INTRODUCTION

Regular physical exercise has been linked with an improved health, robustness and well being while inactivity and sedentary living have been the cradle of diseases and gradual disability in man. Unfortunately, participation in physical exercises is no longer common in our daily life when technology has replaced virtually all our manual regimes with remote machines. The situation is even worse among our youths in the Colleges and Schools where precious leisure time is wasted on less profitable ventures such as spectatority, drug abuse etc. However, the benefits of regular participation in physical exercises to health and fitness have not changed, today only few people would want to debate them. According to Spanos, Karaiskos, Zetou and Portokalis (2007), over the past years, exercises have been included in the programme of most people since the knowledge of its beneficial effects are spreading worldwide.

Traditionally, boys and girls have been encouraged to participate in aerobic activities such as bicycling, running and swimming, however, they have not been encouraged to participate in exercises that are resistive in nature, such as step-up, push-up, pull-up, etc. In recent years, a growing body of evidence has accumulated to support that resistance training can be a safe and effective way of conditioning for youth, more so now that space and time available are rapidly reducing.

Robergs and Robergs (1997) defined resistance training as the muscle contractions performed against a resistance, typically in the form of external loads like those used in weight lifting. This definition is corroborated by the words of Faigenbaum (2003) that resistance training refers to a specialized method of conditioning that involves the progressive use of wide range of resistance loads and a variety of training modalities (e.g. free weight, barbells and dumbbells, weight machines and body weight), designed to enhance muscle function, increase muscle size, improve body composition, boost sports performance and reduce athletic injuries.

Of all the food nutrients, carbohydrate is the most usable substrate for energy production. It can be stored as glycogen in muscle, and liver, functioning as a readily available energy source for prolonged, strenuous exercise, and can also be found in the blood as blood glucose. Therefore blood glucose is a factor both in physical performance and health status of man. It is easy to demonstrate the crucial role played by carbohydrate metabolism in supplying energy for physical work and according to Maughan, Gleeson and Greenhaff (1997) even at rest, failure to maintain the blood glucose concentration which supplies...
carbohydrate fuel to the brain and other tissues, results in central nervous dysfunction which can progress to coma and eventually to death.

Armstrong and Welsman (1997) reported that the blood glucose lowering properties of physical exercise have been recognized for many years, they however concluded that research evidence documenting the precise nature and extent of both immediate and long term benefits of regular physical activity upon blood glucose in young people is relatively scarce and the results equivocal. It is therefore the purpose of this study to investigate the effects of a 12-week resistance training programme on the blood glucose level of College Students in Ekiti State of Nigeria.

HYPOTHESES
1. There will be no significant effect of a 12-week resistance training programme on the blood glucose level of College Students in Ekiti State of Nigeria.
2. There will be no significant effect of a 12-week resistance training programme on the bicarbonate level of College Students in Ekiti State of Nigeria.

METHODS AND PROCEDURES
The research design was a pre-test post-test control group design which involved assigning subjects randomly to both the experimental and control groups. The population for the study comprised six hundred and fifty (650) certified fit students of College of Education, Ikere-Ekiti aged between 20 years and 30 years. Sixty (60) out of these students were selected as sample through a purposive sampling technique and were randomly assigned to both the experimental and control groups with thirty (30) subjects in each group. The two groups were involved in both the pretest, mid-test and post-test measurements, but only the experimental group was involved in the 12-week resistance training programme.

The collection of blood samples was done through the assistance of the College Laboratory Scientists. Two milliliters of fasting blood sample was collected by venepuncture from the antecubital vein of each subject with a hypodermic needle. The blood samples were taken between 8.00am and 9.00am of each day of collection and the samples were stored cold.

Exercise Protocol
The programme comprised a well structured and supervised progressive 12-week strength training programme with 30-60 minutes session of three times per week. The intensity was graduated by adhering strictly to the principles of training. The training session include:
(i) 10-minutes calisthenics exercises
(ii) Resistance exercises which consisted 6-10 different exercises with 2-3 sets in a workout and lasted between 30-60 minutes progressively.

The training programme followed the recommendation of Sale (1989).

DATA ANALYSIS
Both descriptive and inferential statistics were employed. The data gathered were subjected to descriptive statistics of mean, standard deviation and range and inferential statistics of Analysis of Covariance (ANCOVA) was used (using the pre-test as covariate) to determine the significance of the adaptation resulting from the 12-week resistance training at 0.05 level significance. A post hoc analysis was also applied on significant variables using the Multiple Classification Analysis (MCA) to find out the magnitude of the adaptations that took place.

RESULTS AND DISCUSSION
Table 1 below presents the descriptive statistics of the pre-test and post-test values of the blood glucose parameters of the experimental and control groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group</th>
<th>Pre-test Values</th>
<th>Post-test Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean   SD   Range</td>
<td>Mean   SD   Range</td>
</tr>
<tr>
<td>Glucose (mmol/l)</td>
<td>Control</td>
<td>5.02 ±0.95 3.20-6.50</td>
<td>5.15 ±0.55 4.20-6.10</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>4.86 ±1.01 2.90-6.70</td>
<td>4.14 ±0.44 3.20-5.00</td>
</tr>
<tr>
<td>Bicarbonate (mmol/l)</td>
<td>Control</td>
<td>23.80 ±2.22 20-28</td>
<td>22.83 ±2.09 20-28</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>21.90 ±2.22 17.00-26.00</td>
<td>25.70 ±2.07 23.20-32</td>
</tr>
</tbody>
</table>

Table 1 above shows a moderate decline in the values after the resistance training programme from 5.15mmol/l ± 0.55 in the pre-test to 4.14mmol/l ± 0.44 in the post-test values after training in the experimental group. The change in the control group was from 5.02mmol/l ± 0.95 in the pre-test to 4.86mmol/l ± 1.01 in the post-test values. Although the control group also showed a slight decline in the glucose level, the change was not of the same magnitude with the experimental group. The mean values showed a declining tendency in both groups, this disparity experienced in the level of declining change is evident in the mean difference of pre and post test values of 1.01mmol/l and 0.16mmol/l in the experimental and control groups respectively. However, the mean pre-training values of Bicarbonate 23.80mmol/l ± 2.22 for the control group as shown on table 1 was higher than that of the experimental group with 22.83mmol/l ± 2.05. Bicarbonate showed a declining tendency in the control group with a pre-training value of 23.80mmol/l ± 2.22 reducing to a post-
training value of 21.90mmol/l ± 2.22. The experimental group Bicarbonate values increased from a pre-training values of 22.83mmol/l ± 2.05 to a post-training value of 25.70mmol/l ± 2.07.

The observed mean difference showed an increase of 2.87mmol/l for the experimental group, whereas, the control group demonstrated a mean decrease of 1.9mmol/l after the 12-week resistance training programme.

Table 2: Analysis of Covariance (ANCOVA) Table for Glucose Parameters of the Experimental Group

<table>
<thead>
<tr>
<th>Source</th>
<th>Glucose (mmol/L)</th>
<th>Bicarbonate (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariate</td>
<td>32.394</td>
<td>175.920</td>
</tr>
<tr>
<td>Main Effect</td>
<td>10.700</td>
<td>299.838</td>
</tr>
<tr>
<td>Explained</td>
<td>2.990</td>
<td>91.080</td>
</tr>
<tr>
<td>Residual</td>
<td>1256.360</td>
<td>34470.000</td>
</tr>
<tr>
<td>Total</td>
<td>43.159</td>
<td>483.600</td>
</tr>
</tbody>
</table>

F [0.05] = 4.03 (N=30)

Table 2 above present the Analysis of Covariance (ANCOVA) for the glucose parameters of the experimental group.

Table 3: Multiple Classification Analysis (MCA) of ANCOVA on the Glucose Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Grand Mean</th>
<th>Groups</th>
<th>N</th>
<th>Unadjusted Dev'n</th>
<th>Adjusted for Independent + Covariate Dev'n</th>
<th>Beta</th>
<th>Multiple R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>4.4967</td>
<td>1</td>
<td>30</td>
<td>-0.36</td>
<td>-0.42061</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mmol/L)</td>
<td>23.80</td>
<td>2</td>
<td>30</td>
<td>0.36</td>
<td>1.3367</td>
<td>.826</td>
<td>.683</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>2.1784</td>
<td>1</td>
<td>30</td>
<td>1.9</td>
<td>2.1784</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mmol/L)</td>
<td>21.784</td>
<td>2</td>
<td>30</td>
<td>-1.9</td>
<td>-2.1784</td>
<td>.438</td>
<td>.192</td>
</tr>
</tbody>
</table>

F[0.05] = 4.03 (N=30)

The Analysis of Covariance (ANCOVA) results on table 2 showed that the calculated F ratio of 202.996mmol/l for glucose and 187.645mmol/l for bicarbonate were greater than the critical value of 4.03 required to make the effect significant at 0.05 level.
Thus the hypothesis which stated that there would be no significant effects on the blood glucose of college students when exposed to a 12-week resistance training programme was rejected.

The Multiple Classification Analysis (MCA) on table 3 showed that the resistance training programme accounted for about 68.23% of the observed decrease in the glucose level of the subjects, whereas the same training regime accounted for about 19.18% of the observed increase in the bicarbonate levels of the college students.

The pattern of changes in figure 1 showed that the decrease in the glucose level was identical and high from the 1st week to the 12th week in the experimental group while the control group showed a slight decrease between the same period. Figure 2 showed an increase of high magnitude among the experimental group throughout the training period while the control group recorded progressive decrease throughout the training period with the highest occurring towards the tail end of the training regime.

DISCUSSION
As it has been observed, the resistance training programme employed in this study indicated a positive effect of this type of training regime on the glucose parameters in the experimental group. This is shown by the amount of the mean decrease observed in the glucose level (1.01mmol/l) and 2.87mmol/l increase in the bicarbonate level of the experimental group, compared with a mild decrease of 0.16mmol/l and 1.9mmol/l in both the glucose and bicarbonate levels of the control group respectively.

The decreases observed in the glucose level and the increase in the bicarbonate level of the experimental group might be accounted for by the effect of the resistance training on the subjects.

The findings of this study showed similarity with some earlier findings of researchers, though not with the same caliber of subjects. Miller, Sherman and Ivy (1984) reported that a 10-week of strength training regime significantly reduced basal insulin levels and area under the insulin response curve following glucose ingestion. Ganong (1985) also stated that entry of glucose into skeletal muscle is increased during exercise in the absence of insulin most especially with strenuous and prolonged exercise. Hurley, Hagberg and Goldberg (1988) in their findings supported the findings of this study when they found that insulin response to an oral glucose tolerance test was significantly lowered following a 16-week of resistance training programme.

Smoutok, Reece and Kokkinos (1993) reported along the line of this finding when they compared the effects of endurance and strength training on responses to a glucose tolerance test. They concluded that both modalities decreased the total area under the curve for glucose levels and insulin response. Also Robergs and Robergs (1997) ascertained that prolonged exercise is usually accompanied by decrease in body's skeletal muscle and liver glycogen stores which results in skeletal muscle metabolism relying more on blood glucose concentrations and invariably causes the blood glucose level to fall, which is referred to as hypoglycemia.

The observation of this study also corroborated the findings of other researchers (Boule, Haddad, Wells and Sigal, 2001), Tuomilehto et al. (2001) and Willey and Singh (2003) that a large amount of regular, moderate intensity resistance exercises increase insulin sensitivity and enhances glucose tolerance and may prevent the development of type 2 diabetes.

CONCLUSION
Based on the findings of this study, it can be concluded that a 12-week resistance training programme has the capacity to bring about significant reduction in the glucose level and a significant increase in the bicarbonate level of the youth. It can also be concluded from the above statement that regular doses of resistive exercise regimen can improve and enhance health fitness of the youth thereby preventing some debilitating diseases such as diabetes and other chronic cardiovascular diseases.

ACKNOWLEDGEMENT
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REFERENCES


Hurley, B.F., Hagberg, J.M., & Goldberg, A.P., [1988] Resistive training can reduce coronary risk factors without altering VO2 Max or percent body fat.


