic BP	152.79 ± 14.17	159.58 ± 15.40	164.29 ± 24.65	155.00 ± 11.29	0.101
Diastolic BP	86.42 ± 7.95	92.71 ± 10.12	95.92 ± 10.66	88.04 ± 8.25	0.002
Heart Rate	86.46 ± 7.79	92.21 ± 8.52	90.21 ± 8.21	90.46 ± 6.45	0.080
Secondary outcome					
a. Physical fitness					
Cardiorespiratory fitness	273.75 ± 63.30	310.83 ± 118.83	311.67 ± 127.61	340.00 ± 66.85	0.149
Muscle strength	16.70 ± 3.70	18.95 ± 7.86	16.87 ± 6.31	17.36 ± 6.04	0.532
b. Psychological parameters					
DASS 14	4.58 ± 4.73	6.04 ± 7.04	7.83 ± 6.34	3.87 ± 4.00	0.467
Quality of life					
Physical health	54.46 ± 15.19	59.79 ± 9.86	55.42 ± 12.29	56.21 ± 11.35	0.462
Psychological	59.25 ± 9.63	59.87 ± 10.66	55.00 ± 12.94	57.42 ± 12.53	0.065
Social	65.17 ± 8.52	67.50 ± 7.68	60.96 ± 9.55	62.79 ± 9.41	0.415
Environment	68.58 ± 7.68	67.13 ± 12.56	63.13 ±18.73	63.96 ± 9.92	0.083
c. Biochemical profile					
Cortisol	219.89 ± 112.26	216.57 ± 79.16	245.85 ± 92.24	210.53 ± 109.79	0.622
Interleukin-6	5.91 ± 1.16	7.35 ± 1.96	6.01 ± 0.96	5.36 ± 0.62	0.00
CRP	5.87 ± 2.98	6.15 ± 3.29	6.73 ± 4.00	5.90 ± 4.42	0.845

Group A - Control group; group B – Breathing exercise group; group C - HIIT group; group D – mixed exercise group; DASS: Depression Anxiety Stress Scale; QOL: Quality of life, IL-6: Interleukin-6; CRP: C-reactive protein; sig for one way ANOVA.

and 56.21, respectively; psychological health domain of 59.25, 59.87, 55.00 and 57.42, respectively; social relation health domain of 65.17, 67.50, 60.96 and 62.79, respectively; and environmental health domain of 68.58, 67.13, 63.13 and 63.96, respectively. The results showed that the respondents' QoL for the physical health and psychological health domains were in a good category (scores 41-60) while the social relation health and environmental health domains were in the very good category (scores 61-80) (Table 2). Based on the one-way ANOVA test, all parameters showed that baseline values were not different between the four groups ($p>0.05$), except for DBP and IL-6 levels ($p<0.05$).

Safety and Adverse Effects

There were no adverse events related to the exercise session up to date.

Participants reported feeling tired after HIIT training but recovered quickly after resting.

DISCUSSION

Due to the consequences of the COVID-19 pandemic, the recruiting of volunteers and the implementation of this study encountered a few challenges. The research was supposed to be completed in 2020, but it could not be done because Indonesia established a Large-Scale Social Restrictions Policy in early 2020. Finally, this action could only be carried out by the end of 2021 after being permitted to engage in social activities. Another barrier was that some respondents who fit the requirements were unwilling to participate in the study because they were still terrified of meeting so many people. The majority of those who could participate in the study were women because men had to work and could not devote three times a week to the fitness regimen. To encourage a better commitment from the participants, we provided a pick-up service for those who had problems commuting to the exercise centre. We also always remind the training schedule through Whatsapp. Participants who were unable to join the exercise program 3 times in a row or whose attendance rate < 75% would be dropped out of the study.

This is the first randomised clinical trial that examines the benefits of a combined exercise program that includes breathing and HIIT on blood pressure. Previously, these separate exercises have been demonstrated to reduce blood pressure. Hence, our sample size determination was not based on previous study instead we employed Cohen's recommendation.

Slow breathing exercise (SBE) lowers blood pressure by slowing the adaptation of pulmonary stretch receptors and baroreceptors (Jones et al. 2015: Noble & Hochman 2019), decreasing the activity of the sympathetic nervous system (Chang et al. 2013; Critchley et al. 2015), and activating chemotherapeutic receptors (Spicuzza et al. 2000). Slow breathing has recently been discovered to have a function in the long-term regulation of blood pressure by lowering the arterial partial pressure of CO_2 ($PaCO_2$) and limiting renal salt retention (Anderson et al. 2010), and an effective non-pharmacological method to reduce heart rate (HR) in patients undergoing percutaneous coronary intervention (PCI) (Zou et al. 2022). BE can be utilised as a simple and affordable alternative to non-pharmacological hypertension treatment because it is simple to do anywhere and by anyone.

HIIT is considered a more effective and time-efficient intervention to lower blood pressure and improve aerobic capacity compared to other exercises (Costa et al. 2018; García-Hermoso et al. 2016). This reduction in blood pressure is due to HIIT improving cardiorespiratory fitness, hormonal response, and nitric oxide response, which is the main mediator of vasodilation in blood vessels and regulator of blood pressure (Asilah et al. 2019; Ciolac et al. 2010). Meanwhile, Wahl et al. (2014) has reported that HIIT leads to elevated circulating levels of hepatocyte growth factor and vascular endothelial growth factor. It can be hypothesised that HIIT lowers blood pressure through the active stimulation and promotion of angiogenic factors. [54]. HIIT lasting 4-18 weeks can lower SBP more than other types of exercise (Delgado-Floody et al. 2020; Ehlers et al. 2020; García-Hermoso et al. 2016).

It is anticipated that combining the two activities will yield superior outcomes. This study examines the benefits of exercise on blood pressure reduction as well as stress, cardiorespiratory fitness, muscle strength, QoL and cortisol, CRP, IL-6 levels. Exercise may be a substitute for non-pharmacological hypertension therapy that can enhance the QoL for hypertensive patients if the study's results are as anticipated.

Measuring physical fitness within laboratory settings is undeniably a gold standard. However, this approach could be challenging in a community intervention study. This present study employed field physical fitness assessments as alternatives to the laboratory setting. The 6MWT was proven reliable to predict functional capacity among cardiovascular related conditions (Pollentier et al. 2010). Similarly, the handgrip strength test was shown to be effective for muscular strength and endurance prediction (Vaidya & Nariya 2021). We postulated socialising during group exercise benefits participants' wellbeing. We assess their QoL using the DASS questionnaire and to further support this postulation, cortisol, CRP and IL-6 will be measured. These three biomarkers are significant predictors of chronic stress (Noushad et al. 2021).

Following the program for several days, the respondents reported feeling better. Respondents in Group B claimed that their condition improved quickly after performing BEs. While group C and D respondents indicated that their bodies grew healthier and healthier after multiple HIIT activities. Meanwhile, some respondents stated that they were tired at the start of the activity and needed to relax longer. This indicates that the exercises provided can be accepted by respondents.

Limitations

This study was initially planned to be conducted at the end of 2019. However, in that year, the COVID-19 pandemic occurred throughout the world, including Indonesia. This study was to be conducted at the Community Health Service Centre, a primary entry point for basic health services in Indonesia. With the outbreak of COVID-19 cases in Indonesia and the implementation of restrictions on community activities, these Health Service Centres were closed to research services and other activities, focusing soely on COVID-19 patients. This resulted in the delayed execution of this research. Apart from activity restrictions due to COVID-19, the research activities could not be carried out because the respondents belonged to vulnerable groups. They were elderly and had hypertension, putting them at higher risk of contracting COVID-19. If there were additional comorbidities, this would cause serious health problems or even death. In 2020, the research also could not be carried out because the COVID-19 pandemic was still spreading, and other variants of the coronavirus emerged which disturbed the community.

CONCLUSION

Based on the preliminary results, the proposed exercise protocol can be safely applied to hypertensive respondents. This preliminary study found no significant differences in the baseline data oamong the four groups, except for DBP and IL-6 levels.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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