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Effects of Physical Exercise on Body Composition and Resting Blood Pressure among Patients with Uncontrolled Hypertension

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Abstract
Background: Hypertension is one of the major public health challenges worldwide because of its high prevalence and concomitant risk of cardiovascular and cerebrovascular morbidity and mortality. Different studies indicate that majority of the peoples died in sub-Saharan Africa with heart failure and stroke as the result of high blood pressure. Excess body fat, especially upper body fat is associated with enhancing the frequency of hypertension occurrence. The aim of this study was to evaluate the outcomes of physical activity on changes of body composition and resting blood pressure among sedentary hypertensive patients, as an effective non-pharmacological alternative means of control and prevention of hypertension.
Methods: Experimental design was employed to measure the effects of physical activity on body composition among sedentary hypertensive patients. Thirty (30) hypertensive adult participants were selected. Before and after the intervention, participants' mean arterial pressure, body weight, percentage of body fat, waist and hip circumferences were measured for each subject in experimental and control group.
Results: The current findings demonstrated a greater change of body weight, percentage of body fat, and mean arterial pressure between pre and post measurements in the experimental group (Body weight pre 87.0 + 7.26 kg, Body weight post 83.73 + 7.74 kg; Mean arterial pressure pre 123.7 + 3.76 mm Hg, Mean arterial pressure post 120.2 + 4.39mm Hg; and Body fat percentage pre 40.16 + 1.13 %, Body fat percentage post 38.44 + 1.15 %). Among the control group however, all these measurements spontaneously increased significantly ($p<0.0005$) from pre to posttest period.
Conclusion: The results of this experimental study revealed that regular physical exercise is an effective alternative control of hypertension among sedentary hypertensive patients, as evidenced by significant decrease in body composition parameters and resting blood pressure from baseline (pretest) to post intervention period.

Keywords: *Physical exercise, body composition, resting blood pressure and uncontrolled hypertension*

1. Introduction

Hypertension is one of the major health problems within the population around the world. According to the statistics of high blood pressure, around 1.5 billion peoples are suffering by hypertension worldwide. Different studies indicated that majority of the peoples died in sub-Saharan Africa with heart failure and stroke as the result of high blood pressure (1). Excess body fat, especially upper body fat is associated with enhancing the frequency of hypertension occurrence (2). Both high blood pressure plus obesity are the major positive risk factors for atherosclerotic (2). Although there is significant evidence suggesting that physical exercise leads to decrease the body weight and reduced high blood pressure, many adults still did not achieve the recommended daily physical exercise level (3). Furthermore, the trend of engaging in physical exercise among individuals has been shown to decrease as the age increase (4, 5).

A sedentary lifestyle is defined as not engaging in physical activity for a minimum of thirty minutes of moderate intensity (40%-60% VO_2 reserve) with three days of the week for minimum three months (6). Scientific evidence has suggested a significant relationship between a sedentary lifestyle, hypertension and obesity (7). Individuals who do not participate in daily structured exercise are more at risk for developing obesity or hypertension, thus it is important to enhance a physical activity across lifespan. Increase physical activity is recommended to prevent and treat hypertension (7). Hypertension can be a precursor of coronary heart disease. Therefore, it is extremely important for an individual to manage his or her own blood pressure. Hypertension is controllable through both diet and exercise with substantial evidence demonstrating a reduction of resting blood pressure through the chronic use of structured exercise (8). Leading a sedentary lifestyle can promote weight gain, increased body fat and decreased lean muscle mass; eventually lead to obesity (6). Obesity is an epidemic in today's society and can lead to hypertension, diabetes, several types of cancer and heart failure (6). Structured physical exercise is an effective and alternative means of non-pharmacological treatment to high blood pressure, attenuates the development of hypertension, promote weight loss and decreased the total body fat. By contrast, the fundamental means that used for the reductive and possible preventive effects induced by physical exercise not yet clearly stated in Ethiopian context. This indicates that research work must be done in the arena of hypertension because the awareness, treatment and control mechanism of high blood pressure is still extremely low in Ethiopia.

To our knowledge, currently no study has evaluated the impact of physical exercise on blood pressure and the fundamental variables that may aggravate the development of hypertension particularly within hypertensive adult patients. So, this research was intended to contribute to bridging the information gap. Consequently, the aim of this research was to examine the physiological impact of physical exercise on total percentage of body fat, mean arterial blood pressure plus total body weight among sedentary hypertensive patients.

2. Materials and Methods

2.1. Study Design and Timeframe

Experimental design was employed to measure the physiological effect of physical activity on body composition and resting blood pressure among sedentary hypertensive patients attending Jimma University Specialized Hospital. The study was carried on in Jimma University Fitness Center for over a 10 weeks period, from May 2015 to June 2015.

2.2. Study/Subject Population

Each participant was required all the following inclusionary criteria: Adult with non-smoking status; adult with sedentary lifestyle; adult with the ages of 30 to 45 years; adult with body mass index > 30 (kg/m^2); hypertensive blood pressure status ($\geq$140/90 mmHg) and individuals voluntary to participate were included in the study. However, individuals who had side effect to exercise testing such as diagnosed heart disease, osteoporosis, uncontrolled metabolic disease, neuromuscular disease, current musculoskeletal or rheumatoid disorders that are exacerbated by exercise were excluded from the study. All the individuals were recruited from Jimma University Specialized Hospital.

2.3. Hypertension Assessment

Participant's blood pressure was measured and confirmed by medical doctor to establish the status of blood pressure prior to the study period in the exercise testing room in Jimma University Fitness Center. If the subject's systolic arterial BP > 140 mmHg and a diastolic arterial BP > 90 mmHg in at least 2 of the 3 measurements, then the subject was considered to have hypertension (9).

2.4. Equipments and Procedure of Physiological Testing

All participants were assessed the current performance by questionnaire whether they are able to engage in physical activity or they get permission from their physicians to take part in the study. The questionnaire also supervises the feeding habit of the participants to make sure that they are free (protect) from consuming excess amounts of sodium (table salt) during the study, which affect the blood pressure results. In addition, participants were randomly assigned into control and experimental group by analyzing Godin Leisure-Time Activity questionnaire (10). This questionnaire estimated their level of exercise before the study and method of stratification was done in order to ensure that each group had a relatively similar number of 'relatively active' versus 'relatively sedentary' individuals. Both the control and experimental group were undergoing pretest and posttest on resting blood pressure, percentage of body fat, weight and height, waist and hip circumferences. However, only experimental group was completed the exercise protocol.

2.5. Anthropometry Measurement

2.5.1. Body Weight and Height Measurement

Height was measured using a wall-mounted stadiometer. Body weight was measured using a digital calibrated scale. Body weight and height were used to calculate body mass index (BMI) of the participants. The equation BMI = weight (kg)/height (m^2) was used (11).

2.5.2. Waist and Hip Circumferences Measurement

Waist and hip circumferences were measured using a flexible, non-elastic (gulick) tape. A waist-to-hip ratio was used to measure central obesity of the participants (11).

2.6. Blood Pressure Measurement

Sphygmomanometer was used to measure the resting blood pressure using before the start of exercise test, during rest and after the exercise test during passive recovery. Resting blood pressure was then used to indirectly estimate participants mean arterial pressure (estimated by taking the sum of a participant's diastolic pressure and pulse pressure, where pulse pressure is the difference of systolic and diastolic blood pressure). Mean arterial pressure used to describe an individual's average blood pressure (12).

2.7. Body Composition / Body Fat Percentage Measurement

Body composition measurements were obtained using air-displacement plethysmography of a BOD POD. The BOD POD technique has been declared a valid and reliable method. Air-displacement plethysmography has also been shown to place low demands on the subject and convenient method for measuring body composition/ assessing body fat (13).

2.8. Physical Exercise Training Protocol

All participants accomplished the initial Godin Leisure-Time Exercise Questionnaire, Physical Activity Readiness Questionnaire and Diet questionnaire. During week 1 pretest measurement of blood pressure, percentage of body fat, body weight and height, waist and hip circumferences were done on each experimental and control group. In addition, during week 10 posttest measurement on dependent variables were collected to observe the difference. During weeks 2-9, subjects in the experimental group were required to exercise three times per week for 30 minutes per session for 8 weeks period. The exercise training protocol consisted of strength exercises, endurance exercises & flexibility exercises. During the intervention, the control group did not participate in this eight week of exercise intervention.

2.9. Methods of Data analysis

All variables in the survey were coded and entered using SPSS 17 version software. Descriptive analysis including frequency and means were calculated for variables including gender, Age and height. Pre-Post test differences on changes of body mass index, percentage of body fat, body weight, and mean arterial blood pressure within (pre $v_{s.}$ post) each experimental and control group were analyzed using paired-samples t-test; pre test mean difference on dependent variables between groups were analyzed using one-way ANOVA; and post test mean difference on dependent variables between experimental and control group were analyzed using independent samples t-test with statistical analysis software (SPSS). The statistical significance level was established at $p < 0.05$.

2.10. Ethical Considerations

Ethical clearance was obtained from Jimma University Institutional Review Board, College of Natural Sciences. Permission was obtained from director of Jimma University specialized hospital. Prior to signing on informed consent form, all the participants were understood the benefits associated with participating in the study. Then the study was done with an informed written consent obtained from each participant and their physician.

3. Results

A total of 30 hypertensive adult patients completed the 10-week physical exercise training protocol. There was a total of male (n = 17) and female (n = 13) participants. The experimental group consisted of 8 male & 7 female participants, and the control group consisted of 9 male and 6 female participants. Participant's ages ranged from 30 to 45 with a mean age of 38.733 ± 4.417, and their height ranged from 1.4m to 1.8m with a mean height of 1.597 ± 0.096 respectively.

Experimental Group (n=15)			**Control group (n=15)**			
Category	M	SD	M	SD	F	P
Age (yrs)	38.6	4.577	38.8	4.411	0.007	0.936
Body Weight (Kg)	87.4	7.26	84.0	7.00	10.703	0.004
Height (m)	1.617	0.088	1.577	0.102	1.254	0.272
Body Mass Index (Kg/m^2)	34.13	5.12	33.09	3.83	0.398	0.533
Waist Circumference (cm)	105.6	13.92	90.26	11.30	10.961	0.003
Hip Circumference (cm)	117.4	13.63	104.8	13.96	6.185	0.019
Waist to Hip ratio	0.89	0.03	0.86	0.05	5.492	0.026
Systolic Blood Pressure (mmHg)	168.00	9.76	158.00	11.17	6.185	0.019
Diastolic Blood Pressure (mmHg)	102.07	4.35	99.66	5.60	1.718	0.201
Mean Arterial Pressure (mmHg)	123.69	3.77	119.00	5.26	8.016	0.008
Total Body Fat (%)	40.16	1.13	39.24	1.79	2.856	0.102

Table 1: Pre -Test Intervention Mean Comparison of Physical Characteristics between the Experimental and Control Group Attending In Jimma University Specialized Hospital

At the pre-exercise period, there were no significant differences were observed between the control and experimental group regarding participant's age $F (1, 28) = 0.007$, $p = 0.936$, height $F (1, 28) = 1.254$, $p = 1.272$, Hip $F (1, 28) =6.185$, $p =0.019$,waist hip ratio $F (1, 28) =5.492$, $p =0.026$, SBP $F (1, 28) =6.185$, $p =0.019$, DBP $F (1, 28) =1.718$, $p =0.201$, total body fat $F (1, 28) =2.856$, $p =0.102$.

In addition, we also examined weight, BMI, waist circumference and MAP to assess if the control and experimental group were statistically different at pre- intervention period. One-way ANOVA revealed significant differences between groups regarding participant's pre- intervention body weight $F (1, 28) =10.703$, $p =0.004$, mean arterial pressure $F (1, 28) =8.016$, $p =0.008$, and waist circumference $F (1, 28) =10.961$, $p =0.003$. The experimental group exhibited greater average body weight (87.4 ± 7.26), mean arterial pressure (123.69 ± 3.77) and waist circumference (105.6± 13.92) when compared to the control group (84.0 ± 7.00), (119.00 ± 5.26), (90.26 ±11.30), respectively.

Experimental Group (n=15)			Control Group (n=15)			
Category	M	**SD**	**M**	**SD**	**T**	**sig. (2-tailed)**
Body Weight (Kg)	83.73	7.00	85.60	6.76	0.703	0.488
Body Mass Index (Kg/m^2)	33.719	3.779	33.012	4.829	-0.446	0.659
Waist Circumference (cm)	92.733	11.743	105.4	13.558	1.656	0.109
Systolic Blood Pressure (mmHg)	161.93	11.21	163.33	10.32	0.356	0.725
Diastolic Blood Pressure (mmHg)	99.33	4.28	100.67	5.60	0.732	0.470
Mean Arterial Pressure (mmHg)	120.27	4.399	120.87	5.409	0.333	0.741
Total Body Fat (%)	38.440	1.155	40.613	1.729	4.046	0.000

Table 2: Post-Test Intervention Mean Comparison of Physical Characteristics between the Experimental and Control Group Attending in Jimma University Specialized Hospital

An independent-samples t-test was conducted to evaluate the differences between the control and experimental group regarding participant's post- intervention body weight (t (28) = 0.703, p =0.488); mean arterial pressure (t (28) =0.333, p =0.741); systolic blood pressure (t (28) = 0.356, p =0.725); and Waist circumference (t (28) =1.656, p=0.109). There were no significant differences (p >0.05) in body weight, mean arterial pressure, systolic blood pressure and waist circumference between the control and experimental group. The control group exhibited different average body weight (M=85.60, SD=6.76); mean arterial pressure (M=120.87, SD=5.409); waist circumference (M=105.4, SD=9.76); systolic blood pressure (M=168.0, SD=9.76); and body fat percentage (M=40.613, SD=1.729);when compared with the experimental group (M=83.73, SD=7.00), (M=120.27, SD=4.399), (M=92.733, SD=11.743), (M=161.93, SD=11.21), and (M=38.440, SD=1.155), respectively. However, there was significant difference between the control and experimental groups in post-intervention of total body fat (t (28) =4.046, p=0.000).

Experimental Group (n=15)					Control Group (n=15)			
	Pre	Post			Pre	Post		
Variables	M+SD	M+SD	t	sig.(2-tailed)	M+SD	M+SD	t	sig.(2-tailed)
BW (Kg)	87.4 +7.26	83.7+7.74	-8.07	0.000	84.0+ 7.0	85.6 +6.76	+6.80	0.000
BMI (Kg/m2)	34.1+ 5.12	33.0 +4.82	-9.59	0.000	33.0 +3.83	33.7+3.77	+10.02	0.000
SBP (mmHg)	168.0 +9.76	163.33+10.32	-8.00	0.000	158.47 +11.17	161.93 +11.21	+6.85	0.000
DBP (mmHg)	102.07 +4.35	99.33 +4.28	-11.01	0.000	99.66+ 4.48	100.60 +5.60	+11.47	0.000
MAP (mmHg)	123 +3.76	120.2+ 4.39	-10.77	0.000	119+ 5.26	120.8+ 5.4	+8.67	0.000
TBF (%)	40.16+1.13	38.44+1.15	-8.89	0.000	39.24+1.79	40.61+ 1.72	+7.68	0.000

Table 3: Mean Difference of Body Weight, BMI, Mean Arterial Pressure and Total Body Fat within (Pre $V_{s.}$ Post) Experimental and Control Group before and After the Ten-Week Intervention

Note: Data are presented as mean ± standard deviation; BMI = body mass index; BW= body weight; SBP = systolic blood pressure; DBP = diastolic blood pressure; MAP = mean arterial pressure; TBF= Total body fat.

A paired-sample t-test was carried to measure the effect of the intervention on changes of body weight, body mass index, percentage of body fat, and mean arterial pressure within the control and experimental group. As expected, the control group increase their body weight, body mass index, body fat percentage, and mean arterial pressure after the 10-week intervention period (BW pre 84.0 ± 7.0 kg, BW post 85.6 ± 6.76 kg; BMI pre 33.09 ± 3.83 kg/m2, BMI post 33.71 ± 3.77 kg/m2; MAP pre 119.0 ± 5.26 mm Hg, MAP post 120.8 ± 5.40mm Hg; and BFP pre 39.24 ± 1.79 %, BFP post 40.61 ± 1.72 %). Surprisingly, there was strong significant differences on body weight, body mass index, body fat percentage, and mean arterial pressure between pre and post in control group (p<0.0005). However, in the current study our primary objective was to evaluate the effects of 10-week physical exercise training on body weight, body mass index, body fat percentage, and mean arterial pressure within the experimental group of individuals. Our findings demonstrated that pre vs. post measurements on body weight, body mass index, body fat percentage, and mean arterial pressure deceased in the experimental group (BW pre 87.0 ± 7.26 kg, BW post 83.73 ± 7.74 kg; BMI pre 34.13 ± 5.12 kg/m2, BMI post 33.01 ± 4.82 kg/m2; MAP pre 123.7 ± 3.76 mm Hg, MAP post 120.2 ± 4.39mm Hg ; and BFP pre 40.16 ± 1.13 %, BFP post 38.44 ± 1.15 %). The most striking result to emerge from the data is that, there was strong significant differences on body weight, body mass index, body fat percentage, and mean arterial pressure between pre and post in experimental group (p<0.0005).

	Experimental group (n=15)	Control group (n=15)
Variables	M±SD	M±SD
Body Weight (Kg)	-3.66 ±1.75	+1.60± 0.91
BMI (Kg/m²)	-1.12± 0.45	+0.62± 0.24
SBP (mmHg)	-4.66 ±2.25	+3.46 ±1.95
DBP (mmHg)	-2.73 ±0.96	+2.64± 0.91
MAP (mmHg)	-3.46± 1.24	+1.86 ±0.83
TBF (%)	-1.72 ± 0.75	+1.37 ±0.69

Table 4: Overall Mean Difference of Body Weight, BMI, Mean Arterial Pressure and Total Body Fat Percent within Experimental and Control Group before and after the Ten-Week Intervention

Note: Data are presented as mean ± standard deviation; BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; MAP = mean arterial pressure; TBF= Total body fat.

Further analysis showed that, there was significant differences in the overall changes of body weight changes (t (28) = 6.808, p = 0.000); body mass index changes (t (28) = 10.024, p = 0.000); body fat percentage changes (t (28) = 7.68, p = 0.000); and mean arterial pressure changes (t (28) = 8.67, p = 0.000) between pre and post in control group. The control group indicated a greater overall increased in body weight changes by (+1.60±0.91), body mass index changes (+0.62±0.24), total body fat percentage changes (+1.37±0.69) and mean arterial pressure changes (+1.86±0.83). Moreover, there was significant differences in the overall changes of body weight changes (t (28) = -8.072, p = 0.000); body mass index changes (t (28) = -9.596, p = 0.000); body fat percentage changes (t (28) = -8.897, p = 0.000); and mean arterial pressure changes (t (28) = -10.77, p = 0.000) between pre and post in experimental group. The experimental group indicated a greater total decreased (loss) in body weight (-3.66 ±1.75), body mass index (-1.12± 0.45), body fat percentage (-1.72 ± 0.75) and mean arterial pressure (-3.46± 1.24) (Table 4).

4. Discussion

This study has tried to determine the physiological impact of physical activity on body composition and resting blood pressure among hypertensive patients attending in Jimma University Specialized Hospital.

The current finding of this study found that there was a significant difference in overall changes of systolic blood pressure, diastolic blood pressure and mean arterial pressure within the control and experimental group. Therefore, the control group indicated that a greater increased in systolic blood pressure, diastolic blood pressure, and mean arterial pressure whereas the experimental group showed that a greater total decreased (loss) in systolic blood pressure, diastolic blood pressure, and mean arterial pressure. These findings are in agreement with other findings that support physical training can reduce blood pressure. Supporting the current finding, some studies have confirmed that moderate intensity physical activity decline the blood pressure (14, 15, 16,).

The present study finding seem to be consistent with other research which reported that hypertensive individuals who engaged in physical exercise training protocol significantly decline their systolic blood pressure and diastolic blood pressure. Westheim et al. (17) found that physical exercise training is effectively decreasing the systolic blood pressure because of decreasing the sympathetic discharge at the same time decreased the diastolic blood pressure since physical exercise dilate the blood vessels especially in the arteries. In line with this, Tsai et al. (18) reported that enhanced the sodium losses during sweating as well as reduced the sympathetic discharge might be increased by physical activity. Decline the sympathetic nerve activity seen in individuals who participating in physical exercise was believe to be in response to decreasing the systolic blood pressure (19). Physical activity decreases the blood pressure by reducing the total peripheral resistance and enhancing the volume of blood ejected from the heart per minute (20, 21). Vasodilatation is one of the antihypertensive effects of physical activity (14). Physical activity relaxes the blood vessels by increasing the diameter of the lumen space. This successively decreases the pressure specifically generated against the wall of blood vessels as blood move through it. Another important finding was that the control group demonstrated a greater increased in body weight and percentage of body fat while on the contrary; the experimental group exhibited a greater total loss in body weight and body fat percentage. Supporting the current finding, several studies confirmed that physical exercise was correlated with the reduction of percentage body fat, visceral and subcutaneous adipose tissues. In addition, this study also indicated that with the detraining period, there was a negative change in percent body fat (22). The possible explanation for this might be that the impact of the physical exercise to the body weight mainly occurred by the effect on body fat percentage.

The present findings are consistent with those of other studies and suggest that physical activity increased body fat loss, energy expenses and thus occurred in company with weight loss (23). Likewise, Prately et al. (24) reported that moderate intensity aerobic exercise along with decreased caloric intake enhances the weight loss. Furthermore, Oppert et al. concluded that reduction in abdominal visceral fat caused by a negative energy balance with physical activity (25). Likewise, Church et al. (26) demonstrated that as exercise doses increased the greater difference occurred in weight lost and suggesting that the higher the doses of exercise the more compensation that will occur either by decreasing daily physical activity or increasing energy intake. However, decreases in weight, body fat and circumference measures did correlate with the total minutes of exercise, regardless of whether the exercise was of a structured or unstructured nature.

5. Conclusion

The control group showed greater average body weight, mean arterial pressure, waist circumference and body fat percentage when compared to experimental group during post intervention period. Furthermore, a greater total loss of body weight, body mass index, total percentage of body fat and mean arterial pressure were exhibited within the experimental group (pre test vs. posttest). However, a greater increased change of total body weight, body mass index, percentage of body fat and mean arterial pressure were demonstrated within the control group (pre test vs. posttest).

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