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Effects of prescribed low-intensity resistance exercise on prehypertension and other related factors in individuals living within Homa Bay Township, Western Kenya

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ABSTRACT

Prehypertension is the precursor to hypertension. It's anticipated that prehypertension will affect one-third of the population worldwide by 2025. For instance, Homa Bay County Referral Hospital has reported increase of pre-hypertensive patients over the past 5 years. Thus, this study aimed to determine the effects of prescribed low-intensity resistance exercise on prehypertension, anthropometric measurements, and biochemical levels in individuals living within Homa Bay Township. A randomized controlled trial study design was employed on 34 (17 experimental and 17 controls) pre-hypertensive adults. Participants performed prescribed low-intensity resistance exercise for a period of 3 months. Blood pressure, biochemical, and anthropometric data were collected on pre, mid, and post-training. ANOVA with a within-subjects factor of time, and treatment type was used to determine the differences between the two groups. Except for BMI [F (1, 32) =8.06, p=0.008], the study found that the prescribed low-intensity resistance exercise did not affect other anthropometric measurement of pre-hypertensive individuals. Prescribed low-intensity resistance exercises significantly, F (1, 32) =5.01, p=0.03, lowered the pre-hypertensive pressure in the experimental group to normotensive at post-study (from 127.59$\pm$5.01 to 115.88$\pm$6.06 mmHg systolic pressure) as compared to the control group (from 128.94$\pm$4.64 to 122.47$\pm$2.87 mmHg systolic pressure). Although lipid profiles and fasting blood glucose decreased in both experimental and control groups, the decline was more marked in the experimental group, suggesting that prescribed low-intensity exercise could decrease the variables. This study provides evidence that prescribed low-intensity resistance exercises prescription in prehypertension can prevent progression to hypertension.

Keywords: low-intensity resistance exercise, prehypertension, lipid-profile, anthropometric.

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INTRODUCTION

Hypertension is one of the Non-Communicable Diseases (NCD) whose prevalence is on the rise within developing countries *(27)*. According to Guwatudda *(8)*, the prevalence of hypertension and prehypertension is high at 25.9% and 21%, respectively; indicating burden, and future burden of hypertension-related NCDs if no appropriate interventions are implemented. According to Chobanian *(6)*, prehypertension is defined as systolic blood pressure greater than 120mmHg to 139mmHg while diastolic blood pressure is greater than 80mmHg to 89mmHg. Prehypertension does not often have complications *(6)*; however, if no mitigation is applied towards it, one gradually ends up having hypertension *(10)*. Harsh *(9)* noted that hypertension expose one to risk of cardiovascular diseases leading to cerebral vascular accident, eye diseases, and renal diseases.

In Kenya, hypertension is the most common cardiovascular problem and it has increased over the last 20 years *(17)*. Mathenge *(14)* noted that there is a paucity of data on prehypertension prevalence within Kenya, and at the time of the study, the government of Kenya under the Ministry of Health termed hypertension as a silent killer, where, 1 in every 4 Kenyans, has hypertension *(12)*. For instance, Homa Bay County Hospital has reported an increasing number of patients diagnosed with prehypertension over the past 5 years, mostly emerging from individuals living within Homa Bay Township. In July 2014; 912 patients were diagnosed with prehypertension at Homa Bay County Hospital, while in September 2019; 3510 patients were diagnosed with prehypertension showing an increase of more than 300%. Despite hypertension intervention efforts on awareness and antihypertensive drugs within the country, hypertension is still on the rise within the population particularly those living in urban areas. Management of hypertension-related problems is very expensive and places a heavy financial burden on the affected families. Hence, the need to investigate its effective detection and management procedures that will lead to early detection and hence prevention of prehypertension progression to hypertension, and/or, revert pre-hypertensive status to normotensive amongst populations. It is hypothesized that low-intensity resistance exercise can be used as an intervention in prehypertension to prevent the progression of the condition into hypertension. The researcher, therefore, intended to conduct a study to determine the effect of prescribed low-intensity resistance exercises on prehypertension and other related factors in individuals living in Homa Bay Township, Western Kenya.

Anaerobic exercise (also known as resistance training) is characterized by the execution of exercises in which muscles from a specific body segment are contracted against a force that opposes the movement *(24)*. Anaerobic exercise exerts an anti-inflammatory action through the sympathetic nervous system and the hypothalamus-pituitary-adrenal axis, and, has direct effects on blood pressure resulting in a physiological increase of systolic blood pressure (SBP) and diastolic blood pressure (DBP) during training, and further brings about drastic reduction of resting blood pressure *(7)*. Resistance training regimens consist of 2 to 3 sessions per week of 8 to 10 weight-lifting exercises working for the important muscle groups at a resistance (weight) of 30% to 40% of the 1 – repetition maximum (i.e., the heaviest weight that can be lifted once) for upper-body exercises and 50% to 60% of the 1 – repetition maximum for lower – body exercises. The exercise training should comprise 3 sets of 10 to 15 repetitions. Patients should avoid prolonged breath-holding while performing resistance training. If the resistance training program increases the DBP more than 20 mm Hg over baseline or the DBP rises above 120 mm Hg, the program should be reviewed *(24)*. Fagard *(7)* furthered that exercise prescription in patients, more so, with high blood pressure should be individualized, and the prescription should include; frequency, intensity, time, and type.

Pre-participation screening depends on the intensity of the planned exercise and the patient's global cardiovascular risk. The points below highlight recommendations related to pre-participation screening *(13)*: For asymptomatic patients with BP less than 180/110 mm Hg intending to participate in light to moderate exercise (< 60% VO_{2max} or < 6 METs), there is no need for evaluation. Preliminary peak or symptom-limited exercise testing might be warranted when planning a vigorous exercise program (≥ 60% VO_{2max} or ≥ 6 METs) *(21)*. Patients with cardiovascular risk factors or stage 2 hypertension but without CVD or BP greater than 180/110 mm Hg need to be screened before engaging in moderate-intensity exercise (40% to 60% VO_{2max} or 3 to 6 METs), but not for light activity (< 40% VO_{2max} or MET < 3). Exercise testing is essential for all patients with documented CVD, whatever the level of exercise intensity. Vigorous exercise (≥ 60% VO_{2max} or ≥ 6 METs) should only be performed in dedicated cardiac rehabilitation centers. Absolute contraindications to aerobic and resistance training programs include recent myocardial infarction or electrocardiography changes indicating conduction failure such as; complete heart block, acute congestive heart failure, unstable angina, and uncontrolled severe hypertension (BP ≥180/110 mm Hg).

Substantial evidence emphasizes the role of moderate-intensity aerobic exercise in preventing hypertension and managing stage 1 hypertension. There is insufficient evidence that resistance training if done properly, can contributes to lowering both SBP and DBP. Furthermore, there is insufficient evidence about the safety and efficacy of resistance training. Additionally, before starting an exercise program, patients with Stage II hypertension, especially, those with SBP greater than 180 mm Hg and those with CVD or diabetes should have a pre-participation examination. When prescribing exercise, it is important to consider monitoring training programs and to account for the individual's preferences, as this will affect long-term adherence. Further research should focus on the assessment of effect of resistance training *(21)*. Amiri *(2)* compared the effects of walking with low or and high intensities on the body composition of overweight women. The study used 20 overweight women (25-40 years) randomly placed in two groups each with ten individuals: high intensity and low-intensity walking exercises. The period of the walking exercise included 8 weeks and 3 sessions every week, and every session for 30 minutes walking with mentioned intensities. Findings showed that walking with high intensity was more effective on variations of body composition in women with overweight, and could have a more important role in the control of body weight. The study by Amiri *(2)* featured on the effect of exercise on the overweight women while the study by Moinuddin *(18)* featured on the assessment on anthropometric indices and physical activities in pre-hypertensive individuals were not conducted locally (Homa Bay). None of the studies was based on the effect of prescribed low-intensity resistance exercises on pre-hypertensives. The researcher, therefore, is proposing to investigate the effect of prescribed low-intensity resistance exercise on pre-hypertensive individuals at Homa Bay Township.

MATERIALS AND METHOD

Study Settings

The study was carried out at Homa Bay County Hospital within Homa Bay Township area. The researcher employed a randomized controlled trial design. Thirty-four (17 experimental and 17 controls) adults were purposively recruited into the study and followed for three months.

Study procedure

Recruitment Procedure of Participants

Participants were taken through the informed consent process. The consent form included; the title of the research, purpose of the study, description of the study, the involvement of the participant, confidentiality, voluntary participation and withdrawal, alternative to participation, risks, and benefits, compensation, contacts for questioning, and voluntary consent. They signed the consent form after they agree to participate in the study.

To ensure safety or harm of blood draws, hand hygiene was maintained by using soap and water or alcohol swabs, well-fitting gloves, single-use disposable needles, and syringes. This was practiced before and after each participant's contact. The investigator ensured that there was the availability of sufficient laboratory sample tubes for blood storage. In the case of accidental exposure, the incidence was reported and recorded in a register, and thereafter, the support services were promoted such as post-exposure prophylaxis (PEP) to avert HIV infection. Blood sampling was done privately and clearly. After the draw, the used needles and syringes were discarded into the robust sharps container. In case of bleeding or bruising excessively during blood drawing, the physician was contacted as quickly as possible meanwhile the blood drawer continues to apply pressure as recommended by medical practice as the PI tries to stem the blood flow. And in case of exercise accidents such as exertional, the participant was stopped from doing the exercises, and the physician was contacted immediately.

Low-Intensity Resistant Exercise Training Protocol

The researcher explained and prepared the participants for the procedures. Participants completed experiments at the same time in the morning at least 48 hours apart for 3 months duration. Participants were instructed to consume normal meals but advised to take caffeinated beverages 6 hours before exercise. Upon arrival for each session, participants were warmly welcomed and allowed to rest for 10 minutes in a supine position before commencing the exercise. Participants performed four, 2 minutes weight lifting contractions of the upper extremities at 30% maximum voluntary contraction (MVC) with ½ minute rest between contractions for 30 minutes. For the lower extremities exercise; participants performed four, 2 minutes contractions at 40% MVC with 1 minute's rest between contractions for 30 minutes *(24)*. Exercises were concluded after 30 minutes of seated recovery resting position followed by 30 minutes of supine recovery rest.

Anthropometric Data Collection

BMI (kg/m^2) was calculated from the participant's body weight and height using an automated medical weighing and height machine (Stadiometer) (DP3700 DISPLAY – MS4910, Charder Electronic Co., Ltd, Taichung, Taiwan). Waist circumference was measured midway between the iliac crest and the lower rib margin and the hip circumference was measured at the intertrochanteric level. Waist-to-hip ratio (WHR) was calculated as waist (cm)/hip (cm) circumferences. Waist and hip circumferences were measured using a non-distensible Gulick tape measure (DY-BL1201 MPN: 5193, Windham, New Hampshire, United States). Anthropometric measurements were taken pre-training, mid-training, and post-training.

Blood Pressure measurement

Qualified healthcare workers measured the blood pressure of the participants with an automated sphygmomanometer (OMRON M3 HEM-7200-E Omron Matsusaka Co Ltd, Kyoto, Japan) according to AHA Standards *(22)*. The qualified healthcare workers also measured participant blood pressure at the pre-training stage, after mid-training, and post-training as established in the protocol of Ash *(4)*. The participant who was 18 years and above with prehypertension status of systolic blood pressure (121-130) mmHg and diastolic blood pressure of (81-90) mmHg were enrolled in the study. A calibration check was done using a mercury sphygmomanometer (ADC™ 922-11ABK Diagnostix Traditional Desktop, assembled in the US, made in China).

Blood sample collection

Fasting Blood Glucose Level Determination

Fasting blood glucose level was taken after 8 – 12 hours of not taking any meal by a phlebotomist in the morning of pre-training, mid-training, and post-training at Homa Bay County Referral Hospital. The fasting blood glucose was executed by putting blood on a glucose meter strip that was inserted into the machine (glucometer) and the results showed on the screen in 10 – 20 seconds.

Blood Lipid Profile Levels Determination

The participant provided a fasting blood sample of 5ml for values of serum lipid profile (LDL, HDL, Cholesterol, and triglyceride) levels in the morning of pre-training, mid-training, and post-training at Homa Bay County Referral Hospital.

Data management and statistical analysis

Data were entered in a Microsoft Access Database. All experimental results were evaluated and analysis of variance (ANOVA) was used to investigate associations between variables (the relationship between low-intensity resistance exercises and prehypertension). The presentation was done by using charts, tables, and graphs. The significance level was set at $p \leq 0.05$ for both the control and experimental groups for all the parameters that were tested. Data were averaged and presented as means ± SD. Differences in maximum fasting glucose, BP, and lipid profile levels pre, mid, and post-test were analyzed within each group using paired samples t-test: repeated measures design. Data were analyzed using SPSS version 23 software.

Ethical considerations

Approval was sought from Maseno University Ethical Committee (REF: MSU/DRPI/MUERC/00754/19) through the School of Graduate Studies (REF: MSC/SM/00007/2016), thereafter permission was sought from the Homa Bay County, Ministry of Health (REF:HB/MED/B/10/VOL.7/166). A license to conduct the study was given from the National Commission for Science, Technology & Innovation (NACOSTI LICENSE NO: NACOSTI/P/20/4338). The objectives of the study were explained and made available to all the participants in the form of an informed consent form. Participation was voluntary and participants were allowed to withdraw from the study at any time with no consequences. Informed written consent was obtained from all participants and assured of respect, confidentiality, and anonymity before participating in the study. In any case of emergency, appropriate measures were put in place to mitigate the incidence and assure the safety of the participants. All the data were kept secure and confidential, password protected in a locked lab.

RESULTS AND DISCUSSION

Demographic Profile of Respondents

The data from this section gives biographical information of the participants in the study to understand their profile. The information sought included the respondents' gender, age, highest educational level, and age.

Table 1 Biographic information of respondents

Bio-graphic information	Overall (n=34)	Experimental group (n=17)	Control group (n=17)
Respondents' gender			
1.Female (%)	21 (61.8)	10 (58.8)	11 (64.7)
2.Male (%)	13 (38.2)	7 (41.2)	6 (35.3)
3.Total (%)	34 (100.0)	17 (100.0)	17 (100.0)
Highest education level			
1. KCPE (%)	8 (23.5)	5 (29.4)	3 (17.6)
2. KCSE (%)	5 (14.7)	3 (17.6)	2 (11.8)
3. Diploma (%)	8 (23.5)	5 (29.4)	3 (17.6)
4. Higher diploma (%)	4 (11.8)	0 (0.0)	4 (23.5)
5. BSc (%)	5 (14.7)	3 (17.6)	2 (11.8)
6. MSc (%)	4 (11.8)	1 (5.9)	3 (17.6)
7. Total (%)	34 (100.0)	17 (100.0)	17 (100.0)
Respondents' age			
Mean years + SD	34.91±7.29	32.88±6.08	36.94±7.99

Key: SD = standard deviation; n = number of respondents

Results presented in Table 1 shows that the researcher collected data from 34 respondents (17 each for the experimental and control groups). Data were collected from the participants at three time periods: pre-study, mid-study, and post-study. The study also showed that the study sampled slightly more females (62%) compared with male (38%) participants. Gender distribution among the experimental and control groups generally reflected the overall proportion: 59% female and 41% male in the experimental group and 65% female and 35% male participants in the control group. This study sampled both males and females, suggesting that results from this study reflected both genders.

The majority of the respondents were fairly educated, with 62% of them possessing a diploma or higher qualifications. Only 38% of them had basic education (KCPE and KCSE as their highest education qualification). This pattern was maintained, when the data were decomposed into experimental and control groups, with most participants having a diploma or higher qualifications. The results suggested that participants in the study area were fairly educated.

The mean age of the respondents was 35 years and there was no significant difference in age between the experimental group and controls group Since the standard deviation for age was roughly seven, and assuming a Gaussian distribution (skewness=0.19 and kurtosis= -0.72) it implied that most of the participants were aged between 28 and 42 years, suggesting that participants in the study area were relatively youthful. Participants in the experimental group were slightly younger (mean 33 years) compared to those in the control group (mean 37 years).

Effects of prescribed Low-Intensity Resistance exercise on Anthropometric Measurement in Pre-hypertensive individuals

Table 2 shows the anthropometric measurements recorded at pre-training, mid-training, and post-training.

Table 2 Anthropometric measurements at pre-, mid-, and post-training

Variable	Treat.	Pre-Study Mean±SD	Mid-Study Mean±SD	Post-Study Mean±SD	Main effects (F values) Group	Time	Interaction (F value) Group*Time
Height Metres)	Exp.	1.66±0.08[a, k]	1.66±0.08[a, k]	1.66±0.08[a, k]	3.69[ns]	-	-
	Cont.	1.60±0.09[a, k]	1.60±0.08[a, k]	1.60±0.08[a, k]			
Weight (kg)	Exp.	72.65±13.71[a, k]	71.29±12.11[b, k]	69.00±10.28[c, k]	2.65[ns]	18.99[**]	2.21[ns]
	Cont.	77.47±7.49[a, k]	76.41±7.27[ab, k]	75.59±6.98[b, k]			
BMI (kg/m^2)	Exp.	26.29±5.24[a, k]	25.88±4.76[a, k]	25.12±3.99[b, k]	8.06[**]	12.90[**]	1.18[ns]
	Cont.	30.41±4.37[a, l]	30.12±4.30[ab, l]	29.76±4.16[b, l]			
WC (cm)	Exp.	83.24±13.19[a, k]	81.88±12.04[b, k]	79.94±12.19[c, k]	3.11[ns]	33.98[**]	0.08[ns]
	Cont.	90.59±12.83[a, k]	89.18±12.36[b, k]	87.53±11.26[c, k]			
HC (cm)	Exp.	89.82±18.76[a, k]	88.71±17.75[a, k]	86.47±16.21[b, k]	0.31[ns]	24.17[**]	0.48[ns]
	Cont.	92.88±18.11[a, k]	91.82±17.57[a, k]	90.29±16.25[b, k]			
WHR	Exp.	0.96±0.22[a, k]	0.95±0.21[a, k]	0.94±0.18[a, k]	0.54[ns]	1.94[ns]	0.20[ns]
	Cont.	1.03±0.38[a, k]	1.03±0.36[a, k]	1.01±0.32[a, k]			

Key. BMI: body mass index, BMI: body mass index, WC: Waist circumference, HC: Hip circumference, WHR: Waist to hip ratio, SD: standard deviation, Treat. Treatment, Exp.: experimental, Cont.: Control. For every group, means with similar letters in a row (a, b, and c) and for every variable, means with similar letters in a column (k and l) are not significantly different by Tukey HSD test. [**], [*]: significant at 99% and 95% significance levels, respectively.

Height did not change in both experimental (1.66 m) and control (1.60 m) groups in all the three times of study. A mixed-design (repeated-measures) ANOVA with a within-subjects factor of time of the study (pre-, mid-, and post-study) and a between-subject factor of treatment type (experimental and control groups) was conducted to determine the effect of these factors. A non-significant main effect of group was found, F (1, 29) = 3.69, p =0.07. Since height was constant (and its standard deviation) in all the three study periods in both groups, F statistics for both the main effect of time and the interaction between group and time could not be computed. The results suggested that prescribed low-intensity resistance exercise does not affect the height of pre-hypertensive individuals. In addition passage of time had no significant influence on their height.

For similar reasons as those given above, the predicted plot of the interaction between group and time could be drawn.

The weight of participants decreased in both the experimental and control groups, as the study progressed from pre- to mid-and post-study. A mixed-design (repeated-measures) ANOVA with a within-subjects factor of time of the study (pre-, mid-, and post-study) and a between-subject factor of treatment type (experimental and control groups) was conducted to determine the effect of these factors. A significant main effect of time was found, F (1.14, 36.55) = 18.99, p<0.0001. However, the main effect of group, F (1, 32) = 2.65, p =0.113 and the interaction between group and time, F (1.14, 36.55) = 2.21, p =0.143, were found not to be significant. The results showed that the prescribed low-intensity resistance exercise does not affect the weight of pre-hypertensive individuals. On the other hand, changes in the study periods did influence the weight of individuals.

Post-hoc pair-wise comparisons of adjusted predictions revealed that weight measurements in the control group did not significantly differ between mid-study and pre-study or between post- and mid-study (Table 2). However, the weight was significantly lower in post-study relative to pre-study. However, in the experimental group, compared to the pre-study, weight was significantly lower in both mid-study and post-study (Figure 1).

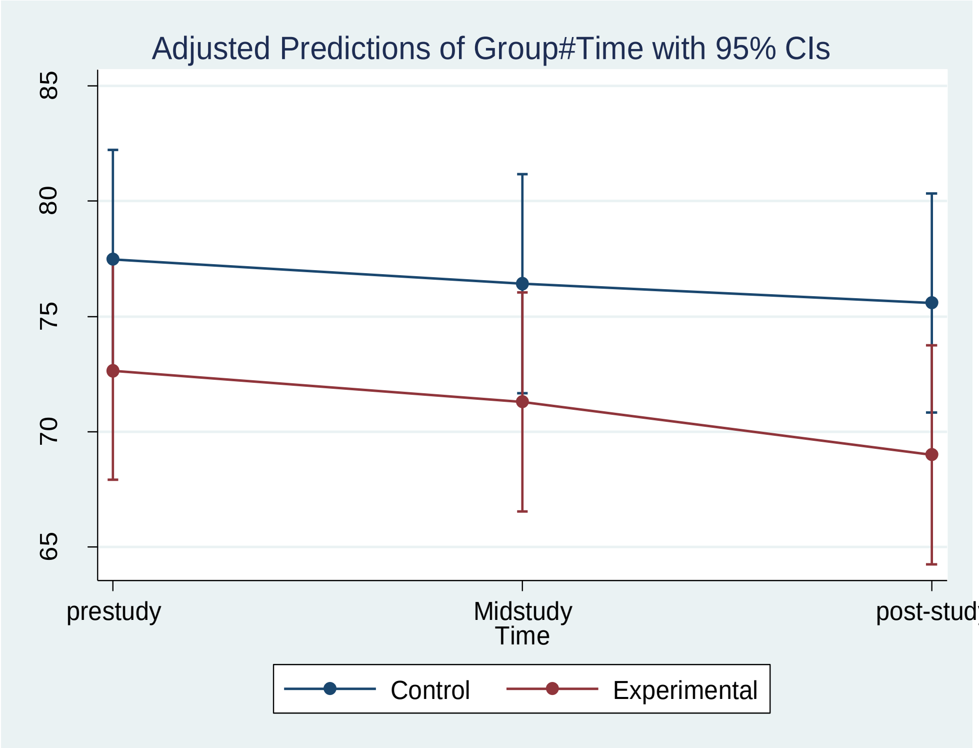

Figure 1: Predicted weight interactions between group and time

The results suggested that weight significantly decreased quickly in the experimental group beginning in mid-study while in the control group, weight significantly decreased only during post-study.

The BMI of participants decreased in both the experimental and control groups, as the study progressed from pre- to mid-and post-study. A mixed-design (repeated-measures) ANOVA with a within-subjects factor of time of the study (pre-, mid-, and post-study) and a between-subject factor of treatment type (experimental and control groups) was conducted to determine the effect of these factors. Significant main effects of group, F (1, 32) = 8.06, p=0.008 and time, F (1.38, 44.08) = 12.90, p<0.0001 were found. However, the interaction between group and time, F (1.38, 44.08) = 1.18, p =0.301, was found not to be significant. The results showed that the prescribed low-intensity resistance exercise and passage of time could affect the weight of prehypertensive individuals.

Post-hoc pairwise comparisons of adjusted predictions revealed that BMI measurements in the control group did not significantly differ between mid-study and pre-study or between post- and mid-study (Table 2). However, the BMI was significantly lower in post-study relative to pre-study. On the other hand, although BMI did not significantly differ between mid-study and pre-study, it was significantly lower in post-study compared to both mid-study and pre-study (Figure 2).

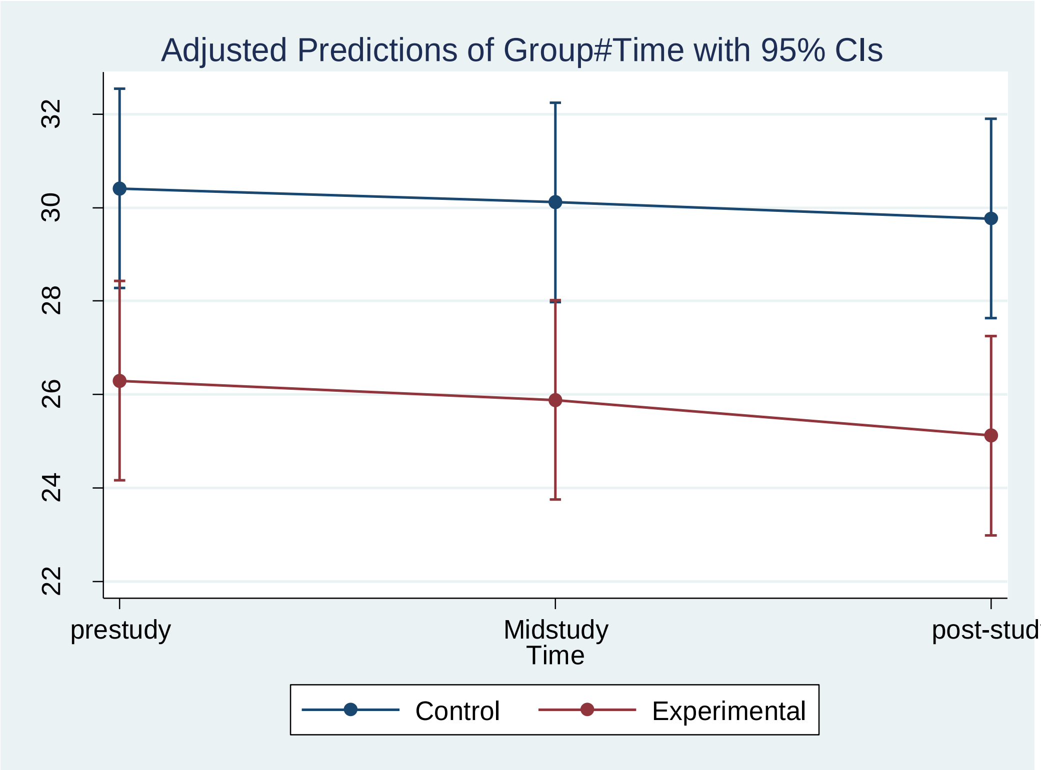

Figure 2: Predicted BMI interactions between group and time

In addition, the ANOVA model predicted that the biggest difference in the BMI means between experimental and control groups would occur in the post-study, as evidenced by non-overlapping confidence intervals. The confidence intervals of the predicted BMI overlap greatly in pre-study and to some extent, in mid-study. The results show that although the BMI means of experimental and control groups already diverged at pre-study, the greatest predicted divergence occurs at post-study. This suggested that low-intensity resistance exercise significantly decreases BMI levels.

The levels of WC decreased in both the control and experimental group during both mid-study and post-study. A mixed ANOVA was conducted to determine the effect of time and group on WC levels. A significant main effect of time, F (1.30, 41.55) = 33.98, $p < 0.0001$ was found. However, the main effect of group, F (1, 32) = 3.11, $p = 0.08$ and the interaction between group and time, F (2, 41.55) = 0.08, $p = 0.84$ were found not to be significant.

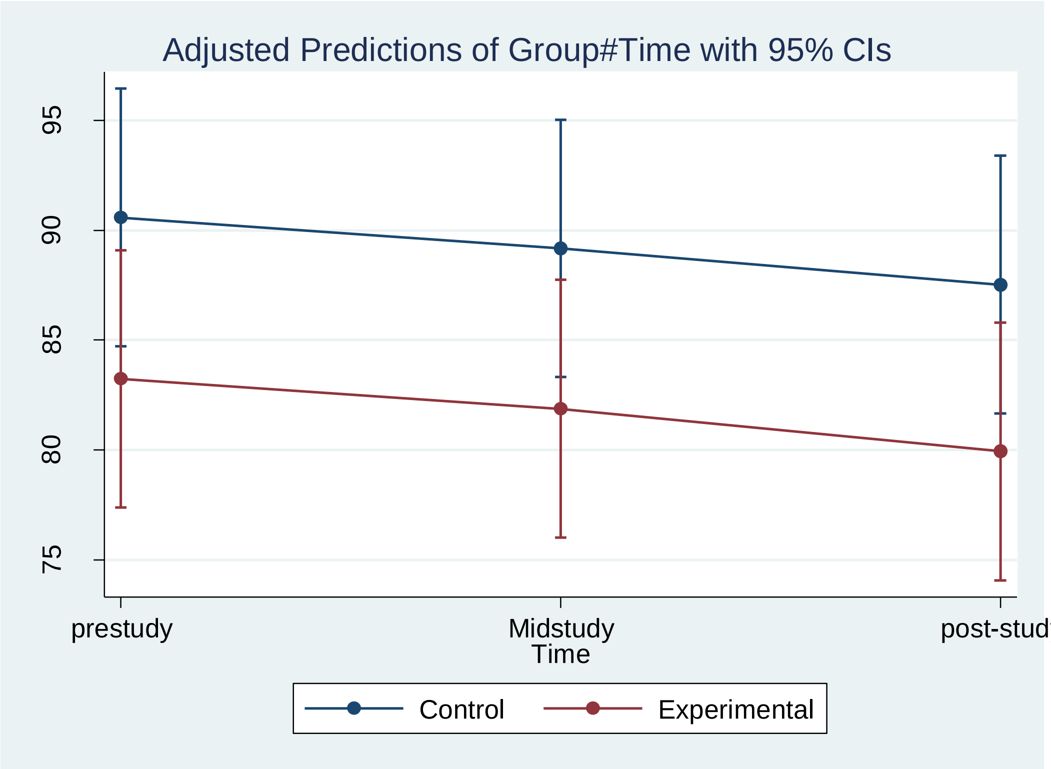

Figure 3: Predicted WC interactions between group and time

Pairwise comparisons showed that in both the experimental and control groups, WC decreased significantly both mid-and post-study compared to pre-study (Table 2 and Figure 3). The findings suggested that over time, WC decreases significantly in both control and experimental groups. Nevertheless, no significant differences were recorded at any time of the study, as evidenced by the overlapping confidence intervals in Figure 3, indicating that low-intensity resistance exercise does not significantly lower WC levels.

The levels of HC generally decreased in both the experimental and control groups during both mid-study and post-study periods relative to pre-study. A mixed ANOVA was conducted to determine the effect of time and group on HC levels. A significant main effect of time, F (1.17, 37.52) = 24.17, p<0.0001 was found on the level of HC. However, group, F (1, 32) = 0.31, p = 0.58 and the interaction between group and time, F (1.17, 37.52) = 0.48, p = 0.52, were found to have no significant effect on the level of HC.

For both the experimental and control groups, HC levels at mid-study were not significantly different from the levels at pre-training (Table 2). However, HC level at post-study in both groups was significantly lower compared to both mid-and pre-study, suggesting that a longer time is required to reduce the level of HC in the body. However, there were no significant differences in HC between experimental and control groups at all time periods (pre-study: z= -0.51, p=0.61; mid-study: z= -0.52, p=0.60; and post-study: z= -0.64, p=0.52) and overlapping confidence intervals on Figure 4.

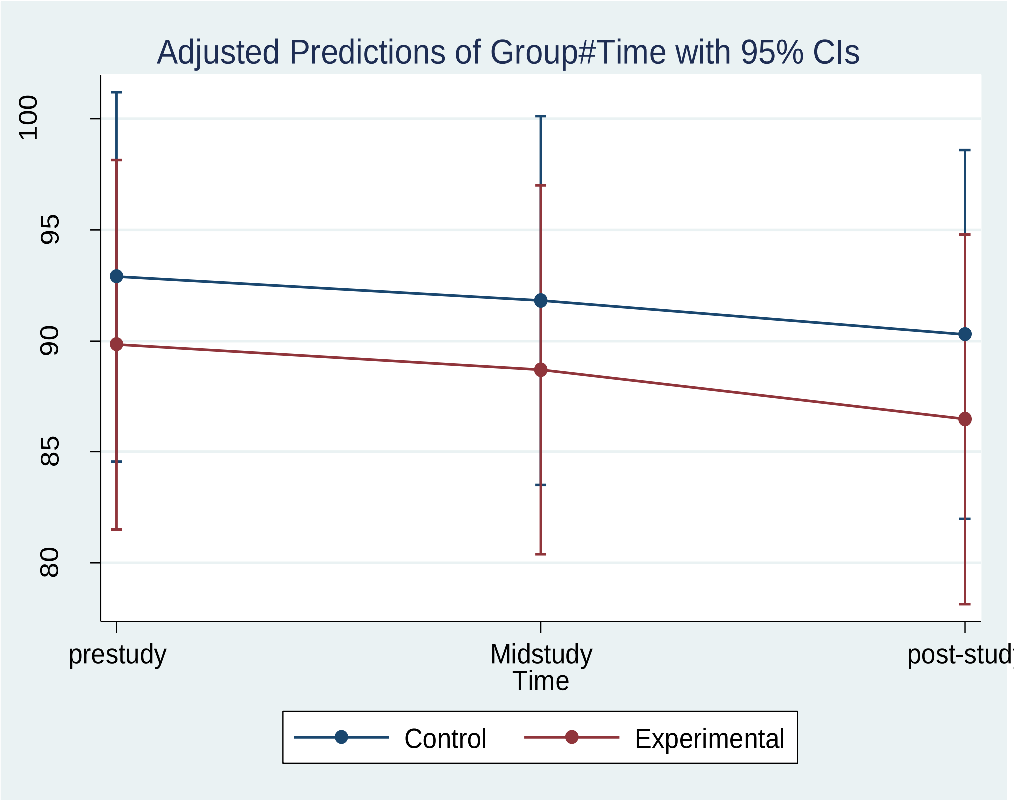

Figure 4: Predicted HC interactions between group and time

Generally, the level of WHR decreased in both the control and experimental groups during the course of the study. A mixed ANOVA was conducted to determine the effect of time and group on WHR levels. Both the main effects of group, F (1, 32) = 0.54, p=0.47 and time, F (1.09, 34.88) = 1.94, p = 0.17 and the interaction between group and time, F (1.09, 34.88) = 0.20, p = 0.68, were found not to have a significant effect on the WHR (Table 2). The results suggested that low-intensity resistance exercise and passage of time do not significantly lower WHR levels. This was evidenced by the overlapping confidence interval in Figure 5.

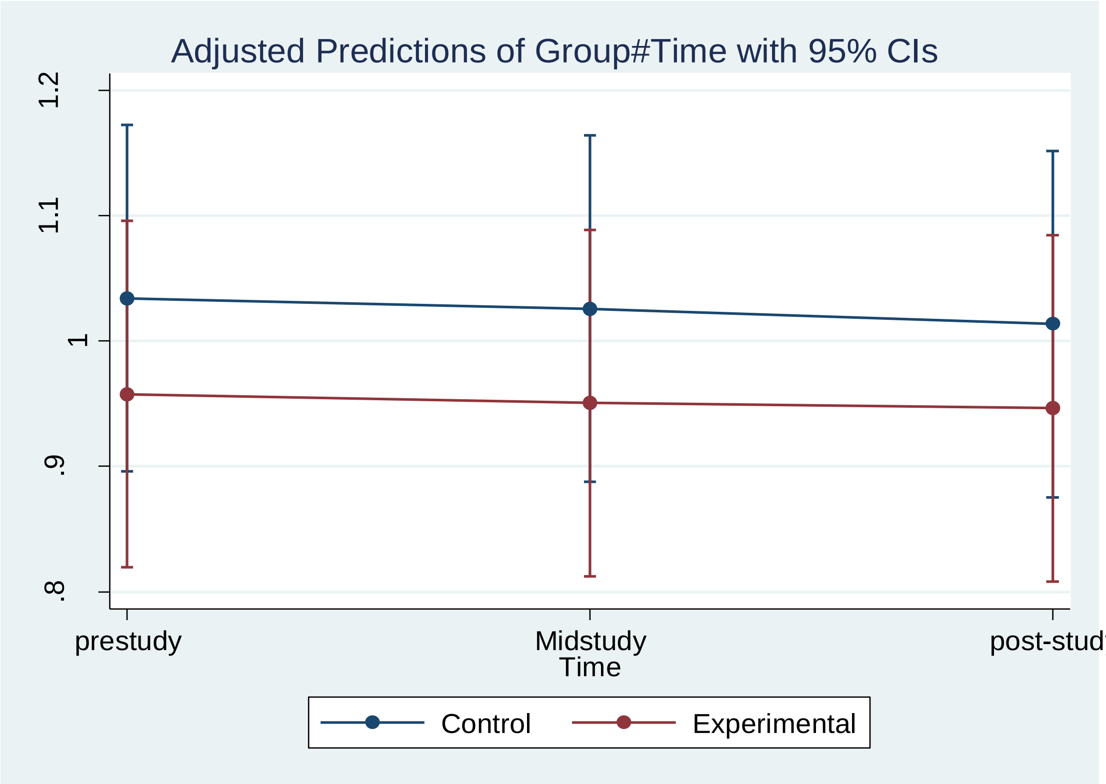

Figure 5: Predicted WHR interactions between group and time

The predicted model shows that the levels of WHR in both control and experimental groups remained almost constant, suggesting that group and time had no significant effect on this variable.

Effects of prescribed Low-Intensity Resistance exercise on Biochemical Characteristics in Prehypertensive individuals

Table 3 shows the biochemical characteristics recorded at pre-study, mid-study, and post-study.

Table 3: Biochemical measurements at pre-, mid-, and post-study

Variable	Treat.	Pre-Study	Mid-Study	Post-Study	Main effects (F values)		Interaction (F value)
		Mean±SD	Mean±SD	Mean±SD	**Group**	**Time**	**Group*Time**
TC	Cont.	$5.00 \pm 1.32^{a, k}$	$4.85 \pm 1.12^{ab, k}$	$4.73 \pm 0.94^{b, k}$	0.0001^{ns}	14.06^{**}	1.65^{ns}
	Exp.	$5.07 \pm 1.57^{a, k}$	$4.92 \pm 1.47^{a, k}$	$4.57 \pm 1.21^{b, k}$	0.91^{ns}		
Triglycerides	Cont.	$1.65 \pm 0.73^{a, k}$	$1.68 \pm 0.66^{a, k}$	$1.66 \pm 0.62^{a, k}$		0.25^{ns}	0.28^{ns}
	Exp.	$1.38 \pm 1.03^{a, k}$	$1.38 \pm 0.99^{a, k}$	$1.41 \pm 0.91^{a, k}$	0.99^{ns}		
HDL	Cont.	$1.36 \pm 0.39^{a, k}$	$1.37 \pm 0.34^{a, k}$	$1.39 \pm 0.30^{a, k}$		5.79^{*}	0.71^{ns}
	Exp.	$1.47 \pm 0.39^{a, k}$	$1.49 \pm 0.38^{a, k}$	$1.54 \pm 0.37^{b, k}$	0.15^{ns}		
LDL	Cont.	$3.47 \pm 1.32^{a, k}$	$3.41 \pm 1.21^{ab, k}$	$3.22 \pm 0.94^{b, k}$		10.11^{**}	1.13^{ns}
	Exp.	$3.41 \pm 1.56^{a, k}$	$3.27 \pm 1.34^{a, k}$	$2.93 \pm 1.22^{b, k}$	0.02^{ns}		
FBG	Cont.	$6.30 \pm 1.34^{a, k}$	$6.01 \pm 1.11^{b\ k}$	$5.52 \pm 0.92^{c, k}$		35.25^{**}	0.18^{ns}
	Exp.	$6.32 \pm 1.37^{a, k}$	$5.92 \pm 0.96^{b, k}$	$5.43 \pm 0.61^{c, k}$	5.01^{*}		
Blood Pressure	Cont.	$128.94 \pm 4.64^{a, k}$	$125.88 \pm 3.90^{b, k}$	$122.47 \pm 2.87^{c, k}$		115.6^{**}	11.99^{**}
	Exp.	$127.59 \pm 5.01^{a, k}$	$124.35 \pm 4.43^{b, k}$	$115.88 \pm 6.06^{c, l}$			

Key. TC: Total cholesterol, HDL: High-density lipoprotein cholesterol, LDL: Low-density lipoprotein cholesterol, FBG: Fasting blood glucose, SD: standard deviation, Treat. Treatment, Exp.: experimental, Cont.: Control. For every group, means with similar letters in a row (a, b, and c) and for every variable, means with similar letters in a column (k and l) are not significantly different by Tukey HSD test. **, *: significant at 99% and 95% significance levels, respectively.

Generally, TC decreased in both the experimental and control groups in mid-and post-study relative to pre-study. A mixed-design (repeated-measures) ANOVA with a within-subjects factor of time of the study (pre-, mid-, and post-study) and a between-subject factor of treatment type (experimental and control groups) was conducted to determine the effect of low-Intensity resistance exercise on the level of TC. A significant main effect of time was found, F (1.23, 39.48) = 14.06, p<0.0001. However, the main effect of group, F (1, 32) = 0.0001, p =0.99 and the interaction between group and time, F (1.23, 39.48) = 1.65, p =0.21, were found not to be significant. The results showed that the prescribed low-intensity resistance exercise does not affect TC of pre-hypertensive individuals. On the other hand, changes in the study periods did influence the TC of individuals.

Post-hoc pair-wise comparisons of adjusted predictions revealed that TC measurements in the control group did not significantly differ between mid-study and pre-study or between post- and mid-study (Table 3). However, TC was significantly lower in post-study relative to pre-study. However, in the experimental group, compared to the pre-study, TC was significantly lower in both mid-study and post-study (Figure 6).

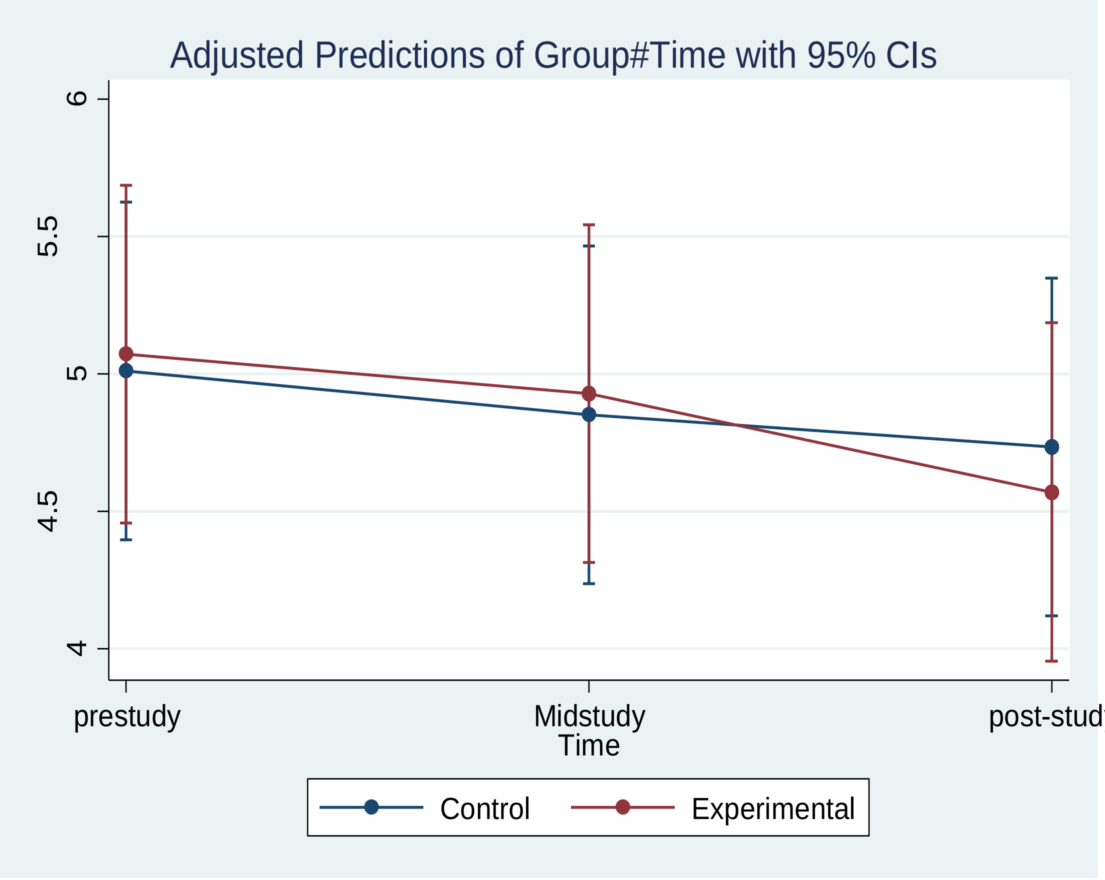

Figure 6: Predicted TC interactions between group and time

The figure shows overlapping confidence intervals in the three study periods (pre-, mid-, and post-study), suggesting that the prescribed low-intensity resistance exercise does not affect TC of pre-hypertensive individuals.

Triglyceride levels of participants generally decreased in both the experimental and control groups, as the study progressed from pre- to mid-and post-study. A mixed-design (repeated-measures) ANOVA with a within-subjects factor of time of the study (pre-, mid-, and post-study) and a between-subject factor of treatment type (experimental and control groups) was conducted to determine the effect of low-Intensity resistance exercise on triglyceride level.

Both the main effects of group, F (1, 32) = 0.91, p=0.35 and time, F (1.59, 51.18) = 0.25, p = 0.73 and the interaction between group and time, F (1.59, 51.18) = 0.28, p = 0.71, were found not to have a significant effect on the triglyceride level (Table 3). The results suggested that low-intensity resistance exercise and passage of time do not significantly lower triglyceride levels. This was evidenced by the overlapping confidence interval in Figure 7.

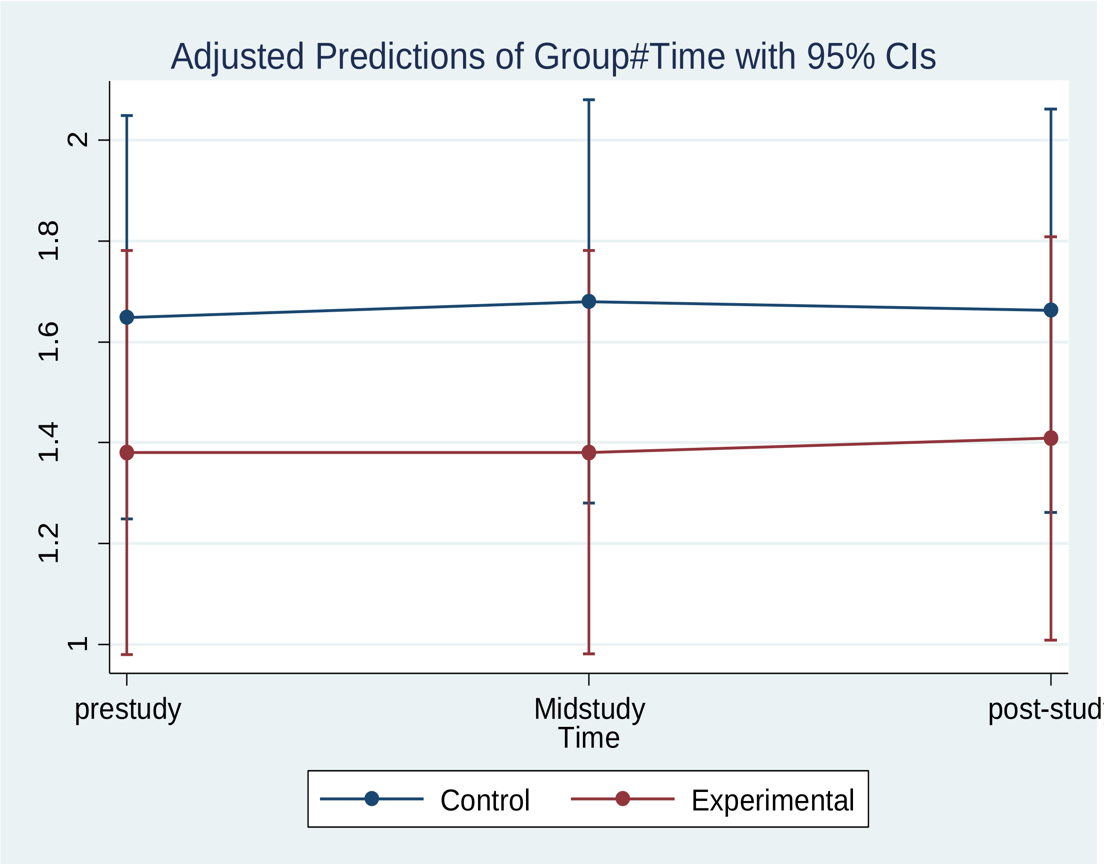

Figure 7: Predicted triglycerides interactions between group and time

The predicted model shows that the levels of triglycerides in both control and experimental groups remained almost constant, suggesting that group and time had no significant effect on this variable.

HDL generally increased in both the experimental and control groups, as the study progressed from pre- to mid-and post-study. A mixed-design (repeated-measures) ANOVA was conducted to determine the effect of low-intensity resistance exercise on the level of HDL. A significant main effect of time, F (1.28, 40.79) = 5.79, p=0.01 were found. However, the main effect of group, F (1, 32) = 0.99, p=0.33 and the interaction between group and time, F

(1.28, 40.79) = 0.71, p =0.44, was found not to be significant. The results showed that the passage of time could affect the HDL of pre-hypertensive individuals.

Post-hoc pair-wise comparisons of adjusted predictions revealed that HDL measurements in the control group did not significantly differ between pre-, mid-, and post-study (Table 3). On the other hand, although BMI did not significantly differ between mid-study and pre-study, it was significantly higher in post-study compared to both mid-study and pre-study (Figure 8).

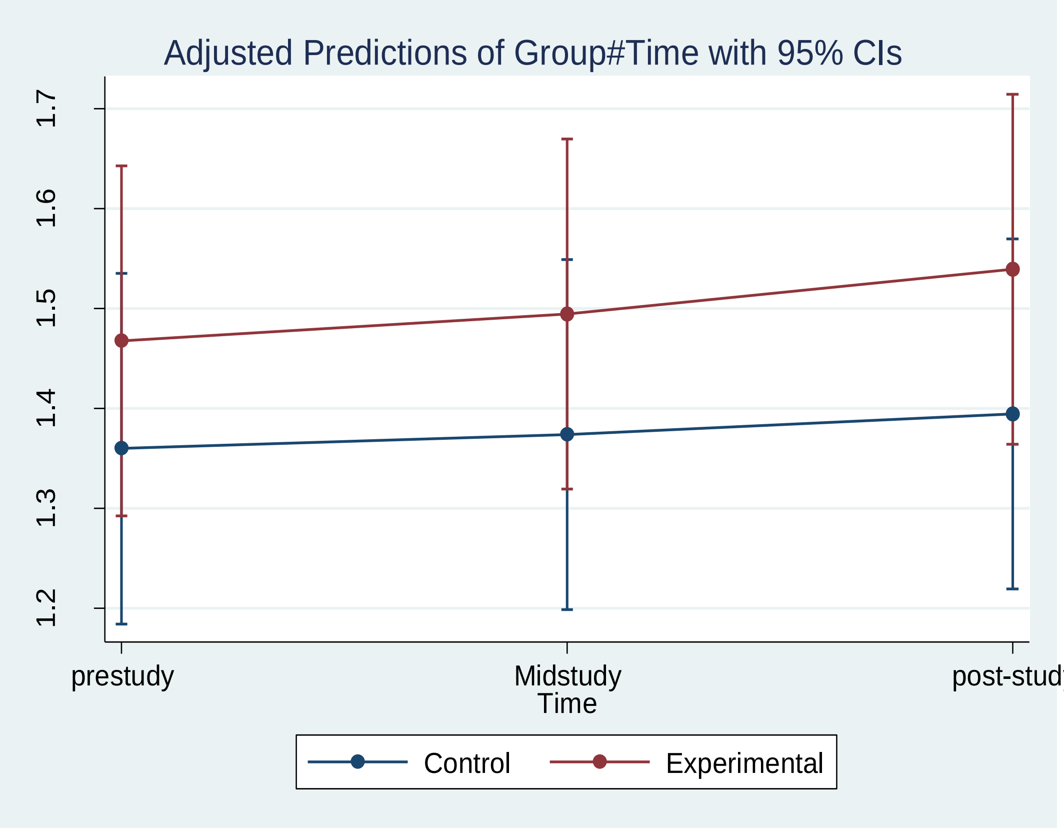

Figure 8: Predicted HDL interactions between group and time

The levels of LDL decreased in both the control and experimental group during both mid-study and post-study. A mixed ANOVA was conducted to determine the effect of time and group on LDL levels. A significant main effect of time, F (1.26, 40.28) = 10.11, p =0.001 was found. However, the main effect of group, F (1, 32) = 0.15, p = 0.71 and the interaction between group and time, F (1.26, 40.28) = 1.13, p = 0.31 were found not to be significant. The results showed that the prescribed low-intensity resistance exercise does not affect the LDL of pre-hypertensive individuals. However, the most marked increase was recorded in the experimental group relative to the control group. On the other hand, changes in the study periods did influence the LDL of individuals.

Post-hoc pair-wise comparisons of adjusted predictions revealed that LDL measurements in the control group did not significantly differ between mid-study and pre-study or between post- and mid-study (Table 3). However, the LDL was significantly lower in post-study relative to pre-study. On the other hand, although LDL did not significantly differ between mid-study and pre-study, it was significantly lower in post-study compared to both mid-study and pre-study in the experimental group (Figure 9).

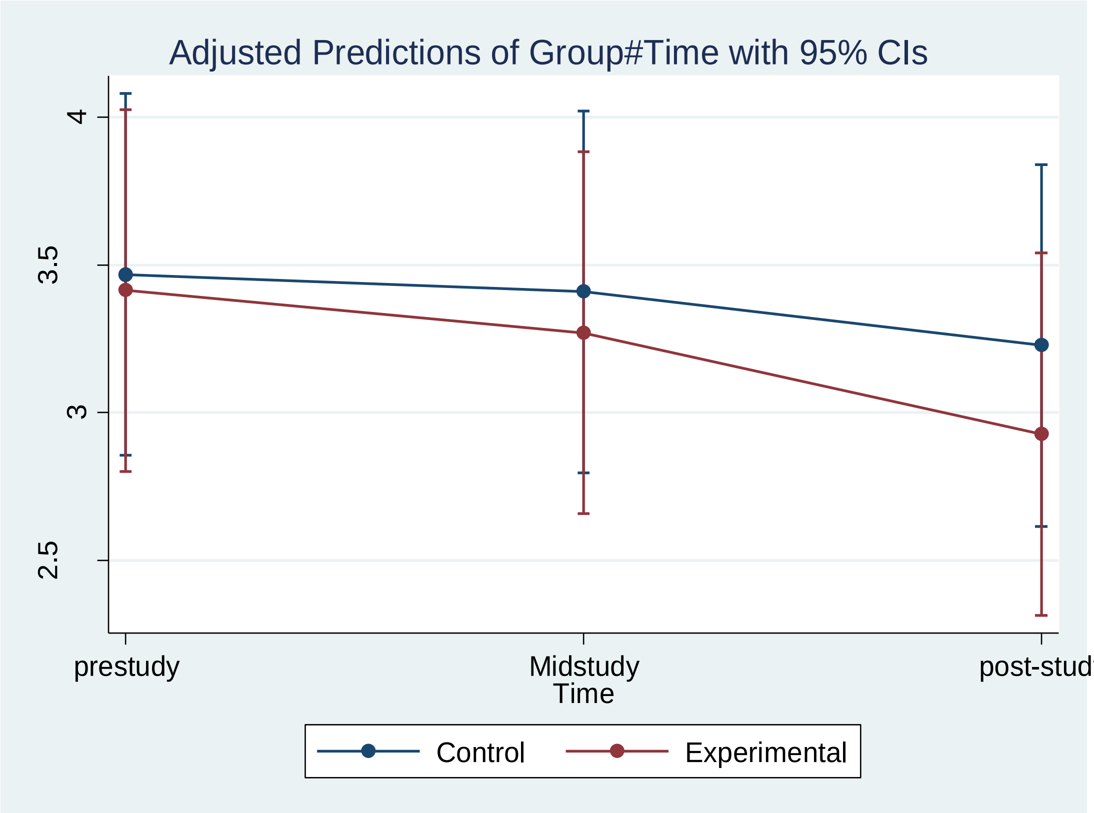

Figure 9: Predicted LDL interactions between group and time

No significant differences were recorded at any time of the study, as evidenced by the overlapping confidence intervals in Figure 9, indicating that low-intensity resistance exercise does not significantly lower LDL levels. However, the most substantial decrease was recorded in the experimental group relative to the control group.

The levels of FBG generally decreased in both the experimental and control groups during both mid-study and post-study periods relative to pre-study. A mixed ANOVA was conducted to determine the effect of time and group on FBG levels. A significant main effect of time, F (1.29, 41.24) = 35.25, $p<0.0001$ was found on the level of FBG. However, group, F (1, 32) = 0.31, p = 0.58 and the interaction between group and time, F (1.29, 41.24) = 0.18, p = 0.74, were found to have no significant effect on the level of FBG.

For both the experimental and control groups, FBG levels significantly decreased at mid-study relative to pre-study and at post-study compared to mid-study (Table 3 and Figure 10).

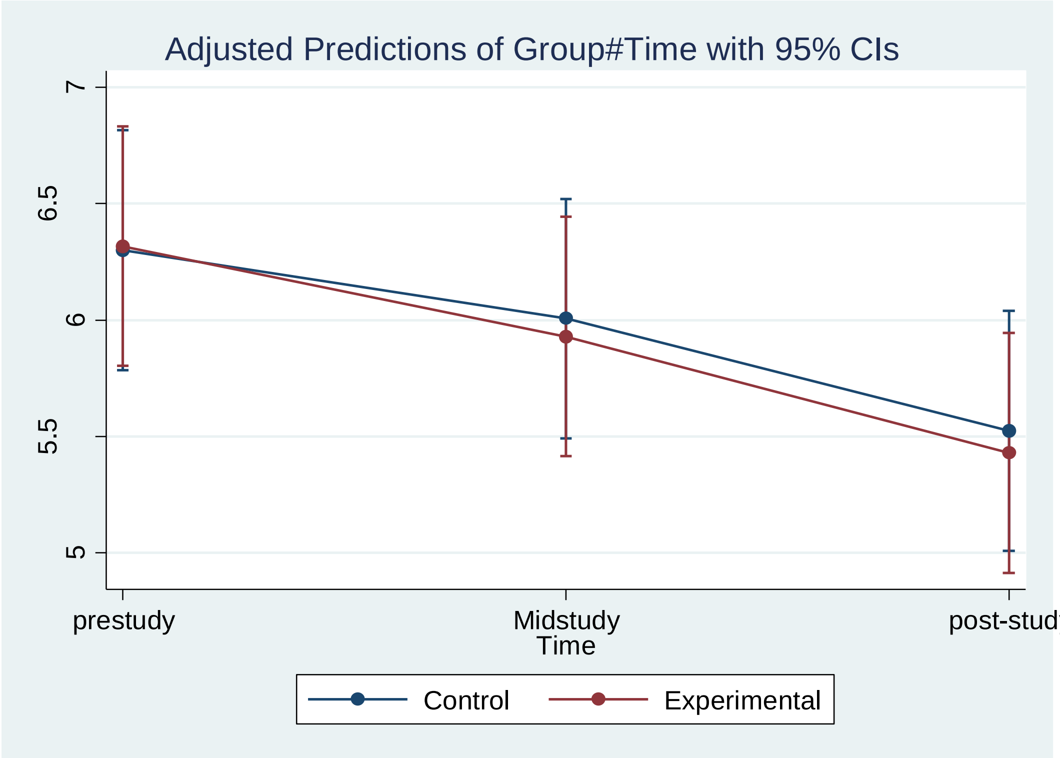

Figure 10: Predicted FBG interactions between group and time

The results suggested that the passage of time significantly lowers the FBG levels. Nevertheless, low-intensity resistance exercise appeared to have no effect on FBG levels at all study periods.

Blood pressure generally decreased in the experimental group during both mid-and post-study periods. A mixed ANOVA was conducted to determine the effect of time and group on blood pressure levels. Significant main effects of both time, F (1.34, 42.82) = 115.6, p < 0.0001 and group, F (1, 32) = 5.01, p = 0.03 were found. In addition, a significant interaction between group and time was also found, F (1.34, 42.82) = 11.99, p <0.0001.

Pairwise comparisons showed that in both the experimental and control group, blood pressure significantly decreased in mid-study relative to pre-study and in post-study compared with pre-study. However, the most dramatic decrease in blood pressure was witnessed in the experimental group rather than in the control, showing that low-intensity resistance exercise lowers blood pressure, especially in post-study (Table 3 and Figure 11).

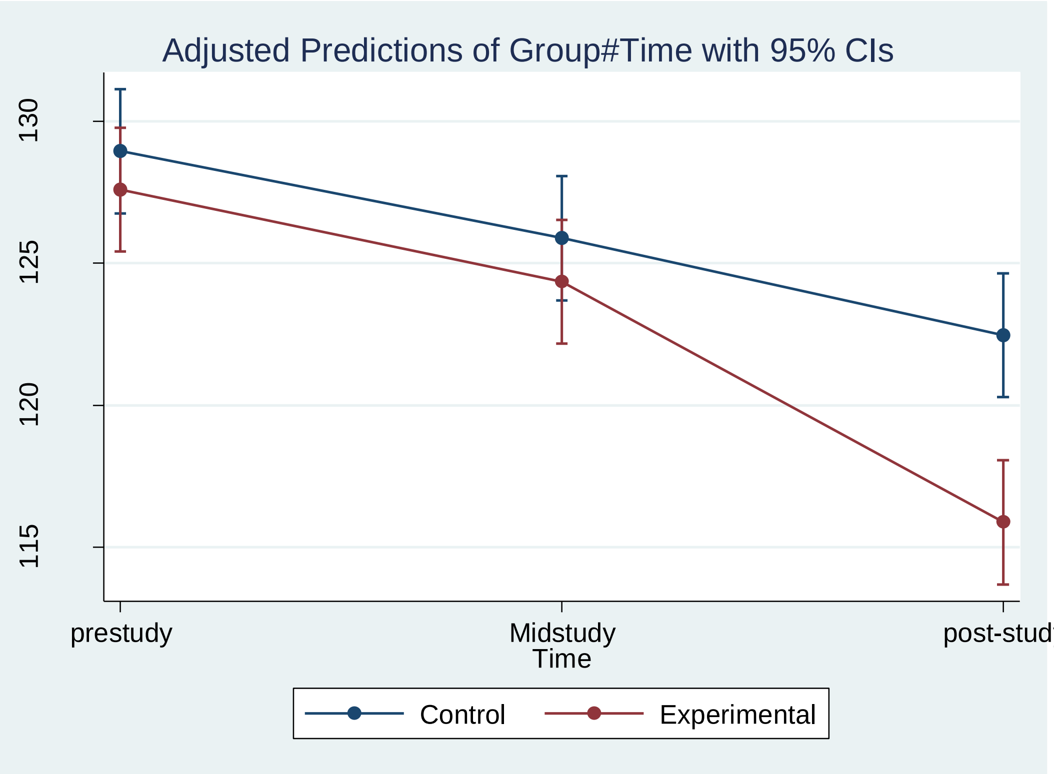

Figure 11: Predicted blood pressure interactions between group and time (the value of blood pressure is the numerator)

There was no significant difference in the level of blood pressure in both experimental and control groups at pre-study and mid-study, as seen from the overlapping confidence intervals in Figure 11. However, during post-study, blood pressure was significantly lower in the experimental group (mean difference: -6.59 mmHg, z= -4.18, p<0.0001). This suggests that low-intensity resistance exercise significantly lowers blood pressure post-study. While blood pressure in the experimental group reduced by 9% at post-study, in the control group, it reduced by just 5%, showing that exercise significantly lowers blood pressure.

The mean blood pressures (Table 3) in the experimental group were 128, 124, and 116 while in the control were 129, 126, and 122, at pre-, mid-, and post-study. Only in the experimental group and at post-study does mean blood pressure decrease to normal pressure (<120) while in the control group and other time periods, the pressure remains pre-hypertensive. This shows that low-intensity resistance exercise conducted to post-study lowers the blood pressure of pre-hypertensives back to normal blood pressure.

DISCUSSION

Effects of prescribed low-intensity resistance exercise on the anthropometric measure in the individual with prehypertension

The first specific objective of this study was to determine the effects of prescribed low-intensity resistance exercise on anthropometric measurement in individuals with prehypertension living within Homa Bay Township. The six anthropometric characteristics investigated included height, weight, Body Mass Index (BMI), waist circumference, hip circumference, and waist to hip ratio. At pre-study, these indices were symptomatic of pre-hypertensive individuals. The average BMI amongst participants in this study was 28.35 kg/m^2, indicating that on average, the respondents were overweight *(11).* Broken down into groups, the BMI of respondents was 26.29 $kg/m^2$and 30.41 kg/m^2 in the experimental and control groups, respectively, suggesting that half of the respondents were obese *(1).* The findings from this study corroborate other researchers that have found a strong correlation between BMI and prehypertension, notably, Ishikawa *(11)*, Moinuddin *(18)*, and Andrea *(3).*

The average WC of the respondents in this study was 86.91cm, with experimental and control groups having a WC of 89.82cm and 92.88cm, respectively. The results suggested that the respondents might not have been overweight as the average WC was 36 inches or 91 cm *(1)*. However, since the recommended WC is different in men (<40 inches or 102 cm) and women (<35 inches or 89 cm), the average WC value in this study was lower because it included the values for women.

The average WHR was 0.99 while it was 0.96 and 1.03 in the experimental and control groups, respectively. The findings indicated that participants in the study were obese, as studies indicate that a healthy WHR is 0.9 or less in men and 0.85 or less in women *(1)*. Given that respondents were pre-hypertensive, the results suggest WHR could be an accurate predictor of hypertension *(1)*.

Height did not change in both experimental (1.66 m) and control (1.60 m) groups in all three times of study, suggesting that the prescribed low-intensity resistance exercise and passage of time did not affect the height of pre-hypertensive individuals. Findings from this study are similar to those by Moinuddin *(18)* and Andrea *(3)*, who found no effect of physical activity on height among pre-hypertensive participants.

The study found that the prescribed low-intensity resistance exercise does not affect the weight of pre-hypertensive individuals, as weight was similar in both experimental and control groups throughout the study period. This finding is similar to that by Amiri *(2)* and Andrea *(3)* who found that low-intensity exercise did not lead to a significant decrease in weight of individuals. The results suggested that although the prescribed low-intensity exercise causes a decrease in weight; the decline was not dramatic. Several explanations could be adduced to this finding. One, low-intensity exercise administered for the period of study is not sufficient to cause a significant decrease in weight. However, the design of the study was such that it was not absolutely controlled as it would have been ethically untenable. Individuals in the control and experimental groups were not kept in identical conditions throughout the experiment. For instance, outside the hours of the experiment, the individuals were not monitored. Thus, individuals in control and experimental groups might have been eating different diets, engaging invariant activities, such as differentiated walking speeds and distances, different sleeping hours, different alcohol drinking volumes, and diverse driving habits. All these different activities might have confounded the ability of low-intensity exercise to significantly lower the weight of individuals.

Such a conclusion is not far-fetched. Analysis of pair-wise comparisons of adjusted predictions revealed that weight measurements in the control group did not significantly differ between mid-study and pre-study or between post- and mid-study. However, the weight was significantly lower in post-study relative to pre-study. However, in the experimental group, compared to the pre-study, weight was significantly lower in both mid-study and post-study. These results implied that over time, weight decreased significantly more quickly in the experimental group relative to the control group, suggesting that low-intensity exercise could decrease the weight of pre-hypertensive individuals.

The pattern of BMI reflects the above deductions. At pre-study, the BMI of the experimental and control groups were already significantly different. However, the ANOVA model predicted that the biggest difference in the BMI means between experimental and control groups would occur in the post-study and not at pre- or mid-study. In other words, although the means of BMI in experimental and control groups already diverged at pre-study, the greatest predicted divergence occurred at post-study, as evidenced by non-overlapping confidence intervals. These results again suggested that low-intensity resistance exercise, which was administered only to the experimental group, do significantly decrease BMI levels.

The prescribed low-intensity resistance exercise was found not to significantly lower both WC and HC levels. This finding was similar to results reported by Amiri *(2)*, Andrea *(3)*, and Moinuddin *(18)*. Both parameters were found to significantly decrease over time in both experimental and control groups. However, while WC decreased significantly at mid- study compared with pre-study, HC was found to reduce significantly only at post-study, suggesting that a longer time is required to significantly lower HC levels. Numerous studies, for instance, Merchant *(16)* and Seidell *(25)* have compared the relative benefits or harm in possessing high or low levels of WC and HC but few have demonstrated the comparative loss of the two parameters. This study may be one of them that reports the comparative reduction of WC and HC over time.

The demonstration that WC decreases more rapidly in individuals that HC could, prognostically, be an important finding. This is because whereas high WC is associated with increased risks of cardiovascular disease and premature death, HC could have the opposite effects: reducing the risk of these diseases *(16, 25)*. WC is caused by increased deposition of abdominal fat. Visceral adipocytes are generally smaller and more lipolytically active than subcutaneous adipocytes, thereby exposing the liver to a higher concentration of free fatty acids. Visceral adipose tissue generates greater quantities of angiotensinogen, plasminogen activator inhibitor-1, tumor necrosis factor-α, and resistin, and less leptin and adiponectin *(16)*. On the other hand, the protective effect of large hips is relatively unclear. The protective effect may be due to biological characteristics of gluteal fat as a fat sink or adduced to the fact HC may be an indirect measure of gluteal muscle mass, which is a proxy for lean body mass *(16)*.

The study found that low-intensity resistance exercise and passage of time did not significantly lower WHR, with the levels of this index remaining almost constant in both control and experimental groups. This was logical. WHR is calculated as a ratio of WC to HC. As discussed above, both of these two measures decreased over time, explaining the constancy of WHR. This study found an elevated WHR amongst the pre-hypertensives, which has been associated with a high risk of cardiovascular diseases *(25)*.

Effects of prescribed low-intensity resistance exercise on fasting blood glucose, blood pressure, and lipid levels in pre-hypertensive individuals

The second specific objective of this study was to quantify the effects of prescribed low-intensity resistance exercise on fasting blood glucose and lipid levels in individuals with prehypertension living within Homa Bay Township. Five biochemical characteristics were investigated: Total cholesterol, triglycerides, High-density lipoprotein cholesterol, Low-density lipoprotein cholesterol, and Fasting blood glucose. In addition, the blood pressure of participants was taken at pre-, mid-, and post-study.

The average baseline values of TC, LDL, and HDL in the study were 5.04, 3.44, and 1.41 mmol/l, respectively. According to guidelines provided by Papackova *(20)* and the National Institutes of Health *(19)*, TC and HDL were within the recommended levels, with TC below 5.2 mmol/l while HDL was above 1mmol/l. However, LDL was at the borderline, with the recommended level of 3.4 mmol/l.

The average FBG in this study was found to be 6.31mmol/l, which indicated that individuals in the study were pre diabetic. The results suggested that unless the respondents changed their lifestyle, they face the risk of developing type II diabetes *(26, 5)*. The correlation between the presence of prehypertension and pre diabetes is not unexpected, as other studies have found similar results *(26, 20, 19)*. These could arise because both conditions are often caused by common factors, for instance, obesity, physical inactivity, aging, family history, and inadequate sleep *(26)*.

The effect of exercise and passage of time was found to have similar effects on TC and LDL. Both variables did not significantly differ in experimental and control groups at the three times of study, suggesting that low-intensity exercise had no significant influence on the two variables. Nevertheless, although each variable decreased in both experimental and control groups with the passage of time, the decline was more dramatic and marked in the former group relative to the latter. For example, TC was higher in the experimental group compared to the control at pre-study but was lower in the former group at post-study. Secondly, confidence intervals (in the plots) were wider apart for both groups at post-study whereas they overlapped more at pre-study. These suggested that low-intensity exercise could have an effect on the variables. This study explains this apparent contradiction by suggesting that although the prescribed low-intensity exercise causes a decrease in both TC and LDL, the decline was not dramatic enough. Since each variable diverged more at post-study in the experimental and control groups, this study concludes that prescribed low-intensity exercise decreases both TC and LDL levels, but more time beyond the post-study period is required.

The similarity in the behavior of TC and LDL documented above is not peculiar. After all, TC is the sum of the body's cholesterol, of which LDL makes a part *(20, 19)*. The other component of TC is HDL. The study found that over time, HDL increased, with a more dramatic increase occurring in the experimental group rather than in the control. This suggested that although low-intensity exercise could increase HDL, the time required for a significant increase could be beyond the post-study period. The probability that low-intensity exercise could reduce TC and LDL ('bad' cholesterol) and increase HDL ('good' cholesterol) is supported by findings from many studies, for instance, National Institutes of Health *(19)* and Papackova *(20)*. The health benefits of HDL and the deleterious effects of LDL are well documented *(26, 20, 19)*.

The results showed that the levels of triglycerides in both control and experimental groups remained almost constant, suggesting that group and time had no significant effect on this variable. The results suggest that it might be relatively difficult to lower the level of triglycerides using low-intensity exercises. This could result from the way triglycerides accumulate in the body – when excess calories are converted and stored in fat cells *(15)*. Respondents might have been taking in more calories than their bodies were able to burn, leading to excess triglycerides.

For both the experimental and control groups, FBG levels significantly decreased at mid-study relative to pre-study and at post-study compared to mid-study. However, no significant differences between experimental and control groups were recorded for FBG at all times of study, suggesting that low-intensity resistance exercise appeared to have no effect on FBG levels. However, a closer examination of the values indicated that at pre-study, mean FBG in experimental and control groups were almost identical. However, the divergence of the values was greatest at post-study, suggesting that low-intensity exercise, conducted over a longer period than post-study, could significantly lower FBG.

The most dramatic effect of low-intensity resistance exercise was observed on blood pressure, with the exercises significantly lowering the pre-hypertensive pressure in the experimental group to normal pressure at post-study. In the control group, the pressure remained pre-hypertensive, even at post-study. This study may be the first to show that low-intensity resistance exercise has the greatest impact on blood pressure relative to FBG, lipid levels, and anthropometric measurements, such as weight, BMI, WC, HC, and WHR. This is pertinent as hypertension is the most common cardiovascular disorder affecting approximately one billion people globally and remains the leading single contributor to the global burden of disease and mortality accounting for approximately 9.4 million deaths annually *(23)*. There is a substantial body of evidence that shows the role of moderate-intensity exercise in preventing hypertension and managing stage 1 hypertension, for instance, Ruivo *(24)*, and Pescatello *(21)*.

CONCLUSION

At pre-study, the six anthropometric characteristics studied: height, weight, Body Mass Index (BMI), waist circumference, hip circumference, and waist to hip ratio were symptomatic of pre-hypertensive. Height did not change in both experimental and control groups in all the three times of study. Except for BMI, the study found that the prescribed low-intensity resistance exercise did not affect the weight, WC, HC, and WHR of pre-hypertensive individuals. Nevertheless, weight decreased more quickly in the experimental than in the control group with the passage of time, implying that the period of study might not have been sufficient to cause a significant decrease in weight. Although the prescribed low-intensity resistance exercise was found not to significantly lower both WC and HC levels, the demonstration that WC decreases more rapidly in individuals that HC could, prognostically, be important.

The effects of prescribed low-intensity resistance exercise on total cholesterol, triglycerides, High-density lipoprotein cholesterol, Low-density lipoprotein cholesterol, fasting blood glucose, and blood pressure was also quantified. The average baseline values of TC and HDL were within the recommended levels, while LDL was at the borderline. The average FBG indicated that individuals in the study were pre-diabetic.

TC, LDL, and FBG levels did not significantly differ in experimental and control groups at the three times of study, suggesting that low-intensity exercise had no significant influence on the variables. Nevertheless, although each variable decreased in both experimental and control groups with the passage of time, the decline was more dramatic and marked in the former group relative to the latter, suggesting that prescribed low-intensity exercise could decrease the variables with a longer period of time than that of the study. Nevertheless, triglyceride levels in both control and experimental groups remained almost constant, suggesting that it might be relatively difficult to lower the level of triglycerides using low-intensity exercises. The most dramatic effect of low-intensity resistance exercise was observed on blood pressure, with the exercises significantly lowering the pre-hypertensive pressure in the experimental group to normal pressure at post-study. In the control group, the pressure remained pre-hypertensive, even at post-study. This study may be the first to show that low-intensity resistance exercise has the greatest impact on blood pressure relative to FBG, lipid levels, and anthropometric measurements, such as weight, BMI, WC, HC, and WHR.

RECOMMENDATIONS

The study makes the following recommendations:

County and national government should increase health facilities for screening prehypertension, who could be put on lifestyle changes that could ultimately reduce their blood pressure.

Health practitioners, national and county governments and individuals should implement and/or practice low-intensity resistance exercises for a reasonable period of time as they could lower the levels of BMI and weight, which are significant correlates of prehypertension. In addition, these exercises decrease WC (associated with deleterious cardiovascular events) more rapidly in individuals than HC (associated with beneficial effects).

The study found that the greatest impact of low-intensity resistance exercise was on blood pressure itself, successfully lowering the pre-hypertensive pressure in the experimental group to normal pressure at post-study. Consequently, health practitioners, national and county governments should prescribe these exercises in pre-hypertensive individuals to prevent the condition from progressing to hypertension, which is now recognized as a significant health burden in the country.

These exercises should also be implemented in pre-hypertensive individuals because they lower the levels of TC, LDL, and FBG.

SUGGESTIONS FOR FURTHER STUDY

This study determined the effects of prescribed low-intensity resistance exercise on prehypertension in individuals living within Homa Bay Township, Western Kenya. Studies could be conducted in other health settings for a longer period with increased sampled size than that of this study in order to definitively understand the effect of low-intensity resistance exercise on parameters such as weight, TC, LDL, FBG, WC, HC, WHR, and lipid levels. A study should be done to determine the comprehension of lifestyle risk factors and the effects of low-intensity resistance exercise on prehypertension.

REFERENCES

1. Ahmed, A., and Baloumi, A. (2019). Comparing measures of obesity: Waist circumference, waist-hip, and waist-height ratios. In, Watson, R, ed., *Nutrition in the prevention and treatment of abdominal obesity* (Second Edition). Arizona: Elsevier.
2. Amiri, H., Mirzaie, B., and Elmieh, A. Effect of low and high-intensity walking programs on body composition of overweight women. *European Journal of Experimental Biology,2013*(5):282-286. Retrieved from www. pelagiaresearchlibrary.
3. Andrea P, Rica R, Evangelist A, et al., (2015). Effects of exercise intensity on post-exercise hypertension after the resistance training session in overweight hypertensive patients. Dove Press Journal. http://dx.doi.org/10.2147/CIA.s79625.
4. Ash et al. The antihypertensive effects of aerobic versus isometric handgrip resistance exercises. J Hypertens. 2017 February; 35(2): 291–299. doi:10.1097/HJH.0000000000001176.
5. Centers for Disease Control and Prevention (CDC). (2012). National Diabetes Prevention Program. Retrieved from http://www.cdc .gov/diabetes/prevention/about.htm
6. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of Hypertension: the JNC 7 report. Jama. 2003; 289:2560-72.
7. Fagard RH. Exercise therapy in hypertensive cardiovascular disease. Prog Cardiovasc Dis. 2011;53(6):404–11. [PubMed].
8. Guwatudda D., Mutyoba J.N., Robert K., Carien L., et al (2015). The burden of hypertension in Sub-Saharan Africa; a four – County Cross-Sectional Study. BMC Public Health 2015. 15:1211.
9. Harsh M., (2010). *Textbook of Pathology*. Six Edition. Jaypee.
10. Hayley V. M, Blair T. J, Tania B. H, Jill L, Kym C. F, William J. K, Paulo T.V. F, and Linda S. P., (2016). Dynamic resistance training as stand-alone antihypertensive lifestyle therapy: A Meta-Analysis. J Am Heart Assoc. 2016;5: E003231 DOI: 10.1161/JAHA.116.003231.

11. Ishikawa, Y., Ishikawa, J., Ishikawa, S., (2008). Prevalence and determinants of prehypertension in a Japanese general population: The Jichi Medical School cohort study. *Hypertension Research*, 31(7), 1323–1330.
12. Jackson K. (May 2017). Ministry of Health. Government of Kenya. Online: http://www.health.go.ke/2017/05/govt-unveils-strategies-to-control-hypertension-the-silent-killer. Accessed 22nd January 2018.
13. Martin J. Hypertension guidelines: revisiting the JNC7 recommendations. J Lancaster General Hospital. 2008;3 (3):91–7.
14. Mathenge W, Foster A, Kuper H. Urbanization, ethnicity and cardiovascular risk in a population in transition in Nakuru, Kenya: a population-based survey. BMC Public Health. 2010; 10:569–581. DOI: 10.1186/1471-2458-10-569. [PMC free article] [PubMed] [Cross Ref].
15. Mayo Clinic Staff (2020). Triglycerides: Why do they matter? https://www.mayoclinic.org/diseases-conditions/high-blood-cholesterol/in-depth/triglycerides/art-20048186
16. Merchant, A., Yusuf, S., and Sharma, A. (2006). A cardiologist's guide to waist management. *Heart*, *92*(7): 865–866.
17. Ministry of Health (MoH). Division of Non-Communicable Diseases. Kenya STEPwise Survey for Non-Communicable Diseases Risk Factor 2015 report.
18. Moinuddin A, Gupta R, and Saxena Y.. Assessment of Anthropometric Indices, salt, and physical activity in the etiology of prehypertension. Journal of clinical and diagnostic research. 2016 Feb, vol-10(2): CC11-CC14.
19. National Institutes of Health (2017). High cholesterol: Overview. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK279318/
20. Papackova, Z. (2015). Fatty acid signaling: The new function of intracellular lipases. *Int. J. Mol. Sci.* , *16*, 3831-3855.
21. Pescatello LS, Franklin BA, Fagard R, Farquhar WB, Kelley GA, Ray CA, et al. American College of Sports Medicine position stand. Exercise and hypertension. Med Sci Sports Exerc. 2004; 36(3):533–53. [PubMed].
22. Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves JW, Hill MN, et al. Recommendations for blood pressure measurement in humans: an AHA scientific statement from the Council on Hypertension Research Professional and Public Education Subcommittee. J Clin Hypertens (Greenwich). 2005; 7:102–109. [PubMed: 15722655]
23. Poulter NR, Prabhakaran D, Caulfield M. Hypertension. Lancet. 2015; 386:801–12. DOI:10.1016/S0140-6736(14)61468-9.

24. Ruivo JA, Alcântara P. Hypertension and exercise [article in Portuguese] Rev Port Cardiol. 2012;31(2):151–8. Epub 2012 Jan 10. [PubMed].
25. Seidell, J., Pérusse, L., Després, J., and Bouchard, C. (2001). Waist and hip circumferences have independent and opposite effects on cardiovascular disease risk factors: The Quebec Family Study. *The American Journal of Clinical Nutrition*, *74*(3), 315–321. Retrieved from https://doi.org/10.1093/ajcn/74.3.315
26. WHO (2019). Mean fasting blood glucose. Retrieved from https://www.who.int/data/gho/indicator-metadata-registry/imr-details/2380. Accessed 20th January 2018.
27. WHO (2021). Hypertension. Retrieved from https://www.who.int/news-room/fact-sheets/detail/hypertension. Accessed on 29th September 2021.