Niger. J. Physiol. Sci. 26(December 2011) 199 – 206
www.njps.com.ng

Nig. J. Physiol. Sci.

Effects of a12-week endurance exercise program on adiposity and flexibility of Nigerian perimenopausal and postmenopausal women

[1*]Ogwumike O.O., [2]Arowojolu A.O. and [1]Sanya A.O

Departments of [1]Physiotherapy and [2]Obstetrics and Gynaecology, College of Medicine, University of Ibadan, Ibadan, Nigeria

Summary: Menopause is a sign of aging in the woman. Loss of ovarian function induces a reduction in resting metabolic rate, physical energy expenditure, fat-free mass and abdominal adipose tissue accumulation. Location of adipose tissue deposit in abdominal region plays an important role in occurrence of hyperlipidemia, diabetes, hypertension and atherosclerosis. Although regular participation in physical exercise have been suggested to improve adiposity and body flexibility which are important health related components of physical fitness, few published studies are available on the effect of exercise on Nigerian menopausal women. This study investigated effects of a twelve-week endurance exercise program (EEP) on central and abdominal obesity as well as flexibility of perimenopausal and postmenopausal Nigerian women. The study employed a pretest- posttest control group design comprising a sample of 175 apparently healthy, literate, sedentary women within age range 40-59 years. They were workers in state and federal establishments in Ibadan North Local Government Area of Oyo State, Nigeria. Based on history of their last menstrual period, women with regular or irregular menstrual cycle status were allocated into perimenopausal group and those who no longer menstruated into postmenopausal group. A table of random numbers was used for further allocation into perimenopausal exercise group (PEMEG, 45), postmenopausal exercise group (POMEG, 45) perimenopausal control group (PEMCG, 42) and postmenopausal control group (POMCG, 43). Waist Hip Ratio (WHR), Body Mass Index (BMI) as well as Hip and Trunk Flexibility (HTF) were evaluated at baseline and 4weekly intervals until end of 12th week. EEP consisted of a 10-station circuit of cardiovascular endurance, flexibility, coordination, abdominal and pelvic floor muscle exercises. Data were analyzed using descriptive and inferential statistics. Mean age of participants was 52.3± 4.1 years, 95% C.I (51.64-52.88) years. Significant reduction occurred between baseline and end of 12th week mean values of WHR in PEMEG (0.86 ± 0.08 vs 0.71 ± 0.07)and POMEG groups (0.88± 0.06 vs0.77 ± 0.07)$p<0.05$ while significant increases were observed between baseline values and end of 12th week mean values of HTF in PEMEG (18.84 ± 4.23vs28.27± 3.82) and POMEG (19.51 ± 4.02vs25.97± 2.36) ($p<0.05$). Significant changes did not occur in BMI in both groups even though mean differences were observed in baseline values compared with end of 12th week mean values of these variables. In PEMCG and POMCG groups, there were no observable changes in mean values of WHR, BMI and HTF from baseline to end of study. Participation in endurance exercise program is essential for perimenopausal and postmenopausal Nigerian women for improved central and abdominal adiposity as well as flexibility.

Keywords*:* Endurance exercise, Adiposity, Flexibility, Menopausal, Body mass index, Waist hip ratio.

**Address for correspondence:*yemfide@yahoo.com

Manuscript Accepted: November, 2011

INTRODUCTION

Women in the menopausal age group face a number of changes in the body system which may lead to loss of health related fitness (Asikainen et al, 2004). Studies in different parts of the world have reported that involvement in physical exercise is very important in creating a healthy lifestyle as well as enhancing a number of health-related fitness components among which are: cardio-respiratory fitness, muscular strength and endurance, body composition and flexibility (Kemmler et al, 2004). The importance of regular participation in endurance exercise program cannot be overemphasized because body composition and abdominal fat distribution (body composition topology) are related to occurrence of disease conditions such as

hyperlipidemia, diabetes, hypertension and atherosclerosis.

Endurance exercise prevents some age-related increases in body fat and it elevates resting metabolic rate which correlates directly with lean body mass (Poehlman and Tchernof, 1998). Some studies suggested increases in body mass index, or total fat mass with menopause (Poehlman et al, 1995; Toth et al, 2000). Cross sectional studies have also shown a fairly consistent pattern of increased central adiposity during menopause (Poehlman et al, 1995, Poehlman and Tchernoff 1998).The loss of ovarian function induces a reduction in resting metabolic rate, physical activity energy expenditure, fat free mass and an increase in fat mass and abdominal adipose tissue accumulation (Poehlman and Tchernof, 1998).

At menopause due to age related changes, substantial loss in tendon flexibility may occur. This may lead to reduced range of motion, soreness and stiffness at the joints (Raab et al, 1988). Inclusion of flexibility training in exercise program is important for improvement in joint range of motion, and function, and enhancement of muscular performance (Raab, et al, 1988; Wilson et al, 1992; Worell et al, 1994).

Few studies exist in literature investigating the effect of exercise on menopausal women generally and in Nigeria in particular (Kemmler, 2005). In the African society, men and women have different patterns of physical activity (Amusa and Udoh, 1982). Men are more likely than women to engage in regular physical activity (Oguma et al, 2002) while women are more likely to be involved in domestic tasks and household chores (Ojowu et al, 2007) as well as activities around child rearing, hence not all women get involved in activities which give them regular physical exercise. This study was designed to investigate the effect of a twelve-week endurance exercise program on body composition variables of central and abdominal adiposity- Body Mass Index (BMI) and Waist Hip Ratio (WHR) as well as Flexibility of perimenopausal and postmenopausal Nigerian women.

MATERIALS AND METHODS

Participants comprised of apparently healthy women who were state and Federal government workers in Ibadan North Local Government area of Oyo State. The study was carried out at the gymnasium of outpatient Physiotherapy Department of the University College Hospital, Ibadan Nigeria from August 2006 to February, 2007. The eligibility criteria for the study included: apparently healthy women aged 40 years and above i.e menopausal age category, sedentary job nature, accessibility to a family physician, or a gynaecologist, mild or controlled hypertension and success at the Tecumseh step test (Montoye et al, 1975). The study excluded women who were on calcium or hormone replacement therapy, those with acute knee osteoarthritis who could not undergo the step test prior to the start of the EEP and those who were not able to comply with three day frequency of exercise training per week. Of the 353 participants who indicated interest in the exercise programme, 175 met the inclusion criteria and were recruited. Based on the history of their last menstrual period (LMP), they were allocated into perimenopausal and postmenopausal groups after which the participants in each of these groups were randomly assigned using a table of random numbers into perimenopausal exercise (PEMEG) and perimenopausal control groups (PEMCG) as well as postmenopausal exercise (POMEG) and postmenopausal control groups (POMCG).

Procedure

Approval of the Health Research Ethics Committee of University of Ibadan and University College Hospital was obtained for this study (UI/IRC/06/0020). Informed consent was obtained from all participants. Information concerning age, occupation and menstrual cycle pattern were obtained.

Using standardized methods, measurements of height and body weight were taken. Body mass index was assessed as the ratio of body weight to height squared (Calle et al, 1999). Waist Circumference (WC) was measured with the participant in standing position, feet together and the minimum girth around the waist which in some individuals could correspond to the abdominal girth was measured with the aid of an inelastic tape measure (Mc Ardle at al, 2000). This was done 4 weekly intervals till end of study. Hip circumference was also measured as described for (WC) above however, the elastic measuring tape was placed at the region of maximum girth around the buttock - the trochanteric region (Mc Ardle et al, 2000).The ratio of waist circumference to that of hip circumference was evaluated as the waist hip ratio.

Flexibility was assessed using the modified sit and reach test. This procedure assesses hip and trunk flexibility (Cornbleet and Woolsey, 1996; McArdle et al, 2000). Participant sat on the floor with back and head against a wall while the legs were fully extended with the soles of the feet against the sit-and-reach box. She then placed her hands on top of each other, while stretching the arms forward, still keeping the head and back against the wall. The distance from the finger tips to the box edge was read off from the

ruler placed centrally on the sit-and-reach-box, this indicated the starting point. The participant flexed the trunk slowly and reached forward as far as possible, head and back having moved away from the wall with fingers sliding along the surface of the box. The final position was held for 2 seconds. The total distance reached was noted from the graduation on top of the box. The reach score or flexibility was the initial position subtracted from the final position in centimeters. Measurement was taken to the nearest 0.1cm (McArdle et al, 2000). Flexibility was assessed every four weeks until the end of the exercise program.

Endurance Exercise Program

This comprised of 10 station circuit training exercises of muscular and cardiovascular endurance, flexibility, co-ordination, abdominal and pelvic floor muscle exercises which took place on alternate days three times per week (Mondays, Wednesdays and Fridays). Exercise commenced with a 5 minute warm up and ended with 5 minute cool down sessions comprising of stretching exercises. The target exercise heart rate (training intensity) was 60 to 80 percent of heart rate reserve (HRR) - [the difference between maximal heart rate (MHR) and resting heart rate (RHR)]. The HRR is calculated using the formula:

H. R max reserve (HRR) = MHR - RHR

Max Heart Rate = 220 - age years.

According to the American College of Sports Medicine (ACSM,1998) it is generally accepted that in order to achieve a training effect, exercise intensity can be established at a training heart rate of either 65 percent to 90 percent of maximum heart rate (H.R. max) or 50 percent to 85 percent of HRmax reserve (HRR) [ACSM,1998]. Participants in the control groups did not participate in the exercise programme but reported at four weekly intervals in order to have their assessments taken. There were 3 consecutive exercise classes per day consisting of 3 different groups of participants in order of their baseline cardio-respiratory fitness (CF) level.

Statistical Analysis

All variables were summarized using descriptive statistics of means and standard deviation. Demographic characteristics of participants as well as the dependent variables at the baseline of study were compared using one way analysis of variance. Two-way analysis of variance was used to compare participants' variables within each group at weeks 0 and end of week 4, 8 and 12 of study. Alpha was set at 0.05.

RESULTS

One hundred and seventy five women, 90 in the exercise group and 85 in the control group participated in this study. Participant's age ranged between 46 to 59 years. Table 1 shows the characteristics of both exercise and control groups at baseline. At different stages in the study, a number of participants voluntarily withdrew. This can be observed from reduction in mean values of number of participants at different time points in the study groups as the study progressed. This is shown in Figure 1.

In tables 2, 3 and 4, two-way analysis of variance (ANOVA) comparison of adiposity variables of the PEME and PEMC groups as well as POME and POMC groups across the study period revealed that at alpha = 0.05, significant decreases were observed only in mean values of waist hip ratio (WHR) across the time point difference. Body mass index (BMI), did not exhibit any statistically significant change($P>0.05$) probably because changes in the body weight of the participants were only minimally different across the study period. For the PEMC and POMC groups no significant changes were observed in the adiposity variables from baseline to the end of the study. In the postmenopausal exercise participants (POME) significant decrease was observed in mean values of waist hip ratio (WHR) $p< 0.05$ from the end of 8^{th} week of study.

Table 5 shows a two way ANOVA comparison of mean hip and trunk flexibilities (HTF) of PEME and PEMC as well as POME and POMC participants across the study period. At baseline, no significant difference in (HTF) was observed within the four

Table 1:

Baseline Characteristics of the Participants

Variables	Exercise Group PREME & POME (n=90)	Control Group PREMC &POMC (n=85)	95% C.I	T	P-Value
Age(yrs)	52.7 ± 3.95	51.7 ± 54.3	51.64-52.88	1.59	0.23
Height(m)	1.61 ± 0.05	1.60 ± 0.04	1.60-1.61	1.95	0.49
Weight(kg)	76.83 ± 10.16	75.93 ± 9.66	74.92-77.87	0.60	0.80
BMI (kg/m^2)	29.74 ± 4.01	29.9 ± 4.18	29.21-30.43	0.26	0.76
WHR	0.87 ± 0.07	0.86 ± 0.06	0.85-.0.87	1.26	0.21
HTF(cm)	19.18 ± 4.11	18.85 ± 4.64	18.37-19.67	0.49	0.62

Data are presented as PEME-Perimenopausal exercise, POME-Postmenopausal exercise, PEMC-Perimenopausal control, POMC-Postmenopausal control, BMI-Body Mass Index, WHR- Waist Hip Ratio, HTF-Hip and Trunk Flexibility

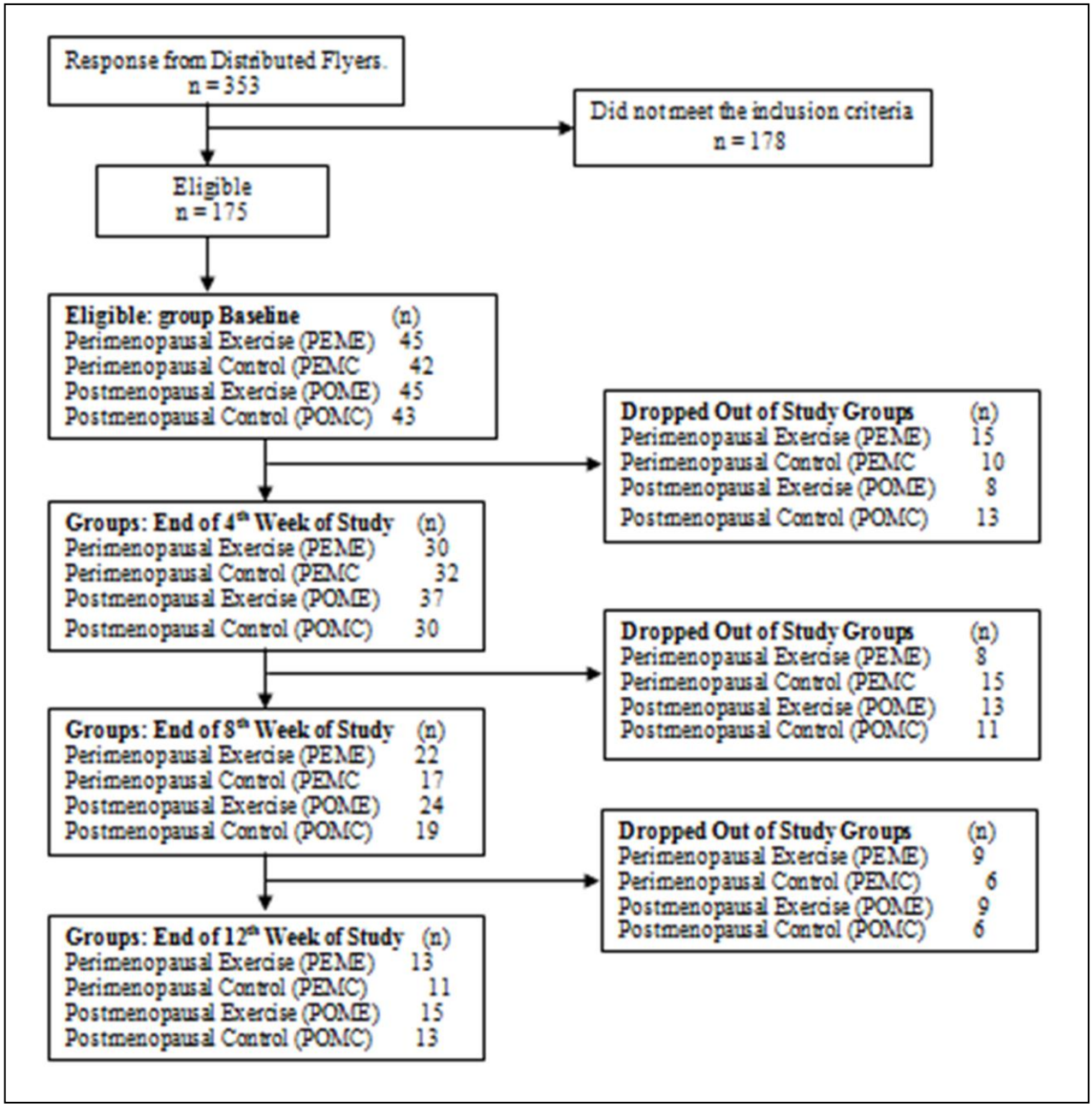

Figure 1.
Attrition of Participants in the Course of the Study

Table 2.
Comparison of Adiposity Measures for Perimenopause and Postmenopause Groups across the Study Period **(Body Weight)**.

Variable	Wk 0	End of Wk 4	End of Wk 8	End of Wk 12	F-value	P
PEMEG	78.30 ± 9.25 (n=45)	77.01 ± 9.44 (n=30)	76.18 ± 9.87 (n=22)	75.38 ± 11.55 (n=13)	0.43	> 0.05
PEMCG	76.56 ± 8.42 (n=42)	76.63 ± 8.91 (n=32)	77.22 ± 8.94 (n=17)	78.14 ± 9.51 (n=11)	0.11	> 0.05
POMEG	75.36 ± 10.91 (n=45)	75.03 ± 10.15 (n=37)	73.94 ± 11.20 (n=24)	72.83 ± 12.16 (n=15)	0.25	> 0.05
POMCG	75.33 ± 10.80 (n=43)	75.80 ± 12.10 (n=30)	76.45 ± 13.37 (n=19)	78.31 ± 14.93 (n=13)	0.21	> 0.05
F value	0.89	0.25	0.36	0.61		
P	>0.05	>0.05	>0.05	>0.05		

Data are presented as $\bar{X}$ ± SD, PEMEG =Perimenopausal Exercise group, PEMCG=Perimenopausal Control group, POMEG = Postmenopausal Exercise group, POMCG = Postmenopausal Control group, n= number of participants.

Table 3.
Comparison of Adiposity Measures for Perimenopause and Postmenopause Groups across the Study Period **(Body Mass Index).**

Variable	Wk 0	End of Wk 4	End of Wk 8	End of Wk 12	F-value	P
PEMEG	30.30 ± 3.82 (n=45)	30.01 ± 3.27 (n=30)	29.40 ± 3.34 (n=22)	28.95 ± 3.65 (n=13)	0.65	> 0.05
PEMCG	30.21 ± 3.99 (n=42)	29.96 ± 4.07 (n=32)	30.32 ± 3.91 (n=17)	30.39 ± 4.03 (n=11)	0.05	> 0.05
POMEG	29.18 ± 4.16 (n=45)	29.04 ± 3.91 (n=37)	28.63 ± 4.41 (n=24)	28.35 ± 4.68 (n=15)	0.20	> 0.05
POMCG	19.48 ± 5.22 (n=43)	19.84 ± 5.34 (n=30)	20.87 ± 5.51 (n=19)	21.87 ± 5.50 (n=13)	0.29	> 0.05
F value	0.74	0.68	13.95	0.95		
P	<0.05	<0.05	<0.05	<0.05		

Data for are presented as $\bar{x}$ ± SD, PEMEG =Perimenopausal Exercise group, PEMCG=Perimenopausal Control group, POMEG = Postmenopausal Exercise group, POMCG = Postmenopausal Control group, n= number of participants.

Table 4.
Comparison of Adiposity Measures for Perimenopause and Postmenopause Groups across the Study Period **(Waist Hip Ratio)**.

Variable	Wk 0	End of Wk 4	End of Wk 8	End of Wk 12	F-value	P
PEMEG	0.86 ± 0.08 (n=45)	0.83 ± 0.09 (n=30)	0.80 ± 0.10 (n=22)	0.71 ± 0.07 (n=13)	11.12	< 0.05*
PEMCG	0.86 ± 0.05 (n=42)	0.85 ± 0.05 (n=32)	0.85 ± 0.06 (n=17)	0.86 ± 0.06 (n=11)	0.20	> 0.05
POMEG	0.88 ± 0.06 (n=45)	0.86 ± 0.06 (n=37)	0.78 ± 0.06 (n=24)	0.77 ± 0.07 (n=15)	21.42	<0.05*
POMCG	0.85 ± 0.08 (n=43)	0.87 ± 0.08 (n=30)	0.84 ± 0.08 (n=19)	0.84 ± 0.09 (n=13)	0.54	> 0.05
F value	1.33	1.38	4.22	10.78		
P	>0.05	>0.05	<0.05	<0.05		

Data are presented as $\bar{x}$ ± SD, PEMEG =Perimenopausal Exercise group, PEMCG=Perimenopausal Control group, POMEG = Postmenopausal Exercise group, POMCG = Postmenopausal Control group, *=Significant, n=number of participants

Table 5.
Comparison of Hip and trunk flexibility of Perimenopause and Postmenopause Groups across the Study Period.

Variable	Wk 0	End of Wk 4	End of Wk 8	End of Wk 12	F-value	P
PEMEG	18.84 ± 4.23 (n=45)	22.98 ± 3.76 (n=30)	26.52 ± 4.00 (n=22)	28.27 ± 3.82 (n=13)	28.86	< 0.05*
PEMCG	18.21 ± 3.92 (n=42)	18.87 ± 3.26 (n=32)	19.03 ± 4.83 (n=17)	19.25 ± 4.61 (n=11)	0.34	> 0.05
POMEG	19.51 ± 4.02 (n=45)	22.96 ± 3.44 (n=37)	25.86 ± 3.25 (n=24)	25.97 ± 2.36 (n=15)	22.96	<0.05*
POMCG	19.48 ± 5.22 (n=43)	19.84 ± 5.34 (n=30)	20.87 ± 5.51 (n=19)	21.87 ± 5.50 (n=13)	0.80	> 0.05
F value	0.85	9.19	13.95	11.68		
P	>0.05	<0.05	<0.05	<0.05		

Data are presented as $\bar{x}$ ± SD, PEMEG =Perimenopausal Exercise group, PEMCG=Perimenopausal Control group, POMEG = Postmenopausal Exercise group, POMCG = Postmenopausal Control group, *=Significant, n=number of participants

Table 6.
Post Hoc Analysis, Showing Significant PEME and POME Variables at Various Time Points in the Study (P < 0.05)

0-4th Week	4th – 8th week	8th – 12th week	0 – 8th week	4 – 12 week	0 – 12th week
-	WHR*	WHR^{+}	WHR^{+*}	WHR^{+*}	WHR^{+*}
HTF^{+*}	HTF^{+*}	-	HTF^{+*}	HTF^{+*}	HTF^{+*}

PEME = Perimenopausal Exercise Group, POME =Postmenopausal Exercise Group, WHR = Waist Hip Ratio, HTF=Hip and Trunk Flexibility, + =Significant PEME variables, *= Significant POME variables

groups. However, significant increases ($P<0.05$) were observed across time-points from the 4^{th}, 8^{th} and 12^{th} week of study for the PEME and POME groups while no statistically significant changes were observed for the PEMC and POMC groups across the time point difference. An across the group comparison of the four groups showed significant increases ($P<0.05$) in mean (HTF) values at the 4^{th}, 8^{th} and 12^{th} week of study.

Table 6 is a post hoc analysis using Duncan multiple range test to pinpoint the time frames within the course of the study when some variables such as WHR and HTF exhibited significant changes.

DISCUSSION

According to various authors, (McKinlay et al, 1992, Cramer, 1995, Morabia and Costanza, 1998, Watkins et al, 2004, NAMS, 2006) the average menopausal age is 51 years while the perimenopausal age is about five years less than menopausal age (Cramer 1995; Watkins et al, 2004). Thus the age group of participants in this study corresponded to those stated by the aforementioned authors. A notable limitation in this study had to do with the attrition rate of participants. Regular participation in exercise programs is usually not a regular feature in Nigerian women. This is because they are usually preoccupied with household and homemaking activities (Ojowu et al, 2007). A number of the participants in this study withdrew at various stages of the exercise program for varied reasons which included traveling out of town to take care of a newly born grandchild, complaints of a busy work schedule, hospitalization of a spouse or other family members and varied other reasons.

For the participants in the exercise training group, minimal body weight changes as regards weight loss was observed across the study period and this was not statistically significant when compared to the baseline values even though mean lower values were observed for both groups. The result of this study is similar to that of Akinpelu, (1990), in which no significant body weight changes were observed in participants of a twelve-week exercise program consisting of hypertensive adult men and women. A previous study by Rodnick and Fricher, (1985) on physical fitness for middle aged participants did not result in significant changes in body weight of participants at the end of six months of exercise. A number of studies provide evidence to suggest that physical exercise alone without caloric restriction (dieting) has only a modest effect on body weight (Despres et al., 1994, Wood et al, 1991, Despres and Lamarche., 1993; Bouchard et al, 1993). According to Stefanick, (1993) individuals who combined exercise with dietary regimen maintain their weight loss more effectively. In this study, no caloric restriction was imposed on the exercise participants, this could have resulted in their minimal weight loss across the study period. In the control group participants, there was also no significant change in mean body weight, on the other hand, a gradual increase in body weight was observed. This observation could suggest that, the relative reduction in body weight of the exercise group of participants even though not statistically significant could be attributed to their involvement in the exercise program.

The baseline mean body mass index of exercise group participants was 29.74 ± 4.01 kg/m^2. This shows they were largely overweight. According to the National Heart, Lung and Blood Institute and National Institute of Diabetes and Digestive and Kidney Disease (1998), overweight was classified as a BMI of 25-29.9 and obesity as a BMI of >30. For women, 21.3 to 22.1 is the suggested desirable BMI range while the corresponding range for men is 21.9 to 22.4 (Calle et al, 1999). The participants in this study therefore formed an appropriate group to be involved in a physical fitness training program because a high BMI is a health risk and links to an increased mortality from all causes such as high blood pressure, diabetes, cardiovascular disease, coronary artery disease and osteoarthritis (Calle et al, 1999). In this study, no significant change was observed in the BMI of participants at the end of the twelve-week exercise program. This may probably be due to the fact that change in body weight was minimal and not statistically significant in the exercise participants at the end of the twelve-week EEP.

At the end of the exercise program, mean waist to hip girth ratio demonstrated a significant change from the baseline value in both PEME and POME groups. At baseline WHR of 0.87 considered to be high risk level for that age group was reduced to a moderate risk value of 0.74 at the end of the EEP. A higher waist to hip ratio has been said to reflect a greater proportion of abdominal fat with greater risk for disease, such as hypertension, hyperinsulinemia, atherosclerosis and type II diabetes (McArdle et al, 2000, Toth et al, 2000, Gower, et al, 2006). According to Wilmore, (1982) substantial reductions of the abdominal girth can result from localized exercise such as, knee-bent sit-ups, which is not due to localized fat losses. He stated further that loss of 7.5 to 10cm in the abdominal girth can occur from sit

up exercise alone without any loss in either total or localized fat. This is due to strengthening of the abdominal muscles, which pulls the abdominal contents back into their normal position. Progressive abdominal weakness leads to a spilling-out of the abdominal muscle contents which results in a pot belly appearance (Wilmore, 1982). In this study, the participants undertook abdominal muscle exercises which could have helped in strengthening the abdominal muscles, thereby pulling the abdominal contents back into place.

The observed significant change in hip and trunk flexibility of the PEME and POME participants as against the PEMC and POMC participants in this study is in consonance with previous observations that stretching exercises may enhance muscle performance (Wilson et al., 1992; Worrell et al., 1994). The primary effect of stretching involves the viscoelastic properties of the tendon. Stretching, results in both a transient increase in the musculo-tendon unit length resulting from actin-myosin complex relaxation (Smith, 1994) and a lasting increase through alteration in the surrounding extracellular matrix (Taylor et al., 1990). A beneficial effect of increased flexibility has been observed in the prevention and treatment of musculoskeletal injuries (Hilyer et al., 1990). Furthermore as associated age related changes often result in substantial loss of tendon flexibility and limit motion (Raab et al, 1988), exercise interventions involving flexibility training was justifiably included in this exercise program and the observed improvement in flexibility of the participants is expected to have led to an improvement of the range of motion in the joints and enhancement of the participants daily activities and physical performance (Raab et al., 1988, Schenkman et al., 1996).

In this study, engagement of Nigerian perimenopausal and postmenopausal women in a twelve-week endurance exercise program led to a reduced relative disease risk in terms of a significant reduction in the waist-hip ratio (abdominal adiposity) of the participants. Also a significant improvement in flexibility resulted in better health-related component of physical fitness of the participants. Based on the result of this study it is recommended that Nigerian women in the perimenopausal and postmenopausal age group should engage regularly in endurance exercise programs.

REFERENCES

American College of Sports Medicine, (1990) Position Stand on the recommended quantity and quality of exercise for developing and maintaining cardio-respiratory and muscular fitness in healthy adults. *Med Sci Sports Exerc*22:265 - 274

American College of Sports Medicine, (1998) Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardio-respiratory and muscular fitness, and flexibility in healthy adults.*MedSci Sports Exerc,* 30, 975-991.

Amusa, I.O and Udoh, C.O (1982) Women and Physical fitness in: Dynamics of Physical Fitness. Adebara Publishers, Oshogbo Nigeria 68-84.

Asikainen,T.M, Kukkonen-Harjula K, Miilunpalo, S (2004). Exercise for health for early postmenopausal women: a systematic review of randomised, controlled trials. *Sports Med.* 34 (11) 753-778.

Bouchard, C, Depres, J.P, Tremblay, A. (1993). Exercise and obesity.*Obesity Res.*1, 133-147

Calle, E.E., Thun, M.J., Petrelli, J.M.,et al. (1999) Body-mass index and mortality in a prospective Cohort of U.S. Adults 34. *N Engl J Med* 1, 1097 – 1105.

Cornbleet, S. L.l Woolsey, N. B. (1996). Assessment of hamstring muscle length in school aged children using the sit and reach test and the inclinometer measure of hip joint angle. *PhysTherap*76: 850-855.

Cramer, D.W, Harlow, B.L and Xu, H. (1995). Cross sectional and case-controlled analyses of the association between smoking and early menopause. *Maturitas* Sep: 22 (2): 79-87

Despres, J.P. (1994). Physical activity and adipose tissue in: Bouchard, C Shepherd R.J and T Stephens (eds) Physical Activity, Fitness and Health, Champaign, Illinois, Human Kinetic Publishers 358-368.

Despres J. P and Larmache B (1993). Effects of diet and physical activity in adiposity and body fat distribution: Implication for the prevention of cardiovascular disease. *Nutr. Res. Rev.* 6, 137-159.

Gower, B. A; Munoz, J; Desmond, R; et al. (2006) Changes in Intra-abdominal fat in early postmenopausal women: Effects of hormone use. *Obesity* 14 (6): 1046-1055.

Hilyer, J.C., Brown, K.C., Sirles, A.T et al. (1990). A flexibility intervention to reduce the incidence and severityof joint injuries among municipal firefighters. *J Occup Med* 32: 631-637.

Kemmler, W., Lauber, D., Weineck, J, et al. (2004).Benefits of 2 years intense exercise on bone density, physical fitness and blood lipids in early postmenopausal osteopenicwomen.Results of the Erlanger Fitness Osteoporosis Prevention Study (EFOPS). *Arch Intern Med* May 24 164: 1084-1091.

Kemmler, W (2005) Exercise helps women Starting Menopause. Med Sci Sports Exerc. 37, 194-203. News Release, *American College of Sports Medicine.*

McArdle, W.D., Katch, F.I., Katch, V.L. (2000). Training the anaerobic and aerobic energy systems. Essentials of Exercise physiology.Lippincott Williams and Wilkins 2nd Edition 365.

McKinlay, S.M., Brambilla, D.J, and Posner, J.G (1992).The normal menopause transition. *Am J Hum Biol* 4: 37 - 46.

Montoye H.J (1975) Physical activity and health, an epidemiologic study of an entire community. In: McArdle W.D, Katch F.I, Katch V.L (2000). Training the anaerobic and aerobic energy systems.Essentials of exercise physiology Lippincott Williams and Wilkins 2nd Edition 365.

Morabia .A, Costanza, M. C. (1998) World Health Organisation Collaborative Study of Neoplasia and Steroid Contraceptives. International Variability in ages at menarche, first livebirth, and menopause. *Am J Epidemiol*148, 12: 1195-1205.

National Heart, Lung and Blood Institute and National Institute of Diabetes and Digestive and Kidney Disease (1998): Federal Guidelines for Identifying, Evaluating and Treating Overweight and Obesity. In McArdle W, Katch, F and Katch V. C. (Eds) Essentials of Exercise Physiology, 2nd Edition Lippincott Williams and Wilkins 537.

North American Menopause Society (2006).Menopause Guidebook. Cleveland, OH: NAMS.

Ojowu, O.H., Bulus and B.Omonona (2007). Nigeria Poverty Assessment.Mimeo, National Bureau of Statistics, Nigeria. Retrieved in November, 2010 from http://ageconsearch.umn.edu/bitstream.

Paluska, S.A., Schwenk, T. Physical activity and mental health- current concepts. *Sports Med* 29: 167-179.

Poehlman, E. T. and Tchernoff, A. (1998) Traversing the Menopause: Changes in Energy Expenditure and Body Composition. *Coron Artery Dis* 9(12): 799-803.

Poehlman, E. T; Toth, M. J.; Garder, A. W. (1995) Changes in energy balance and body composition at menopause: A controlled longitudinal study. *Ann Intern Med* 123 (9): 673-675.

Raab, D.M., Agre, J.C., McAdam, M, et al. (1988). Light resistance and stretching exercise in elderly women: effect upon flexibility. *Arch Physiol Med Rehabil* 69: 268-272.

Schenkman, M, Shipp, K.M, Chandler, J, et al. (1996). Relationship between mobility of axial structures and physical performance. *Phys Ther 76: 276-285.*

Smith, A. (1994). The warm-up procedure to stretch or not to stretch? *J Orthop Sports Phys Ther*19:12-17.

StefanickM.L. (1993) Exercise and weight control. In: Exercise and sport Sciences Reviews (21). Holloszy J.O. (Ed) Baltimore: Williams and Watkins 363-396.

Taylor, D.C, Datton, J.D, Seaber, A.V., et al. (1990). Viscoelastic properties of muscle-tendon units: The bio mechanical effects of stretching. *Am J Sports Med* 18: 300-309

Toth, M. J; Tchernof, A; Sites, C; et al. (2000). Menopause-related changes in Body Fat Distribution. *Ann N Y AcadSci* 904 (1), 502-506.

Wilson, G.J., Elliot, B.C and Wood, G.A (1992). Stretch Shorten Cycle performance enhancement through flexibility training. *Med Sci Sports Exerc 24: 116-123.*

Worrel, T.W., Smith, T., Winegardner J. (1994). Effect of stretching on hamstring muscle performance. *J Orthop Sports Phys Ther 20: 154-159.*

Wood, P. D; Stefanick, M. C; Williams, P. T et al. (1991) The effects on plasma lipoproteins of a prudent weight reducing diet with or without exercise in overweight men and women. *N Engl Med J 325: 461-466.*