Volume-3, Issue-9, Sept-2014 • ISSN No 2277 - 8160

Research Paper | Physical Education

# Differential Effects of Two Exercise Modes on Glycaemic and Anthropometric Indices of Female Out-patients, recently Diagnosed with type 2 Diabetes

**Joshua Emeka Umeifekwem** — Department of Health and Physical Education, University of Nigeria, Nsukka

**Chukwugozie NOkwuosa** — Department of Medical Laboratory Sciences, Faculty of Health Sciences & Technology, College of Medicine, University of Nigeria, Enugu Campus

**ABSTRACT**

*Physical Exercise has been recognized as a major cornerstone in type-2 diabetes management and prevention of type-2 diabetes. However, determining the differences in efficacy of identified beneficial exercise modes in managing type-2 diabetes has not been well established. This study examined the differential effects of two exercise modes (Aerobic Endurance Exercise and Progressive Resistance Exercise) on glycaemic and anthropometric characteristics of female out-patients type 2 diabetics. A pre-test post-test quasi-experimental research design was adopted for the study. Fourteen out of 18 female (CA 36-58 years) and out-patient type-2 diabetics who registered and met the inclusion criteria at the Medical Centre, University of Nigeria, Nsukka participated in the study. They were randomly assigned to two experimental groups of Aerobic Endurance Exercise (5 females: mean age 45.6 years) and Progressive Resistance Exercise (4 female: mean age 46.2 years) and one control group of 6 females (mean age 48.8 years). Glycaemic and anthropometric measures were obtained from all the three groups at the beginning and at the end of the training respectively for comparison. Experimental groups were subjected to a six station circuit training model of 2day/week exercise training in respective exercise modes for fifteen weeks. The descriptive and inferential statistics of analysis of covariance (ANCOVA) were employed for data analyses. Results indicated that Progressive Resistance Exercise generally accounted for the significant difference between pre-test and post test Casual Plasma Glucose mean scores of the experimental and control groups [F= 8.909> 3.98 (df 2,11) p< .05]; Body weight, [F = 64.602 > 3.98 (df 2, 11 ) p<.05].There was no significant difference in the post test body weight measures between Progressive resistance exercises (PRE) and control p= -.412 <.05. Also, both AEE and PRE had no significant effect on the waist-to-hip ratios of the two experimental type-2 diabetic female group who participated in the programme [F= 1.789<3.98 (df 2,11) p< .05].*

**KEYWORDS : Type-2 Diabetes, Aerobic Endurance Exercise, Progressive resistance exercise, Body composition, glucose**

## Introduction

Excessive percentage body fat distribution has been identified as significant risk factor for certain chronic diseases. Over fat (Obesity) and overweight are both implicated in various metabolic and endocrine syndromes such as impaired glucose metabolism and diabetes particularly type-2 diabetes (T2DM) (Corbin, et al., 2002; Wilmore and Costil, 1999). Son, et al. (2005), concluded that high Percent Body Fat (PBF) and Waist-to-Hip Ratio (WHR) were major risk factors associated with diabetes even when Body Mass Index (BMI), is normal.

Given the fact that the majority of persons with type-2 diabetes are overweight, one may view the chronic obese/overweight state in the genetically prone individual as a predisposing factor in precipitating the medical syndrome of type-2 diabetes mellitus. Therefore, preventing and treating obesity as a clinical problem in managing type-2 diabetic patients make regular physical activity an imperative. According to Tremble and Donaldson (1998), weight loss of up to 10% in susceptible individuals can not only be significantly beneficial in reducing the risk of developing type-2 diabetes mellitus but also in improving metabolic control after the disorder might have manifested.

Physical Exercise as a therapeutic component for T2DM management has been adjudged one of the most effective, economical and reasonable treatment option for the management and prevention of type-2 diabetes. According toWallberg-Henrickson, Rincon and Zierath (1998), exercise therapy has salient advantage over other intervention measures such active participation of patients in the management regimen, ease of administration and minimal adverse effects. Willey and Fiatarone-Singh (2003), affirmed thatexercise directly targets the metabolic derangements of diabetes compared with many medications that primarily increase available insulin supply.

Physical exercise effects on substrate utilization and insulin sensitivity potentially lower blood glucose and lipid levels, moreso, the physiological basis for a relationship of exercise effect on carbohydrate metabolism and glucose tolerance has been well documented. Horton (1988) Wallberg-Henrikson (1998), and Boughouts and Keizer (2000), demonstrated that during a single prolonged session of physical activity, contracting muscles appear to have a synergistic effect with insulin in enhancing glucose uptake into the cells. This effect appears to be related to both increased blood flow in the muscle cell. The enhancement as observed can persist for 24 hours or more as glycogen levels in muscles are being replenished.

Aerobic Endurance exercise training has gained wider popularity as a major exercise stimulus for prevention and management of type-2 diabetes essentially owing to the fact that pioneer research in the area of Exercise and treatment of type-2 diabetes were conducted using that mode of exercise (Dunstan, 2002). According to Vignati and Cunningham (1986), aerobic endurance exercise is characterized by exercise that requires great expenditure of energy which stimulates the cardio-respiratory system by utilizing a large portion of the skeletal muscle mass for at least 15 minutes per exercise session. Based on the generally observed encouragingresults of those studies, aerobic endurance exercise became the most advocated form of exercise used for the management of type-2 diabetes mellitus especially in patients below the age of 55 years( Eriksson, et al. ,1997).White and Sherman (1999) reported marked improvements in glucose tolerance tests oftype-2 diabetics within one week of aerobic training and improved glycaemic control as reflected in glycosylated haemoglobin after 6-12 weeks of an aerobic exercise programme.

However, despite these findings, caution by Eriksson, et al. (1997) andHonkola, et al. (1997) that aerobic exercise may not be advisable for some type of patients such as those with severe obesity, has necessitated the interest to explore other forms of exercise mode in the management of Type-2 diabetes. Consequently, following Eriksson and co-workers' (1997) postulation that "since peripheral insulin resistance is a major defect in type-2 diabetes, it could theoretically be appropriate to use an exercise programme, aiming at improving muscle function and strength through hypertrophy (i.e. resistance training) in the treatment of type-2 diabetic patients", researchers have redirected attention to the Progressive Resistance exercise (PRE) as a complementary exercise mode in exercise and diabetes research.

PRE is a system of exercise regimen that provides some form of resistance in pre-determined steps to the contracting muscles in order to stimulate the body to increase power and strengths. The method of force production in PRE follows the principles as described by DeLorme and Watkins(1948) which include 1. Performing a small number of repetitions until fatigue, 2.Allowing sufficient rest between exercise for recovery, and 3.Increasing the resistance as the ability to generate force increases. Evidence emanating from few reviews of randomized controlled trials on the effects of PRE in exercising body showed likely potentials of resistance exercises to improve metabolic conditions in type-2 diabetes. For example, Eriksson, et al. (1997), demonstrated that a programme of progressive resistance type exercise had significant training effect on muscle endurance and glycosylated haemoglobin ($HbA_{1C}$) of moderately obese type-2 diabetic outpatients. Ishii, et al. (1998), reported the efficacy of 4-6 weeks of moderate intensity (40-50%/RM) resistance exercise in improving insulin sensitivity by 48%, but not body composition in a group with type-2 diabetes; Dunstan, et al. (2002), found that High intensity PRE was effective for maintaining the gymnasium based improvement in muscle strength and lean body mass but not glycaemic control in older patients with type-2 diabetes; In another study, Castaneda, et al. (2002) found that Hispanic subjects with type-2 diabetes who underwent 16 weeks of high intensity PRE, had significant decrease in fasting insulin levels and waist circumferences and significant increase in muscle glycogen content and mean muscle strength when compared with control subjects.

Few studies have however investigated the differential effects of both aerobic Endurance and Progressive Resistance exercises on characteristics of individuals with type-2 diabetes. Indeed, Eriksson, et al. (1997) found that resistance training led to higher increase in insulin sensitivity than seen in patients who engaged in aerobic or no training. Smutok, et al. (1993) had inferred that both aerobic and resistance training improved glucose metabolism and reduced insulin response to oral glucose (in men) in the same way. Also, Boulé, et al. (2003) reported that the results of meta-analysis of effects of exercise on $HbA_{1c}$ concentration did not differ based on type of exercise (i.e. aerobic versus resistance training). Unfortunately, most of these studies were conducted with male population or mixed population. In addition, results of experimental studies have been equivocal (Boulé, et al 2001). Pierce (1999) specifically, expressed concerns about the studies design with respect to duration, intensity and modes of exercise regime adopted for the exercise programme and called for need to scale up research in this area.Consequently, Loureiro, Nayga (2006) and Beckman (2004) concluded that lack of specific guidance about prescribing an exercise training programme for primary care physicians was a major constraint to integrating exercise to treatment therapy.

Research efforts are still minimal in assessing simultaneouslythe training effects of both Aerobic Endurance and Progressive Resistance Exercises on a number of glycaemic and anthropometric characteristics of type-2 diabetics based on gender categories. Effort to facilitate the development of specific exercise models based on a dose-response relationship fashion, even for gender categories of type-2 diabetics remains an important phase in exercise and T2DM research.This study therefore assessesdifferential effectsof two exercise modes on glycaemic and anthropometric indices of recently diagnosed type 2 diabetic female outpatients.

Five postulated research hypotheses of no significant difference on post exercise, glycaemic indicator, body weight,Body Mass Index,Percent Body Fat,Body Circumference (Waist-to-Hip Ratio) of newly diagnosed female type-2 diabetics in the two experimental (AEE and PRE) and non-exercising control groups following a 15-week supervised two separate modes of exercise programme guided the study.

## Methods

***Participants*** Twenty four (18)recently diagnosed type-2 diabetic female out-patient volunteers who officially registered in the Medical Centre, University of Nigeria, Nsukka constituted the population of the study. Fourteen qualified volunteers (CA 36-58 years) who met the inclusion criteria (no complications, type-2 diabetes controlled by diet or oral agent, sedentary lifestyle and blood pressurenot exceeding 175/100mmHg ,do not use insulin and certified fit to participate by a physician) were selected andparticipated in the study. The 14 volunteers (mean age 46.9 years), were randomly assigned to either of the two experimental groups [AEE: 5females (mean age 45.6 years), PRE: 4females (mean age 46.2 years)] and control 6 females (mean age 48.8 years). The participants gave their written informed consent to participate in the study after all the procedures and possible risks of participation were explained. The study was approved by the University of Nigeria, Ethics Committee.

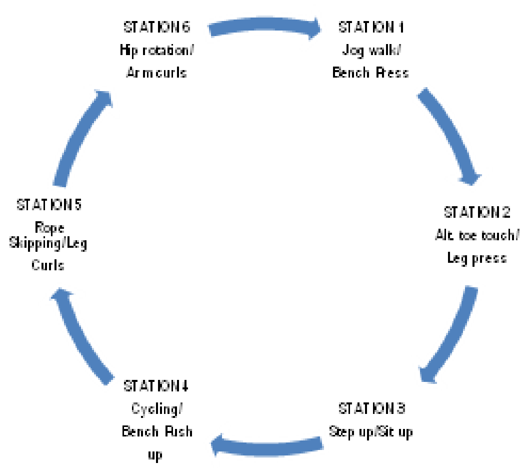
### Procedure for data collection

Comprehensive pre-test and corresponding post-test measures of the glycaemic and anthropometric characteristics were obtained from all the participants at the beginning and at the end of the training respectively. Research assistants helped in recording, observing and timing the subjects where necessary. The participants in the two different exercise modes were subjected together to the outlined exercise protocol in categories as a homogenous unit.

### Exercise Protocol

1. The Aerobic Endurance Exercise (AEE) programme and the Progressive Resistance Exercise (PRT) were the two modes of exercise approach.
2. Fifteen weeks was the span of period for the application, monitoring and collection of data on the experimental treatments. The groups performed the exercises, 2 days/week following the Eriksson, et al. (1997) protocol.
3. The Circuit model as described by Fox, Bowers and Foss (1989) was modified and adopted for the Aerobic Endurance Exercise while, the circuit design for the Progressive Resistance Exercise followed the protocol as described by Reilly and Thomas (1978). The circuits for both exercise modes were made up of six stations, which included three lower and three upper body exercises.
4. Sequences of exercises were arranged so that no two consecutive stations consisted of exercises involving the same muscle group (Fig. 1.).
5. The training adopted the progressive incremental workload approach. Aerobic Endurance Exercise group participants worked at 40-60% their maximum heart rate, while in the PRE stations, each participant worked according to his assessed repeated maximum test (1 RM) as described by Dunstan, et al. (2002), the participants worked between 40-60% 1 RM. The loads were adjusted to ensure that the working muscles felt exertion after performing as many repetition as possible but not more than 12 repetitions in one set. The loads were increased periodically every two weeks for the 15-week training period using repetition maximum approach for calibration to ensure progressive overload.

**Figure 1 Circuit profile of the Exercise stations for both AEE and PRE Modes**




### Data analyses

The data generated from the pre-test and post-test measures were analyzed using the Statistical Package for Social Sciences (SPSS 11.0) for both the descriptive and inferential statistics of analysis of covariance (ANCOVA).The Sidak Pairwise multiple comparisons was employed where ANCOVA had revealed significant differences among the groups at P<.05 level of significance. The eta square ($R^2$) was used to determine the size of effect.

## Results

**Table 1. Summary of the Ranges, Means and Standard Deviation of Pre and Posttests of Casual plasma Glucose and Anthropometric measures for AEE and PRE Group**

| | Aerobic Endurance (females) | | | | | | Progressive Resistance Exercise (females) | | | | | | Control (Females) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| t | Pre-training | | | Post-training | | | Pre-training | | | Post-training | | | Pre-training | | | Post-training | | |
| | Range | Mean | SD | Range | Mean | SD | Range | Mean | SD | Range | Mean | SD | Range | Mean | SD | Range | Mean | SD |
| Height (M) | 1.56-1.69 | 1.63 | 0.52 | | | | 1.56-1.76 | 1.71 | 0.11 | | | | 1.59-1.72 | 1.65 | 0.55 | | | |
| Age (Years) | 36-53 | 45.60 | 6.73 | | | | 36-52 | 46.20 | 7.30 | | | | 39-58 | 48.83 | 7.03 | | | |
| Body weight (BW) (Kg) | 80.00-89.40 | 84.78 | 3.60 | 76.10-84.20 | 80.06 | 3.11 | 79.60-88.00 | 83.20 | 3.97 | 78.30-87.50 | 82.08 | 4.13 | 72.40-90.00 | 83.28 | 5.20 | 71.90-89.50 | 82.57 | 5.88 |
| Body mass Index (BMI) ($Kg/m^2$ | 29.10-34.60 | 31.90 | 2.36 | 27.60-32.40 | 30.14 | 2.09 | 28.40-33.20 | 30.85 | 2.45 | 28.20-32.40 | 30.38 | 2.18 | 27.90-32.90 | 30.65 | 2.15 | 27.70-33.00 | 30.83 | 2.18 |
| Waist to Hip (WHR) | 0.80-0.91 | 0.86 | 0.05 | 0.78-0.90 | 0.84 | 0.05 | 0.79-0.94 | 0.83 | 0.04 | 0.78-0.86 | 0.82 | 0.03 | 0.78-0.88 | 0.83 | 0.04 | 0.80-0.88 | 0.83 | 0.03 |
| Percent Body Fat (PBF) (%) | 29.90-33.20 | 31.40 | 1.52 | 28.10-30.80 | 29.44 | 1.21 | 30.80-33.90 | 32.40 | 1.27 | 28.80-31.60 | 30.00 | 1.17 | 23.10-31.30 | 28.31 | 3.25 | 24.20-31.30 | 27.80 | 2.54 |
| Casual Plasma Gluc. (CPG) | 194.00-254.00 | 236.60 | 24.94 | 198.00-217.00 | 206.00 | 7.71 | 186.00-264.00 | 216.75 | 33.24 | 165.00-190.00 | 176.25 | 11.09 | 185.00-283.00 | 238.17 | 36.44 | 180.00-245.00 | 227.67 | 25.32 |

**Table 2.Analysis of Covariance for Casual Plasma Glucose (CPG) Values of Female Participants in AEE, PRE and Non-Exercising Control Groups**

| Source | Sum of Squares | df | Mean Square | F | Sig. | PartialEta Squared ($R^2$) |
|---|---|---|---|---|---|---|
| Corrected Model | 7310.75[b] | 3 | 2436.9 | 9.405 | .002 | .719 |
| Intercept | 4467.04 | 1 | 4467.0 | 17.240 | .002 | .610 |
| COVARIATES | 961.900 | 1 | 961.90 | 3.712 | .080 | .252 |
| MAIN EFFECT (1, 2, & 3) | 4616.73 | 2 | 2308.4 | 8.909 | .005 | .618 |
| Residual Error | 2850.18 | 11 | 259.11 | | | |
| Corrected Total | 10160.9 | 14 | | | | |

**a. Computed using alpha = .05 Critical value of f = 3.98 < .05**

The means and standard deviations of the pretest and posttest values of the females' CPG for the three groups in Table 1.show that the pretest values of CPG for the AEE, PRE and the control groups were 236.60 $\pm$ 24.94mg/dl, 216.75 $\pm$ 33.24mg/dl and 238.17 $\pm$ 36.44mg/dl respectively. For posttest the scores were 206.00 $\pm$ 7.71mg/dl, 176.25 $\pm$ 11.09mg/dl and 227.67 $\pm$ 25.32mg/dl in that order for the groups. There were observed mean differences in CPG values between the pretest and posttests measure (AEE – 30.8mg/dl; PRE = -40.5mg/dl and Control – 10.5mg/dl), which also indicate a greater percentage of reduction in the experimental group than the control.

The F-ratio due to treatment among the three groups (F = 8.91) was however, higher than the critical value of 3.98 (df 2, 11) and was found to be significant at .05 alpha level [F (df 2, 11) = 8.91, p =.005]. This indicates that there was a significant difference in mean CPG of different exercise groups of participants with an effect size of $R^2$ = 618 or 61.8% (Table 2). The null hypothesis was not supported. However, the multiple pairwise comparisons performed shows (Table 3.) that there was significant difference in CPG mean values only between the pair of progressive resistance exercise group and the control and therefore the PRE accounted for the significant difference recorded in the study.

**Table 3.Multiple Pairwise Comparisons for Casual Plasma Glucose (Female)**

| (I) Exercise | (J) Exercise | Mean Difference (I-J) | Std. Error | Sig.[a] |
|---|---|---|---|---|
| Endurance | Progressive<br>Control | 24.231<br>-21.231 | 11.172<br>9.750 | .150<br>.148 |
| Progressive | Endurance<br>Control | -24.231<br>-45.462* | 11.172<br>10.840 | .150<br>.004 |
| Control | Endurance<br>Progressive | 21.231<br>45.462* | 9.750<br>10.840 | .148<br>.004 |

***The mean difference is significant at the .05 level.**

**Table 4.Analysis of Covariance (ANCOVA) for the Mean Post Training Body Weight of Females in the Experimental Groups [AEE (1) PRE (2)] and Non-Exercising Control Group [NEC (3)]**

| Source of Variation | Sum of Squares | df | MS | F | Sig. | $R^2$ |
|---|---|---|---|---|---|---|
| Corrected Model | 277.584 | 3 | 4.702E-02 | 250.957 | .000 | .987 |
| Intercept | 4.702E-02 | 1 | 259.217 | .128 | .728 | .012 |
| COVARIATES | 259.217 | 1 | 23.819 | 703.054 | .000 | .986 |
| MAIN EFFECT (1, 2, & 3) | 47.637 | 2 | .369 | 64.602 | .000 | .926 |
| Residual Error | 4.056 | 11 | | | | |
| Corrected Model | 281.640 | 14 | | | | |

**a. Computed using alpha = .05 Critical value of f = 3.98 < .05**

**Table 5.Multiple Pairwise Comparisons for Body Weight (Female)**

| Exercise | Exercise | Mean Difference | Sig. of Comparison |
|---|---|---|---|
| Aerobic Exercise | PRE<br>Control | -3.571*<br>-3.983* | .000<br>.000 |
| PRE | AEE<br>Control | 3.571*<br>-.412 | .000<br>.680 |
| CONTROL | AEE<br>PRE | 3.983*<br>-.412 | .000<br>.680 |

In Table 1.thepretest and posttest means and standard deviation values of the female body weights in the two experimental and control groups were presented. AEE pretest mean and standard deviation values include 84.78 $\pm$ 3.60kg, and for the posttest, 80.06 $\pm$ 3.11kg in that order. The corresponding means and standard deviations of the pretest body weight values for the PRE group were 83.20 $\pm$ 3.97kg and posttest values 78.30 – 87.50kg, 82.08 $\pm$ 4.13kg. The control group had for pretest 83.28 $\pm$ 5.20kg and posttest 82.57 $\pm$ 5.88kg as respective values for means and standard deviations. A simple comparison shows that marginal differences occurred between the pretest and posttest values of the two experimental groups and the control group (AEE: -4.72kg; PRE: -1.12kg and control -0.71).

The F-ratio due to treatment between the experimental and control groups in Table 4.was 64.60, p<. 05 and was found to exceed the critical value of 3.98 (df 2, 11) [F = 64.60>3.98(df 2, 11) p<.05]. This implied that there was a significant difference in body weights of the three groups.The null hypothesis was not supported. The sidak adjustment for multiple comparisons (Table 5.) however, revealed that the mean differences in the group's body weights were significant between the AEE and PRE groups and between the AEE and control group and not significant between PRE and control. In addition, the ratio of variance due to treatment reveals $R^2$ = .926 or 92.6% as the size of effect

**Table 6.Analysis of Variance for Body Mass Index Values of Female Participants in the AEE, PRE and Non-Exercising Grou**

| Source | Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 55.31b | 3 | 18.444 | 415.08 | .000 | .991 |
| Intercept | .104 | 1 | .104 | 2.348 | .154 | .176 |
| COVARIATES | 55.139 | 1 | 55.139 | 1240.9 | .000 | .991 |
| MAIN EFFECT (1, 2, & 3) | 5.868 | 2 | 2.934 | 66.034 | .000 | .923 |
| Residual Error | .489 | 11 | 4.E -0.2 | | | |
| Corrected Total | 55.820 | 14 | | | | |

**a. Computed using alpha = .05 Critical value of f = 3.98< .05**

**Table 7.Multiple Pairwise Comparisons for Body Mass Index**

| (I) Exercise | (J) Exercise | Mean Difference (I-J) | Std. Error | Sig.[a] |
|---|---|---|---|---|
| Endurance | Progressive<br>Control | -1.251*<br>-1.446* | .144<br>.132 | .000<br>.000 |
| Progressive | Endurance<br>Control | 1.251*<br>-.195 | .144<br>.136 | .000<br>.449 |
| Control | Endurance<br>Progressive | 1.446*<br>.195 | .132<br>.136 | .000<br>.449 |

***.The mean diff. is significant at the .05 level; a. Adjustment for multiple comparisons: sidak.**

The means and standard deviations of the Body Mass Index of the female participants are shown in Table 1. as follows. The pretest mean and standard deviation for the Aerobic Endurance Exercise group was 31.90 $\pm$ 2.36kg/m$^2$, while the posttest value was 30.14 $\pm$ 2.09kg/m$^2$. Also, the mean and standard deviation values of the posttest for the Progressive Resistance Exercise group were 30.85 $\pm$ 2.45kg/m$^2$ and 30.38 $\pm$ 2.18kg/m$^2$. Finally, in the control group, the pretest mean and standard deviation was 30.65 $\pm$ 2.15kg/m$^2$ while 30.83 $\pm$ 2.18kg/m$^2$ was the posttest scores. The pretest-posttest mean differences for the three groups were as follows: AEE, PRE and control were -1.78kg/m$^2$, -0.47kg/m$^2$ and 0.33kg/m$^2$ respectively showing that the AEE group had a greater difference in its pretest-posttest mean differences than the PRE and control groups.

The analysis of covariance results in Table 6. regarding the effects of the two modes of exercise programmes on body mass index of the three groups of female participants indicates that the F-ratio of the main effects of treatment (66.03) was higher than the critical value of 3.98 (df, 2, 11) and was found to be significant at .05 alpha level of significance [F = 66.03 > 3.98 (df 2, 11) p<.05]. Similarly, the null hypothesis was not supported. The size of effect of treatment was given as $R^2$ .991 or 99.1%; in addition, the Sidak's multiple comparisons (Table 7) indicated that the significant differences are found between Aerobic Endurance Exercise and Progressive Resistance Exercise and between the Aerobic endurance exercise and the control but not between the progressive resistance group and control.

**Table 8.Analysis of Variance for Percent Body Fat Values of Female Participants in the AEE, PRE and Non-Exercising Groups**

| Source | Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared ($R^2$) |
|---|---|---|---|---|---|---|
| Corrected Model | 52.706[b] | 3 | 17.569 | 63.844 | .000 | .946 |
| Intercept | 2.202 | 1 | 2.202 | 8.003 | .016 | .421 |
| COVARIATES | 39.165 | 1 | 39.165 | 142.32 | .000 | .928 |
| MAIN EFFECT (1, 2, & 3) | 1.500 | 2 | .750 | 2.726 | .109 | .331 |
| Residual Error | 3.027 | 11 | .275 | | | |
| Corrected Total | 55.733 | 14 | | | | |

**a. Computed using alpha = .05 b. R Squared=.946 (Adjusted R Squared = .931**

The means and standard deviation values of the femalespretestpercent body fat scores as presented in Table 1, indicate that the AEE, PRE and control groups had 31.40 $\pm$ 1.52 percent, 32.40 $\pm$ 1.27 percent and 28.31 $\pm$ 3.25 percent respectively. While they had in their post test 29.44 $\pm$ 1.21 percent, 30.00 $\pm$ 1.17 percent and 27.80 $\pm$ 2.54 percent in the same order. The groups pretest-posttest mean PBF differences of -1.96 percent for AEE, -2.4 percent for PRE and -0.51 percent for the control group appear to indicate a very minimal reduction of percent body fat following those exercise programmes.

The analysis of covariance (Table 8) shows that the F-ratio of 2.726 was smaller than the table value of 3.98 (df 2, 11) at .05 alpha level and therefore, was not statistically significant [F = 2.726 < 3.98 (df 2, 11) p<.05]. Moreso, the strength of effect of treatment appears weak as given by $R^2$ = .331 or 33.1 %. Therefore, the null hypothesis was supported.

**Table 9.Analysis of Covariance for Body Circumference (Waist-to-Hip Ratio) Values of Female type-2 diabetes participant in AEE, PRE and Non-exercising Control**

| Source | Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared ($R^2$) |
|---|---|---|---|---|---|---|
| Corrected Model | 1.9E-02[b] | 3 | 6.E-03 | 39.258 | .000 | .915 |
| Intercept | 8.7E-06 | 1 | 9.E-06 | .053 | .822 | .005 |
| COVARIATES | 1.8E-02 | 1 | 2.E-02 | 107.31 | .000 | .905 |
| MAIN EFFECT (1, 2, & 3) | 5.8E-04 | 2 | 3.E-04 | 1.789 | .213 | .245 |

| Source | Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared ($R^2$) |
|---|---|---|---|---|---|---|
| Residual Error | 1.8E-03 | 11 | 2.E-04 | | | |
| Corrected Total | 2.1E-02 | 14 | | | | |

**a. Computed using alpha = .05 b.R Squared =.915 (Adjusted R Squared = .891**

With reference to waist-to-hip ratio, the case summaries in Table 1. show that the means and standard deviations of the pretest for the AEE, PRE and Control groups were 0.86 $\pm$ 0.05cm, 0.83 $\pm$ 0.04cm and 0.83 $\pm$ 0.04cm in that order, while the post test values also follow as 0.84 $\pm$ 0.05cm, 0.82 $\pm$ 0.03cm and 0.83 $\pm$ 0.03cm in the same order. The respective mean differences of pretest-posttest means for the AEE, PRE and control groups were -0.02, -0.01 and 0.00 showing that there were very low differences accounted for by the respective exercise programmes.

Further to the above, the analysis of covariance (Table 4.15) indicate, that the F ratio (1.79) of the main effects of treatment was less than the table value of 3.98 (df 2, 11) and was not significant at .05 alpha level, [F = 1.789 < 3.98 (df 2, 11) p<.05]. In addition, the effect size of treatment was given as $R^2$ = 245 or 24.5%. The hypothesis wassupported.

## Discussion

### Casual Plasma Glucose

The result of this study, showed that aerobic endurance and progressive resistance exercise groups had their plasma glucose significantly reduced both when compared with baseline and with the control subjects (-30.8mg/dl). This result is consistent with the findings of Holloszy, et al. (1986), Segal et al. (1991) Richter, et al. (2001) who utilized aerobic endurance mode of exercise to examine the rate of glucose uptake in type-2 diabetes. Colberg and Swain (2000) had reported that repeated bouts of an intense activity can result in significant muscle glycogen depletion which greatly enhances post activity insulin sensitivity. This may have explained the finding since the participants engaged in exercises for up to 30 minutes in a supervised setting.

The multi comparison however showed that the observed significant difference was explained by the exercise effect inthe progressive resistance exercise group alone and not aerobic group. Progressive resistance exercise (PRE) had been shown to improve glucose degradation rates, increase glycogen storage capacity, increase GLUT 4 receptors on skeletal muscle in healthy persons, (Miller, et al., 1994) and in glucose intolerant subjects (Fluckey, et al., 1994).This finding of significant reduction of females in PRE group corroborates the finding of Ishii, at al. (1998), Dunstan, et al. (2002) and Ibañez, et al. (2005) who reported significant glucose disposal rates in older men with type-2 diabetes following 2-3 times weekly of progressive resistance training at moderate intensity. The finding is encouraging as it supports the contention of Fiatarone-Singh (2000) that at intensities between 60-100% IRM "PRE elicit structural functional and metabolic changes in skeletal muscle". The present study used intensities of between 50 – 70% IRM.but the reduction in CPG among the aerobic group was not significant.

The findings of this study therefore suggests that the progressive resistance exercise might be a better option than the aerobic endurance when deciding on the type of exercise regimen for females diagnosed with type 2 diabetes especially with regards to reduction in casual plasma glucose.

### Weight

The result of this study revealed that the effects of the exercises resulted in significant reduction on body weights of females (64.60) type-2 diabetics who participated in the study following a 15-week aerobic endurance exercise regimen. However, multiple comparisons show that the aerobic endurance exercise accounted for the observed difference as there were significant mean differences between AEE and PRE on one hand and AEE and Control on the other hand. Conversely, PRE had no significant reduction effects on females' body weights (Table 3). The findings in this study is consistent with those of Bryner, et al. (1999), who found that the body weights of the aerobic endurance group decreased significantly than the resistance exercise group following 12 weeks of physical activity.

Incidentally, the findings of this study did not corroborate those of Boulé, et al. (2001) who undertook a meta-analysis of results on the effects of structured exercise intervention on body mass. They found, no post intervention body weight difference between exercise and control groups. However, the finding that the post exercise body weight ofwomen with type-2 diabetes in this study did not change significantly following participation in PRE programme interestingly, suggests agreement with the findings of Ibañez, et al. (2005) although women were not included in the study. Explanation may not be unconnected with the nature and structure of the exercise programme, thus, although the exercise training was twice weekly, efforts were made to encourage participants to attend. They were also supervised throughout the duration of the programme. Some of the results in previous studies that did not record any change in body weight failed to include elements of supervision of the programmes for e.g. Boulé, et al. (2002) and Dunstan, et al. (2005).

The finding that women's weights were significantly reduced by AEE modesmay have reflected women's high level of commitment to their physique and weight watching. Thus, they may have been extraordinarily determined to achieve results in the programme. Whitemore, et al. (2005) observed that although women had difficulty meeting optimal goals for exercise, they nevertheless report higher levels of physical activity.Besides, decrease in weight of participants may not be directly related to the modes of exercise alone, especially since they were not asked to abstain from their usual medication – during the training period. According to ADA position statement (2002) results from few studies concerning exercise and weight reduction in type-2 diabetics are confounded by simultaneous use of unusual diets and other interventions.

### Body Mass Index

The result of this study shows that the Body Mass Index (BMI) for both aerobic endurance and progressive endurance groups were significantly reduced by exercise training modes employed in the study. Unfortunately, it was revealed that progressive resistance exercise did not have any significant change in females' BMI in that category. The relationship between the risk of death and BMI is disease specific, and low BMI is beneficial with respect to heart arteries and diabetes mellitus (Andres, 1990 and Wallace, 2002). The result of the study was however surprising especially when one considers the frequency of the exercise (twice- weekly). However, the patients' tenacity in compliance with the full regimen of the training may have contributed to the observed reduction recorded in the study. The aerobic endurance exercise had a greater reduction effectthan those in the PRE groups (AEE (M)= – 1.61kg/m$^2$,AEE (F)= – 1.78kg/ m$^2$ and control M = 0.28kg/m$^2$ ,and F = 0.33kg/m$^2$: PRE (M)= – 1.06kg/m$^2$. PRE (F)= – 0.47kg/m$^2$ and control M = 0.28kg/m$^2$ F = – 0.33kg/m$^2$). When these results are compared with the norms provided for categorization of relative risk of BMI to diabetics mellitus (Wallace, 2002) it was found that although the post training measures of males and females in both exercise modes did not drop from "higher risk" category to a "lower risk" one, it was however markedly important in at least stabilizing the BMI of the experimental groups, unlike the control which had a rather high increase in BMI over the study period.

Unfortunately, literature is scarce on effects of exercise on the BMI of type-2 diabetics therefore comparison could not be made based on other research results. It was therefore adduced that the observed changes in the BMI was the result of the effect of exercise mode adopted for the study.

### Percent Body Fat

The result of this study showed that there were significant reductions in percent body fat (PBF) of males in both categories of exercise modes after the programme. However, observed reductions in PBF of females in both exercise modalities were not significant, as they did not differ significantly from those in the control group. Unfortunately, most research on aerobic exercise and type-2 diabetes did not examine body composition (Sigal, et al. 2004) and so comparisons of the findings of this study remain difficult. Although studies (Bouchard and Despress, 1995, Gettmann and Pollock, 1981) have shown that both modes of exercise regimen lead to fat mass reduction especially when exercise protocol was the circuit-type, fewer research studies have demonstrated this trend of results in type-2 diabetes (Sigal, et al. 2004).

Nevertheless the finding that women PBF did not change in both exercise modes was however expected. This is because according to the American College of Sport Medicine Position Stand (2000), although physical activity promotes beneficial physiological changes in type-2 diabetics, the type-2 diabetics are usually unable to exercise at a level that is required for significant weight loss to occur and that the often reported body fat losses due to exercises are often not significant. Presumably, the women who participated in this study may have been unable to exercise at a level that would have induced fat losses. However, even when studies on exercise and type-2 diabetes rarely examine body composition, Sigal, et al. (2004) speculated that loss of fat which may not have shown might have been partially offset by increased lean body mass. This study however did not cover lean body mass.

**Body Circumference (Waist-to-Hip Ratio)**

Generally, the results show that aerobic endurance exercise and progressive resistance exercise did not produce any significant difference in the Waist-to-Hip Ratio at baseline among female type-2 diabetes patients.This finding disagrees with that of Castaneda, et al. (2002) who reported decrement in waist circumference of group of type-2 diabetes elderly men that underwent a 16-week progressive resistant training andIbañez and co-workers (2005) demonstrated a 10% reduction in visceral and subcutaneous abdominal fat of type-2 diabetic older males using the progressive resistance training.

Most of the studies on aerobic exercise and type-2 diabetes have failed to test the exercise's effects on waist-to-Hip ratio. This may not be unconnected with the earlier finding (Boulé, et al., 2001) that aerobic exercise promotes glycaemic control by changing muscle metabolism, but not merely by improving body composition.However when the results of both the aerobic endurance and progressive resistance exercises were compared with the classification table, the baseline Waist-to-Hip Ratio advanced from 0.84 (moderately high risk) to 0.89 (post exercise) in aerobic endurance. While in the PRE group Waist-to-Hip Ratio similarly stepped up from 0.82cm to 0.83cm post exercise (moderately high risk). Therefore as can be seen, the exercises had no reduction effect.

**Conclusion**

It was concluded that following a 15-week supervised two separate modes of exercise programme two sessions per week,Aerobic Endurance Exercise training effect would significantly reduce body weights, BMI but not on CPG of females recently diagnosed type-2 diabetes. Similarly, Progressive resistance exercises (PRE) would have significant reduction effect on CPG, but not on body weights, BMI. Both Aerobic endurance exercise and Progressive resistance exercises may not demonstrate significant reduction effect on the PBF and waist-to-hip ratio of the females.

## REFERENCES

American College of Sport Medicine.(2000) .ACSM's Guidelines for Exercise Testing and prescription.Philadephia, Lippincott William & Wilkins. | American Diabetes Association.(2000). Diabetes mellitus and exercise (position Statement).Diabetes Care 23 (Suppl. 1): S50-S54. | Beckman, T. J. (2004). Prescribing exercise: is your physician's head in the game?Archival Internal Medicine164:2066 –2067. | Borghtouts, L.B. & Keizer, H.A. (2000). Exercise and insulin sensitivity: a review. International Journal of SportsMedicine 21:1-12. | Bouchard, C. &Despres, J.P. (1995). Physical activity and health: atherosclerotic, metabolic, and hypertensive disease. Research Quarterly for Exercise and Sport 66:268-275. | Boulé, N.G., Kenny, G.P., Haddad, E., Wells, G.A. &Sigal, R.J. (2003). Meta-analysis of the effect of structure exercise training on cardiorespiratory fitness in type 2 diabetes mellitus. Diabetologia46:1071-1081. | Boulé, N.G., Haddad E., Kenny, G.P., Wells, G.A. &Sigal, R. J. (2001). Effects of exercise on glycemic control and body mass in type 2 diabetes mellitus: a meta-analysis of controlled clinical trials. JAMA 286.10:1218-1227. | Bryner, R.W., Ullrich, I.H., Sauers, J., Donley, D., Hornsby, G., Kolar, M. &Yeater, R. (1999). Effects of resistance and aerobic training combined with an 800 calorie liquid diet on lean body mass and resting metabolic rate. Journal of the American College of Nutrition 18.2:115-121. | Castaneda, C., Layne, J.E., Munoz-Orians, L., Gordon, P.L., Walsmith, J., Foldvari, M., Roubenoff, R., Tucker, K.L., &Nelson, M.E. (2002). A randomized controlled trial of resistance exercise training to improve glycemic control in older adults with type 2 diabetes. Diabetes Care 25:2335–2341. | Colberg, S.R. & Swain, D.P. (2000). Exercise and diabetes control. The Physician and Sport Medicine 28.4.Retrieved May 29, 2006 from file:IIA:\ the physician and sports medicine Exercise and Diabetes control.Htm. | Corbin, C.B, Lindsey R, Welk G.I &Corbin,W.R. (2002). Concept of Fitness and Wellness. A comprehensive Lifestyle Approach 4th Ed. Boston. McGraw Hill. | Costill, D.L., Cleary, P., Fink, W.J. & Foster, C. (1979).Training adaptations in skeletal muscle of juvenile diabetics.Diabetes 28-818-826. | DeLorme, T.L. & Watkins, A.L. (1948) Techniques of progressive resistance exercise. Archives of Physical Medical Rehabilitation.29: 263-273. | Dunstan, D.W., Daly, R.M., Owen, N., Jolley, D., deCourten, M., Shaw, J. &Zimett, P. (2002). High-intensity resistance training improves glycemic control in older patients with type 2 diabetes. Diabetes Care 25:1729–1736. | Eriksson, J., Taimela, S., Eriksson, K., Parviainen, S., Peltonen, J. &Kujala U. (1997). Resistance training in the treatment of non-insulin-dependent diabetes mellitus.International Journal Sport Medicine 18:24-246. | Fluckey,J.D.,Hickey, M.S.,Brambrink, J.K., Hart, K.K., Alexander, K. & Craig, B.W.(1994). Effects of resistance exercise on glucose tolerance in normal and glucose-intolerant subjects. Journal of Applied Physiology 77:1087–1092. | Fox, E.L., Bowers, R.W. & Foss, M.L. (1989). Physiological Based of Physical Education and Athletics 4th ed. Dubuque, Wm. C. Brown. | Gettman, L. R.& Pollock, M. L. (1981). Circuit weight training: A critical review of its physiological benefits. The Physician and Sportsmedicine9.1: 44-60. | Holloszy, J.O., Schultz, J., Kusierkiwicz, J., Hagberg, J.M. &Ehsami, A.A. (1986).Effects of exercise on glucose tolerance and insulin resistance brief review and some preliminary results. Acta medical scandinavica.Supplementatum 711:55-65. | Honkola, A., Forsen, T. & Eriksson, J. (1997). Resistance training improves the metabolic profile in individual with type 2 diabetes. ActaDiabetologia 34: 245-248. | Horton, E.S. (1988). Role and management of exercise in diabetes mellitus.Diabetes Care 11.2: 201-211. | Ibanêz, J., Izquierdo, M., Arguelles, I., Forga, L., Larrion, J.L, Garcia-Unciti, M., Idote.,&Gorostiaga, E. M. (2005). Twice-weekly progressive resistance training decreases abdominal fat and improves insulin sensitivity in older men with type diabetes. Diabetes Care 28: 662-667. | Ishii, T., Yamakita, T., Sato, T., Tanaka, S. &Fujii, S. (1998). Resistance training improves insulin sensitivity in NIDDM subjects without altering maximal oxygen uptake. Diabetes Care 21:1353–1355. | Loureiro, M.L. &Nayga, R.M. Jr. (2006). Obesity, weight loss, and physician'sadvice.Social ScienceMedine, 62:2458 –2468. | | Miller, J.P, Pratley, R.E., Goldberg, A.P., Gordon, P., Rubin, M., Treuth, M.S., Yan, A.S. & Hurley, B.F. (1994). Strength training increases insulin action in healthy 50-to 65-yr-old men. Journal of Applied Physiology 77: 1122-1127. | Pierce, N.S. (1999). Diabetes and exercise.British Journal of Sports Medicine 33.3:161-172. | Reilly, T. & Thomas, V. 1978. Multi-station equipment for physical training: design and validation of a prototype. Applied Ergonomics 4: 201-206. | Richter, E.A., &Galbo, H. (2001).Diabetes and Exercise. The Novo Nordisk Foundation, and the Danish Medical research Council, Publication. | Sigal, R.J., Kenny, G.P., Wasserman, D.H., &Castaneda-Sceppa, C. (2004).Physical activity/exercise and type 2 diabetes.Diabetes Care 27.10:2518-2539. | Smutok, M. A., Reece, C., & Kokkinos, P. F. (1993).Aerobic vs. strength training for risk factor intervention in middle-aged men at high risk for coronary heart disease.Metabolism 42: 177-184. | Tremble, J.M, & Donaldson, D. (1999). Is continued weight gain inevitable in type 2 diabetes mellitus? Journal Research of Social Health 119.4: 235-9. | Vignati, L. &Cunnigham, L.N. (1986).Exercise and Diabetes.Joslin's Diabetes Mellitus. A. Marble, L.P. Krall, R.F. Bradely, A.R. Chrislieb&Soeldner Eds.. Philadelphia: Lea and Febiger. 453-464. | Wallace, J.P. 2002. Obesity.ACSM'S Exercise management fo persons with chronic Diseases and Disabilities. J.C. Durstine and G.E. Moore Eds. New York: Lippincott, Williams and Wilkins. 149-156. | Wallberg-Henriksson, H., Rincon, J. &Zierath, J.R. (1998). Exercise in the management of non-insulin dependent diabetes mellitus. Sports Medicine 25. 1:25-35. | White, R.D. & Sherman, C. (1999). Exercise in diabetes management maximizing benefits, controlling risks. The physician and Sports medicine 4.27:36-44. | Wilmore, J.H. &Costil, D.C. (1999). Physiology of Sports and Exercise. Champaign ILL: Human Kinetics Publishers. | Willey, K.A. &Fiatarone-Singh, M.A. (2003). Battling insulin resistance in elderly obese people with type 2 diabetes: bring on the heavy weights. Diabetes Care 26:1580–1588. |