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Supervised Community Based Outdoor Group Exercise: As Prevention And Treatment Of Arterial Blood Pressure And Body Weight

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Abstract

Background: Sedentary lifestyle predispose to Cardiometabolic diseases which are the number one cause of death in the world. Despite large data are available; the benefits of supervised community based outdoor group exercise (SCBOGE) have not been addressed in the study area. The aim of this study was to examine the effect of SCBOGE on arterial blood pressure and body weight. Methods: A total of (n= 184) subjects were sampled from four different physical exercise training sites for a periods of 12 weeks. Subjects were classified purposely into three different groups took account of resting arterial blood pressure. The first 72 subjects were grouped as normotensive (NTS) and the second 38 subjects were high normal hypertension (HNH) or mild and the controlled subjects were 74. Quasi-experimental quantitative pre- post-test study design was used. Data were taken twice, at baseline and post exercise intervention and it were analysed using SPSS 24 software version. Results: The results indicated that in NTS, the mean($\bar{x}$) resting arterial systolic and diastolic blood pressure reduced by 4.24 and 2.76 mm Hg respectively, and a p-value of <0.05 was obtained, however; as compared to NTS, a better systole (6.26 mm Hg) and diastole (4.0 mmHg) $\bar{x}$ reduction were observed in HNH subjects. This study showed a strong foundation for future researchers to examine the different result observed in the two experimental groups. Unlike to the control group ($p \geq 0.05$), both experimental groups again showed a significant body weight reduction. Conclusions: Participation in SCBOGE program is effective in bringing about a significant health outcome over 12 weeks if the exercise activities are assisted by qualified individuals.

KEYWORDS: Cardiometabolic diseases, High normal Hypertension, Normotensive, Sedentary.

INTRODUCTION

The health, social and economic benefits of regular physical activity is well studied. In this regards, several studies reported that, regular physical activity is a key protective factor for the prevention and management of non-communicable diseases (NCDs). A recent meta-analysis study has demonstrated that after statistical adjustment for physical activity, sedentary time was independently associated with a greater risk for all-cause mortality, cardiovascular disease (CVD), cancer and type 2 diabetes mellitus (T2DM) mortality in adults (ACSM'S 2018).

Hypertension is an important public health challenge in both economically developing and developed countries (Kearney et al. 2004). It is one of the most common NCDs affecting a quarter to about half of the adult population in many countries (Amalia W. 2004). According to world health statistics (WHS, 2020) report, hypertension is considered a major risk factor for the development of several NCDs, including CVD, cerebrovascular disease, brain diseases and end-stage renal disease. Similarly a study of Carpio-rivera et al. (2016) report indicated that hypertension affects 25% of the world's population and is considered a risk factor for cardiovascular disorders and other diseases. Globally, the number of people with hypertension is growing dramatically and is estimated to reach close to 1.6 billion people, or 30 per cent of the world's population by 2025 (Kearney 2005).

A report of WHO, (2009) indicated that, physical inactivity has been identified as the fourth leading risk factor for global mortality (6% of deaths globally). This follows high blood pressure (13%), tobacco use (9%) and high blood glucose (6%). Overweight and obesity are responsible for 5% of global mortality. In a further Alwan, A. & WHO, (2011) reports, levels of physical inactivity are rising in many countries with major implications for the general health of people worldwide and for the prevalence of NCDs such as cardiovascular disease, diabetes and cancer and their risk factors such as raised blood pressure, raised blood sugar and overweight. A recent, WHO, (2020) updated report also indicated that physical inactivity is a leading risk factor for premature death from NCDs such as CVD, hypertension, T2DM, and a number of cancers.

Likewise, Booth et al. (2000); Lellamo & Volterrani (2010); Matthews, et al. (2012); Sousa, A.S *et al (*2020) reported that, prolonged periods of sitting or sedentary behaviour are associated with deleterious health consequences independent of physical activity (PA) levels. This indicated that physical inactivity is a recognized major risk factor for CVD, and a widening variety of other chronic diseases, including diabetes mellitus, cancer, obesity, hypertension, depression, bone and joint diseases (osteoporosis and osteoarthritis) etc. Persons who are less active and less fit have a 30% to 50% greater risk for overweight induced diseases such as high blood pressure.

Table-1: Classification of Blood Pressure for Adults (BP, in mmHg)

Category	Systolic	Diastolic
Optimal	<120	<80
Normal	120-129	80-84
High Normal	130-139	85-89
Grade 1 Hypertension (mild)	140-159	90-99
Grade 2 Hypertension(moderate)	160-179	100-109
Grade 3 Hypertension (sever)	≥180	≥110
Isolated Systolic Hypertension	≥140	≥90

Source: WHO (2005) and ACSM'S (2018)

In Ethiopia, in connection to sedentary lifestyle and alarming rate of hypokinetic disease, urban dwellers have been developing a habit of outdoor group physical exercise for a general health purpose inconsistently without exercise professionals advising, prescriptions and supervision; as a result the effectiveness of supervised community based outdoor group exercise (SCBOGE) is not yet studied and reported. Therefore, the purpose of this study is to examine the effects of 12 weeks supervised community based outdoor physical exercise training, as prevention and control of blood pressure and body weight managements.

2. MATERIALS AND METHODS:

This part of the study discussed the materials and methods used by the researcher throughout the study. As a result, the effect of “supervised community based outdoor group exercise" (SCBOGE) training was investigated. At the very beginning of the study, the researcher hypothesized that, subjects who actively engaged in supervised outdoor community based exercise program were more likely to improve their arterial blood pressure and body weight than the control group.

2.1. **Study Area**

This study was conducted in Addis Ababa, the capital and largest city of Ethiopia. "Addis Ababa is a highly developed and important cultural, artistic, and financial centre of Ethiopia. The city holds 527 square kilometres of area in Ethiopia. The population density is estimated 5,005,524. The city sits in rolling hills 2,355m above sea level and is a safe and atmospheric city".

2.2. **Study Design**

To determine the cause-and-effect relationships existed between the independent and dependent variables; and also to answer the research hypothesis, quantitative experimental study with quasi-experimental pre-test post-test study design was employed.

2.3 **Study Participants and Sampling Techniques**

In this study, four (4) different community based outdoor group exercisers were included as a target population. Among this population (*n=832*) the required sample size (*n=270*) was first determined by Taro Yamane’s formula and finally the sampled subjects were subjected to the inclusion and exclusion criteria as a result a total of (n= 184) subjects who met the criteria were actively participated throughout the study.

To determine the required and a representative sample size from the target population (n=832) Taro Yamane’s formula *was used.*

$$n = \frac{N}{1 + N(e)^2}$$

Where:

- *n= sample size required (?)*
- *e = allowable error (%) in this case 5% or 0.05*
- *N = number of people in the population (in this case 832)*

These subjects (*n=184*) were categorized in to three different groups. The first seventy two (n = 72) experimental subjects were categorised as normotensive group (NTG). The second thirty eight (n=38) experimental subjects were categorised as High Normal hypertensive group (HNH) and the last seventy four (n= 74) individuals were controlled groups (CG). The control group did not receive any professional supervision or guidance but they followed their usual life style without taking any of the intervention. However, in addition to the exercise intervention, the HNH group was administered anti-hypertensive medication by their own physicians, except this there was no any other difference between the two experimental groups.

2.4 Inclusion and Exclusion Criteria

Before initiating the exercise program and to meet the objective of the study, pre-participation health screening was done to identify and excluded those individuals who had risk factors for adverse exercise-related events. To implement the screening procedure, subjects were asked to fill validated questionnaires such as the American Heart Association (AHA)/ the American College of Sports Medicine (ACSM) Health/ Fitness Facility pre-participation screening questionnaire and also the revised physical activity readiness questionnaire (PAR-Q) before starting to participate in the *SCBOGE*. Besides to this, each high normal hypertensive subjects were told to visit and consult their physician for a general check-up form the stress of the exercise regularly as a result they did not face any uncertainty to the exercise training protocol. specifically the study excluded those individuals, who had high health risks associated with physical activity, typically those individuals who have severe medical problem preventing participation from exercise like a history of acute or chronic musculoskeletal injury during exercise, cardiovascular, respiratory or other chronic illness, having Grade one (1) and above hypertension ; whose ages were ≥55 and above; those who participated previously in a structured group or individual based exercise training program during the preceding two months; female exercisers (b/c their number was very few, thus the study did not consider female participants); and subjects who were obese (BMI ≥30) and those individuals who did not show interest and unable to provide verbal informed consent.

2.5 Data Collection Instrument and Procedures

In this study, primary data was collected by the researcher himself and also by professional nurse, who has long periods of work experience at different hospital setting.

2.5.1. **Resting Arterial Blood Pressure Measurement (RABPM)**

RABPM were taken using a standard mercury sphygmomanometer and stethoscope. The cuff used was adapted to the arm circumferences and was inflated to a level at which the distal arterial pulse was not palpable. To obtain reliable blood pressure (BP) data, three consecutive readings of BP after 5 minutes of rest at two minutes of interval were taken for both systolic blood pressures (SBP) and diastolic blood pressure (DBP) and average of the 3 readings was calculated for the subsequent analysis. To ensure the reliability of the data, the readings for the exercise groups were made under similar conditions and setting i.e. before starting the exercise training program at baseline in the morning between 7 and 8 A.M. in sitting position with the arm at the level of the heart, in a quiet isolated setting. The post-tests were also taken in a similar method at the end of 12wks. In a similar method, blood pressure of the control group was recorded twice i.e. at the beginning and end session of the study period.

All BP measurements procedure were taken by qualified nurse within three consecutive days of similar environments and setting, following the ACSM's and WHO (2005) BP measurement protocol and guidelines.

2.5.2. **Body Mass Index (BMI) Measurement**

BMI was calculated by the researcher and two sport science trained students' using the formula Weight (kg)/Height^2 (m^2) and was graded as per the WHO - International Classification of BMI: Normal

18.5–24.99, Overweight 25–30, and obese ≥30. Height (cm) and weight (kg) were measured with subjects wearing light clothes and bare-footed using a calibrated beam balances (Avery Ltd, Birmingham, UK). In order to accurately calculate BMI, subjects' standing height was first measured using a fixed metric stadiometer after removed their shoes. For accurate height, the back of the head, shoulder blades, buttocks and heels touched the stadiometer. To improve reliability, subjects' weigh routinely measured in the morning (12 hours since eating). To monitor changes in body mass, measurement was taken at the same time of day, under the same conditions, using the same set of scales.

Ethical Issues

This study was carried out with subjects outside of any organisations, as a result signed consents were obtained from each subjects prior to beginning of the study. Subjects' were given full information about the research including the purpose of the study, the nature of the research procedure, both risk and benefits and allowed to make the decision to change their mind and withdraw from the study at any time during the study period without penalty, besides to this, they were told that their personal data will not be used for any other purpose and above all they understand about the privacy and confidentiality of their personal data.

EXERCISE PROTOCOL:

The exercise training protocol was entirely taken from the ACSM's exercise training protocol recommendation for individuals with hypertension, (ACSM'S 2018). However, it was slightly adopted by considering the overall situation and the nature of the subjects. The two experimental groups were received this exercise intervention protocol in a similar fashion.

Table-2: FITT Recommendations for Individuals with Hypertension

FITT	Aerobic	Resistance	Flexibility
Frequency	5-7d.wk^{-1}	2-3 d.wk^{-1}	≥2-3 d.wk^{-1}
Intensity	Moderate intensity (60-85% of predicted maximum heart rate or 40%-59% Vo_2R or HRR; PRE 12-13 on a 6-20 scale)	The exercise begin with 40%-50% 1-RM and progressively increase to 60%-70% 1-RM; may progress to 80% 1-RM.	Stretch to the point of feeling tightness or slight discomfort.
Time	≥30 min.d^{-1} of continuous or accumulated exercise. If intermittent exercise performed, begin with a minimum of 10 min bouts.	2-4 sets of 8-12 repetitions for each of the major muscle group.	Hold static stretch for 10-30s; 2-4 repetitions of each exercise.
Type	Prolonged, rhythmic activities using large muscle group (walking, cycling, swimming)	Resistance machines, free weights, and/or body weight.	Static, dynamic, and/or PNF stretch

Key: 1-RM, one repetition maximum; HRR, heart rate reserve; PNF, proprioceptive neuromuscular facilitation; RPE, rating of perceived exertion; VO_2R, oxygen uptake reserve.

Source: American College of Sports Medicine,, In Riebe, D., In Ehrman, J. K., In Liguori, G., & In Magal, M. (2018).

STATISTICAL ANALYSIS:

The dependent t-test (also called the paired t-test or paired-sample t-test) was used to determine whether there was a statistical significant difference between the mean of the pre and post test results as a results of the exercise interventions. The probability level of statistical significance was set a priority at $P < 0.05$ in all comparisons. Descriptive statistics were expressed as means ± SD. The data were processed in SPSS software version 24. Results were summarized and presented in the form of tables and brief text explanation.

RESULTS:

The descriptive statistics of body mass index (kg/m^2) data at baseline and post-exercise intervention for the three groups in response to supervised community based outdoor group exercise training program (*SCBOGE*) are shown in Table 2.

Table 2 Paired Samples statistics of Body Mass Index (kg/m^2) data at Baseline and Post-exercise intervention for the three groups in response to *SCBOGE.*

Groups	Age (years)	N	Mean (x̄)		Mean Diff	Std. Deviation	t-value	df	P-value
			Pre	post					
NT	46.4±5.4	72	27.2760	25.0000	2.27600	.71605	15.893	71	.000
HNH	47.9±5.2	38	27.2600	24.6400	2.62000	0.95394	13.733	37	.000
Cont.	48.2±5.8	74	27.0440	26.8800	0.16400	1.83141	0.448	73	.658

Key: NT= Normotensive subjects; HNH = High Normal Hypertensive subjects; Cont. = Control Group. SCBOGE = Supervised community based outdoor group exercise. The level of significance was set at < 0.05.

Comparisons of the normotensive (NT), high normal hypertensive (HNH) and control group subjects BMI revealed that except the control group (p =.658), both experimental groups i.e. NT and HNH subjects showed significant body weight reduction (p= 0.000) as a results of 12 weeks SCBOGE. The paired sample test mean difference of both experimental groups are almost similar, however, the HNH subjects BMI mean difference (2.62000) is slightly exceed than the NT subjects (2.27600) however, no statistical significant change observed in both groups. Unlike to the experimental groups, the control group did not show any body mass index (BMI) change.

Table 3 Paired samples statistics of resting Systolic and Diastolic Blood Pressure Data at Baseline and Post-exercise intervention for the three groups in response to *SCBOGE*.

Groups	N	Mean		Mean Diff	Std. Deviation	t-value	P-value
		Pre	post				

NT	72	---	---	---	---	---	---
Systolic (mmHg)	-	116.5600	112.3200	4.24000	4.38064	4.839	.000
Diastolic(mmHg	-	77.9200	75.1600	2.76000	2.52124	5.473	.000
HNH	38	---	---	---	---	---	---
Systolic (mmHg)	--	138.2667	132.000	6.26667	2.98727	8.125	.000
Diastolic(mmHg		87.733	83.7333	4.0000	2.10442	7.362	.000
Cont.	74	---	---	---	---	---	---
Systolic (mmHg)		117.9000	117.7000	.20000	1.73509	.515	.612
Diastolic(mmHg		76.5000	76.2000	.30000	1.94936	.688	.500

Key: NT= Normotensive subjects; HNH = High Normal hypertensive subjects; Cont. = Control Group. SCBOGE = Supervised community based outdoor group exercise. The level of significance was set at < 0.05

Comparisons of the normotensive (NT), *high normal hypertensive (HNH)* and control group subjects systolic and diastolic blood pressure revealed that except the control group systolic and diastolic BP (p =.612 & .500), both experimental groups i.e. NT and HNH subjects showed significant blood pressure (p < .05) reduction as a results of 12 weeks *SCBOGE*.

As clearly depicted in the above table 3 although, a significant systolic and diastolic blood pressure reduction was observed in both experimental groups, the magnitude of paired sample test mean difference results indicated that HNH subjects showed a better results than the NT subjects' systolic and diastolic blood pressure. This noticeable blood pressure-lowering result indicated in HNH subject seems from the combined effect of antihypertensive drugs in adjacent to the exercise intervention protocol. As it was indicate in the above table-3, no significant blood pressure and body weight change (P > .05) were observed in control group. Thus, it is possible to understand the benefits of SCBOGE program as a prevention control and rehabilitation treatment or mechanism of blood pressure and body weight managements in both NT and HNH subjects.

DISCUSSION:

As clearly indicated in the result section, 12 weeks supervised community based outdoor group exercise (SCBOGE) intervention demonstrated a significant reduction of resting arterial blood pressure (systolic and diastolic) as well as on body weight in both experiment groups, however; the control group did not show any a significant change either in arterial blood pressure or body weight physiological variables. In the former groups, a significant systolic and diastolic arterial blood pressure changes were observed both in normotensive (NT) and high normal hypertensive (HNH) subjects. However, the magnitudes of reduction in both experimental subjects were not similar.

As it was depicted in table-3, a better mean ($\bar{x}$) reduction of arterial blood pressure was observed in HNH subjects rather than the NT. This $\bar{x}$ result variation between the experimental groups may raise question since both groups underwent in a similar exercise intervention or protocol, but there was a clear distinction in $\bar{x}$ blood pressure difference result at the end of the intervention between the two experimental groups, i.e. in addition to the exercise intervention, the HNH subjects were administered anti- hypertension pharmacological agents by their own physician in conjunction to participating in the SOCBPE. Even though further study is needed in the future, it seems that, a combination intervention (exercise and pharmacological agents) is preferred to either of a single intervention for a better result.

In connection to the current study, previous studies widely indicated the enormous benefits of physical exercise in relation to health. Pescatello, L. S. (2015) demonstrated that even modest reductions in blood pressure (2-3 mmHg) by endurance or resistance exercise training decrease coronary heart disease (CHD) risk by 5% to 9% , stroke risk by 8% to 14%, and all cause of mortality by 4% in the general population. Supporting to the present study, Lellamo & Volterrani 2010 reported that along with pharmacological therapy, there is now established evidence and overall consensus in current guidelines on the effectiveness of regular physical activity in the treatment of hypertension, in combination with drug(s) therapy or even alone. Similarly, Kokkinos, et al. (2001) demonstrated that an overwhelming number of epidemiological and interventional exercise studies provide unequivocal support that increased physical activity, of adequate duration, intensity and volume lowers BP significantly, alone or as an adjunct to pharmacological therapy.

Other studies also reported the benefits of physical exercise, for example Fagard & Cornelissen, (2007) described that exercise is a cornerstone therapy for the prevention, treatment and control of hypertension. Grassi et al. (1994) studied young normal blood pressure individuals and verified that after 10 weeks of physical exercise, besides the decrease on the systolic and diastolic blood pressure, a significant reduction on the sympathetic nerve activity was also observed (36%). Lellamo & Volterrani (2010) stated that regular exercise reduces the incidence of hypertension. In addition to preventing hypertension, regular exercise has been found to lower blood pressure in hypertensive subjects.

The effectiveness of aerobic exercise on normotensive individuals was also studied and reported. For example, Kelley GA, Kelley KA, Tran ZV (1995) reported that aerobic exercise trainin*g* produces small, yet significant, decreases in resting systolic and diastolic blood pressure (SBP and DBP) in normotensive individuals. A decrease of ~4 mmHg has been reported following training and, although small, is considered to reduce risk for future hypertension and cardiovascular disease (Kelley GA, Kelley KA, Tran ZV, 1995; Pescatello et al., 2004). Chronic aerobic exercise of adequate intensity, duration, and volume that promotes an increased exercise capacity leads to reductions in resting SBP and DBP of 5–7 mm Hg and reductions in exercise SBP at submaximal workloads in individuals with hypertension (ACSM'S 2018).

It is quite clear that the type or mode and quality of the exercise prescription play a major role in most physiological variables including on blood pressure. However, equivocal studies reported on the effectiveness of the exercise mode either aerobic or strength or combined. For example, an increased interest in the importance of strength training for treating risk factors and hypertension, the main recommendation for primary and secondary prevention in hypertension is still dynamic endurance training, like aerobic fitness training, walking, swimming and cycling (Fagard & Cornelissen, 2007). As a supplement, strength training with low resistance, perhaps 40–50 per cent of maximal capacity (RM = repetition maximum), expressed as "moderate intensity" strength training, and many repetitions could be recommended (ACSM, 1993).

Many studies reported the importance of aerobic exercise, however there are fewer data on resistance training; the data suggest that resistance training of moderate intensity is able to reduce blood pressure (Fagard & Cornelissen, 2007). Resistance exercise has also been shown to reduce both SBP and DBP by 3---5mmHg by increasing parasympathetic tone and thereby reducing peripheral vascular resistance (PVR) when the exercise regime concentrates on muscle resistance (Ruivo JA, 2012). In a meta-analysis study, 64 different studies were analysed, on a total of 2344 hypertensive patients, suggested that resistance exercise is an operative stand-alone antihypertensive treatment. Resistance training lowers SBP, DBP, and MABP. The scale of effect is greater than that before described during aerobic exercise or resistance training. It has been suggested that resistance training has the possibility to reduce BP. In studies that hypertensive patients performed above eight resistance bouts each session, demonstrated greater decreases in SBP compared to studies using a smaller amount than eight exercises bouts per session. DBP was reduced also, following resistance exercise; however, greater reductions were seen in untreated hypertension individuals, performing more than three resistance exercise bouts sessions per week (Saghiv & Sagiv, 2020).

The current exercise training protocol was adapted from the ACSM'S exercise guideline which recommends that most adults engage in moderate-intensity cardiorespiratory exercise training for ≥30 min.d^{-1} on ≥5 d.wk^{-1} for a total of ≥150 min.wk^{-1} or vigorous-intensity cardiorespiratory exercise training for ≥20 min.d^{-1} on ≥3 d.wk^{-1} (≥75 min.wk^{-1}), or a combination of moderate- and vigorous-intensity exercise to achieve a total energy expenditure of ≥500–1000 MET min.wk^{-1}. On 2–3 d.wk^{-1}, adults should also perform resistance exercises for each of the major muscle groups, and neuro-motor exercise involving balance, agility, and coordination. The exercise program should be modified according to an individual's habitual physical activity, physical function, health status, exercise responses, and stated goals (Garber, et al., 2011).

Therefore, in the present study, the subjects engaged both in aerobic and strength training, this was clearly demonstrated under the exercise training protocol section. Similar to the effectiveness of the present exercise protocol on blood pressure control and body weight managements a number of previous studies also supported and reported that both structured aerobic and strength exercise has great effect on body weight management and blood pressure control. Combined resistance and aerobic exercise training is an approach suggested by the American College of Sports Medicine in hypertensive patients. It is recommended to train 30 min of aerobic exercise at 50–60% VO2 reserve 4–5 days a week, accompanied by moderate resistance exercise 60%–80% 1 RM, 8–12 repetitions, 2–3 days per week. A recent meta-analysis of 68 trials on hypertensive patients supports the efficacy of combined resistance and aerobic exercise training as antihypertensive therapy. Together, the studies demonstrated in patients with hypertension a decrease in SBP and DBP. A previous meta-analysis, informed of an extensive difference in the BP decreases in SBP and DBP, also demonstrated that studies with a developed procedural quality gained greater BP drops related to lesser methodological quality trials (Pescatello et al. 2004).

CONCLUSIONS:

As indicated above in the result and discussion section, well designed and close supervised community based outdoor group exercise training showed significant results not only on body weight managements but also it showed remarkable effects in the prevention and control of resting systolic and diastolic arterial blood pressure.

Based on the current study result, it is possible to arrive and conclude that, supervised community based outdoor group exercise (SCBOGE) training program is an effective therapy both for normotensive and high normal hypertensive (HNH) individuals as prevention and treatment modalities. Therefore, the relevance of SCBOGE training program should be encouraged and cultured highly. In addition to this, if the group exercise training program is appropriately designed, prescribed and monitored in a scientific manner by exercise science professionals and if different professionals like physicians, clinical exercise physiologist, exercise physiologists, dietician, certified physical fitness trainers etc., work jointly on individuals having minor or chronic disease a better result may be obtained and above all patients will be more benefited.

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Conflicts of interest

The authors of this article declared that there are no conflicts of interest that could be interfered with the publication of this article.

REFERENCES

1. Alwan, A., & World Health Organization. (2011). *Global status report on noncommunicable diseases 2010*. Geneva, Switzerland: World Health Organization.
2. Amalia Waxman (2004). WHO’s global strategy on diet, physical activity and health, Scandinavian Journal of Nutrition, 48:2, 58-60.
3. American College of Sports Medicine (1993).Position stand. Physical activity, physical fitness, and hypertension. Med Sci Sports Exerc. Oct; 25(10): i-x. PMID: 8231750.
4. American College of Sports Medicine (2018). In Riebe, D., In Ehrman, J. K., In Liguori, G., & In Magal, M. *ACSM's guidelines for exercise testing and prescription*.
5. *Booth FW, Gordon SE, Carlson CJ, Hamilton MT (20000). Waging war on modern chronic diseases: primary prevention through exercise biology. J Appl Physiol: 88(2):774-87.*
6. Carpio-Rivera, E., Moncada-Jiménez, J., Salazar-Rojas, W., & Solera-Herrera, A. (2016). Acute Effects of Exercise on Blood Pressure: A Meta-Analytic Investigation. *Arq Bras Cardiol.* , 106(5):422-433.
7. Fagard RH, Cornelissen VA. (2007). Effect of exercise on blood pressure control in hypertensive patients. Eur J Cardiovasc Prev Rehabil:4:12-7.
8. Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Nieman, D. C., et al. (2011). Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness in Apparently Healthy Adults: Guidance for Prescribing Exercise. *American College of Sports Medicine Postion Stand*, 1334-1359.
9. Grassi G, Seravalle G, Calhoun DA, Mancia G. (1994). Physical training and baroreceptor control of sympathetic nerve activity in humans. Hypertension: 23:294-301.
10. Kearney PM, Whelton M, Reynolds K, Whelton PK, He J. (2004).*Worldwide prevalence of hypertension: a systematic review. J Hypertens: 22(1):1-9.*
11. Kearney PM, Whelton P, Reynolds K, Muntner P, Whelton PK, He J. (2005). Global burden of hypertension. Analysis of worldwide data. Lancet: 365:217-23.

12. Kelley GA, Kelley KA, Tran ZV. Aerobic exercise and resting blood pressure: a meta-analytic review of randomized, controlled trials. Prev Cardiol. 2001 Spring;4(2):73-80.
13. Kokkinos PF, Narayan P, Papademetriou V. (2001). Exercise as hypertension therapy. Cardiol Clin.; 19: 507-516.
14. Lellamo, F., & Volterrani, M. (2010). Effect of exercise training in essential arterial hypertension. *Rev Bras Hipertens*, vol.17(2):68-71.
15. Matthews CE, George SM, Moore SC, et al. (2012). Amount of time spent in sedentary behaviours and cause specific mortality in US adults. *Am J Clin Nutr*.; 95(2):437–45.
16. Pescatello LS, Franklin BA, Fagard R, et al. (2004). Exercise and hypertension Med Sci Sports Exerc, :36:533–53.
17. Pescatello, L. S., MacDonald, H. V., Lamberti, L., & Johnson, B. T. (2015). Exercise for Hypertension: A Prescription Update Integrating Existing Recommendations with Emerging Research. *Current hypertension reports*, *17*(11), 87. https://doi.org/10.1007/s11906-015-0600-y
18. Ruivo JA, Alcântara P. (2012). Hypertension and Exercise. Rev Port Cardiol. Feb; 31(2):151-8. Portuguese. doi: 10.1016/j.repc.2011.12.012.
19. Saghiv, M. S., & Sagiv, M. S. (2020). *Basic Exercise Physiology: Clinical and Laboratory Perspectives.* Switzerland: Springer.
20. Sousa, A.S., Mendes, J., Guerra, R.S. *et al.* (2020). Sitting time and associated factors among Portuguese older adults: results from Nutrition UP 65. *Eur J Ageing* **17,** 321–330. https://doi.org/10.1007/s10433-019-00532-y
21. World Health Organization (2005). WHO Clinical Guidelines for the Management of Hypertension, World Health Organization, Geneva, Switzerland.
22. World Health Organization. (2009). WHO Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks. Geneva.
23. World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour: at a glance Geneva. World Health Organization. https://apps.who.int/iris/handle/10665/337001. License: CC BY-NC-SA 3.0 IGO
24. World Health Statistics (2020). Monitoring Health for the SDGs, Sustainable Development Goals. Geneva: World Health Organization; 2020. Licence: CC BY-NC-SA 3.0 IGO.