



**British Journal of Education, Society &  
Behavioural Science**  
3(2): 163-173, 2013

SCIENCEDOMAIN *international*  
[www.sciencedomain.org](http://www.sciencedomain.org)



---

## **Aerobic and Progressive Resistance Exercise Effects on Body Composition of Primary School Children in Ibadan, Nigeria**

**Ademola Olasupo Abass<sup>1</sup> and Monday Omoniyi Moses<sup>1\*</sup>**

<sup>1</sup>*Department of Human Kinetics and Health Education, Faculty of Education, University of Ibadan, Ibadan, Oyo State, Nigeria.*

### **Authors' contributions**

*This work was carried out in collaboration between the two authors. Author AAO worked on the research design, performed statistical analysis and wrote the protocol for exercise trainings. Author MMO worked on the materials for trainings and led exercise training teams and actualized exercise training programmes as well as wrote the first draft of the manuscript. The authors read and approved the final manuscript.*

**Review Article**

**Received 21<sup>st</sup> February 2012**  
**Accepted 5<sup>th</sup> November 2012**  
**Published 19<sup>th</sup> February 2013**

---

### **ABSTRACT**

**Aims:** The study determined the effectiveness of aerobic exercise (AE) and progressive resistance exercise (PRE) trainings on the body composition measured in terms of percent body fat and body mass index of primary school children in Ibadan, Nigeria.

**Study Design:** Randomized classic experimental study with a pre, post test and control groups were adopted.

**Study Population and Place of Study:** The study comprised of 180 primary school children with 7-12 years of age range drawn from both public and private schools in Ibadan, Nigeria. It was conducted in the Exercise Physiology Laboratory and Sports complex of the University of Ibadan, Ibadan, Nigeria from October, 2010 to July, 2011.

**Methodology:** Systematic random sampling technique was used to assign the participants into AE, PRE experimental groups and control group. Pretest-posttest data were collected using the Large skinfold calliper (model 3003) on seven skinfold sites of chest, triceps, subscapular, axilla, supriliac, abdomen and thigh; and body mass index. Data were analysed using mean, analysis of covariance (ANCOVA) and Scheffé post hoc test.

---

\*Corresponding author: Email: [moniy152002@yahoo.com](mailto:moniy152002@yahoo.com);

**Results:** Results showed that percent body fat in PRE group had a pre-test and post-test means of  $7.21 \pm 4.23$  and  $7.17 \pm 4.22$  with mean difference of 0.04%, AE group had a pre-test and post-test means of  $6.04 \pm 3.59$  and  $7.89 \pm 3.85$  with mean difference of 1.85%. It also revealed pre-test and post-test means of  $14.81 \pm 3.29$  and  $14.80 \pm 2.20 \text{ kg/m}^2$  for BMI in the PRE group with mean difference of  $0.01 \text{ kg/m}^2$ , pre-test and post-test means of  $15.09 \pm 1.66$  and  $15.66 \pm 2.07 \text{ kg/m}^2$  for BMI in the AE group with mean difference of  $0.57 \text{ kg/m}^2$ . It finally exposed that there were significant differences in the effect of the training regimens on body mass index [ $(F_{3, 176}) = 6.365, p < 0.05$ ] and that AE enhanced better improvement in percent body fat and body mass index.

**Conclusion:** The study concluded that for effective achievement of good body composition, AE training should be mostly considered in the training modes of primary school children in Ibadan, Nigeria.

*Keywords: Percent body fat; body mass index; public and private school children; aerobic and progressive resistance exercises.*

## 1. INTRODUCTION

Childhood obesity is one of the most serious public health challenges of the 21<sup>st</sup> century. The problem is global and is steadily affecting many low- and middle-income countries, particularly in urban settings. The prevalence has increased at an alarming rate. A study reported that in 2010 the number of overweight children under the age of five is estimated to be over 42 million globally [1]. Close to 35 million of these children are living in developing countries [2] Nigeria being inclusive. Consumption of unprocessed foods is almost becoming an abomination among children whenever the opportunity to eat arises. WHO reiterate that intake of excess processed foods results into accumulation of fats measured in terms of percent body fat (%BF) and body mass index (BMI)(1). Body composition is composed of a variety of different tissue types including lean tissues (muscles, bones and organs) that are metabolically active and fat (adipose) tissue that is not [3].

Fat is an essential component of the human body necessary for normal physiological functioning. However, despite the statutory effects of fat in the body, its excessive accumulation is undesirable. There is empirical evidence that pointed out that excess cholesterol or hypercholesterolemia occurs when there is abnormally high level of cholesterol or lipoprotein in the blood [4]. An international organization reported that nutritional deficiencies, diet-related diseases and general poor health afflict an estimated one-third of world children population [2]. It is now also known that heart diseases can begin in childhood, especially in overweight children [5]. The risk factors associated with cardiovascular diseases in children include being overweight, having high blood pressure, high cholesterol and diabetes [1]. It was reported that the prevalence of obesity among 457 school children in the age group 6-19 years in Nigeria is 3.2% for males and 5.1% for females [6]. There is empirical study established that based on weight for age, 3.7% males and 3.3% females were classified as obese when triceps skinfold thickness was used as the basis of obesity [7]. Another study also found out that 18% of children aged 5-15 years from a relatively privileged section of a community were found to be obese [8].

An earlier discovery of international organisation reported that children in low- and middle-income countries like Nigeria are more vulnerable to inadequate pre-natal, infant and young child nutrition [1]. At the same time, they are exposed to high-fat, sugar, salt, energy-dense, and micronutrient-poor foods, which tend to be lower in cost. These dietary patterns, in

conjunction with low levels of physical activity, result in sharp increases in childhood obesity while under-nutritional issues remain unsolved [2]. An observational study showed that obesity was previously rare in Africa (including Nigeria) where people especially children consumed unprocessed foods [9]. There was a decreased calorie intake relative to energy expenditure in developing communities [10,11].

In line with the earlier submission on that the problem of child obesity in the past three decades may be easing in some countries, it expected to encourage participation in exercise [12]. To reduce accumulation of excess fat by Nigerian children, advocacy for physical activity participation has been on increase among healthcare providers (HCPs) including physical and health education teachers at the primary and post primary school levels. Along with dietary and behaviour treatment components, exercise or physical activity (PA) is generally considered one of the cornerstones of paediatric treatment [13]. Increasing energy expenditure may accelerate loss of fat mass by creating a negative energy balance and potentiate the maintenance of changes in body composition [14]. Majority of studies in overweight or obese children and adolescents have focused on aerobic exercise (AE) [10,11,14]. The studies carried out indicated that AE has little effect on gross measures such as bodyweight and body mass index (BMI) but is usually associated with favourable changes in body composition [13,15]. AE may decrease body fat, attenuate the loss of lean body mass normally seen during dietary energy restriction and mediate the accumulation of visceral adipose tissue but the latter is associated with cardiovascular risk in the paediatric population [16]. Resistance exercise (RE) is used to develop the strength and size of skeletal muscles. When properly performed, resistance training can provide significant functional benefits and improvement in overall health and well-being. The goal of resistance training is to gradually and progressively overload the musculoskeletal system so it gets stronger [17]. Hence, progressive resistance training is a strength training method in which the overload is constantly increased to facilitate adaptation. Progressive resistance is essential for building muscle and reaching goals Research shows that regular resistance training will strengthen and tone muscles and increase bone mass [18]. Many of the HCPs only support participation in physical activities at least three days per week consecutively for a minimum of two months without taking into cognizance either the AE or PRE type especially at the primary school level. The review of the literature on pediatric obesity significantly revealed that more evidence-based studies on effective interventions to reduce childhood lean body fat should be embarked on [19]. This necessitates the need for a study that will streamline the focus of healthcare providers in assisting children in their early stage of life to prevent adult obesity.

## **2. MATERIALS AND METHODS**

The study was a randomized classic (before and after) experimental research design with two experimental comparison groups and one control group [20]. One of the two experimental groups is actually for comparison because the trainings are not the same while the third group is a pure control group. A total of one hundred and eighty (180) volunteered pupils were drawn conveniently from four (two public and two private) primary schools in Ibadan based on type of school. The sample size ranges proportionately between thirteen [13] and ten [10] pupils from primary three [3]; and twenty [20] and eighteen [18] from primary four. In primary five [5], fifteen [15] pupils were from three schools and twelve [12] from one school. Primaries three to five classes were used due to the advice of Parents' Teachers' Association (PTA) on age barrier. Each of the schools had representation ranges from 40 to 48 pupils. Systematic random sampling technique was used to allocate sixty [60]

participants to each of the three groups, namely: the aerobic exercise (AE), the progressive resistance exercise (PRE) and the control group.

The study was conducted in the Exercise Physiology Laboratory and Sports complex of the University of Ibadan, Ibadan, Nigeria from January and July, 2011. The AE and PRE trainings were a twelve – week interval trainings in which participants in the experimental groups were exposed to repeated periods of work, interspersed with rest periods three times per week [21]. The AE group participated in low intensities (35–54%HRmax) workloads while the PRE group took part in short moderate intensities (55–69%HRmax) workloads with increment at scheduled interval [22]. The AE and PRE trainings adhered strictly to the American College of Sports Medicine [23] on quality and quantity of exercise trainings. In the aerobic exercise training, the participants engaged in five-station weekly activities of three sets with 3, 2 and 1 repetitions respectively in the first week. Week second, third, fourth, fifth, eighth, ninth, tenth and eleventh had four sets of 4, 3, 2 and 1 repetition respectively whereas weeks six and Seven with four sets had 4, 3, 3 and 3 repetitions. The last week had five sets with 5, 4, 3, 2 and 1 repetition in each of the stations. Excluding warm up and cool down, the participants were made to continuously rotate within the stations until activities were completed.

The Progressive resistance exercise training protocol was on incremental number of repetitions (3 sets of 3 to 12 repetitions each) [24]. Appropriate overload was applied, rate of progression was carefully considered, and resistance exercise training effect was monitored periodically to examine the programme. The training session involved ten minutes callisthenic exercise as a form of warm-up. Resistance was increased with each set. Participants were randomly divided into six lines of ten participants each. Seven exercises were given one after the other and lasted for between thirty to sixty minutes progressively under the guide of instructor. The control group did not partake in any organised training during the period.

The PRESTIGE Stadiometer with weighing scale manufactured in India with Model Number of HM0016D was used to measure body weight and height of the participants. Body weight of the participants was collected by standing on weighing scale dressed in a gymnastic cloth and was recorded in kilograms to the nearest 0.1kg. The height of the participants was measured as each stood on Stadiometer bare-footed, erect, feet together with heel, buttocks, proximo-posterior trunk and rear of the head in contact with the bar of the Stadiometer. The figures obtained for body weight divided by the square of that of the height were computed and recorded as body mass index (BMI). The body mass index BMI which is expressed in  $\text{kg/m}^2$  was used to define gross obesity ( $\text{BMI} >40\text{kg/m}^2$ ), obesity  $\text{BMI} >30\text{kg/m}^2$  and overweight  $\text{BMI} >25\text{kg/m}^2$ , normal weight between  $19\text{kg/m}^2$  and  $25\text{kg/m}^2$  and underweight less than  $19\text{kg/m}^2$  [24].

The large skin-fold calliper (model 3003) made by Cambridge Scientific Industries Incorporated, U.S.A., was used to measure skinfold thickness of seven skin-fold sites of chest, triceps, subscapular, axilla, suprilliac, abdomen and thigh of the participants. The calliper is graduated from 0mm to 67mm, with a constant pressure of 10g/mm. The researchers pinched the right side (for consistency) of the pupils' skin at the appropriate site to raise a double layer of skin and the underlying adipose tissue, but not the muscle. The calliper was then applied 1 cm below and at right angles to the pinched skin and a reading was taken two seconds later. The mean of two measurements was taken. Where the two measurements differ greatly, a third was done with the median value taken. The body density equations were used viz: The equations are gender oriented: for boys, Body Density

=1.112 - (0.00043499 X SUM7) + (0.00000055 X SUM7<sup>2</sup>) - (0.00028826 X Age); Body Fat Percentage = [(4.95/Body Density) + 4.5] 100; while for girls, Body Density =1.097 - (0.00046971 X SUM7) + (0.00000056 X SUM7<sup>2</sup>) - (0.00012828 X Age). Body Fat Percentage = [(4.95/Body Density) + 4.5] 100 (girls). (Note: SUM7 is the sum of all the seven sites measurements in mm) (26,27).

An empirical evidence established  $r = 0.90$  for weekly frequency of participation in at least 30 min of Aerobic and progressive resistance exercises (28). Studies reported  $r = 0.89$  for 7 sites skin-fold (26,27),  $r = 0.9$  for weight-height indices (29), and strong Pearson product-moment correlation coefficients of 0.97 for sphygmomanometer, stethoscope ( $r=0.98$ ), stadiometer ( $r=0.99$ ) and weighing scale ( $r=0.96$ )(30).

The cooperation of the participants were sought via a collected signed letter of introduction from the Head of the Department of Human Kinetics and Health Education, University of Ibadan, which was given to the pupil's parents, proprietor/proprietress / Head-Teacher, pupil's class teacher for identification purpose. With this, awareness interaction on exercise and its benefits were given to the pupils after a discussion with their teachers that were well incorporated into the trainings. Finally, they all filled informed consent through their head teachers, class teachers and parents.

Data on the percent body fat and body mass index of the participants were collected before (pre) and after (post) training programmes that lasted for twelve [12] weeks by the researchers with the help of fifteen Physical educators used as assistants. The assistants were trained by ISAK certified exercise trainers for three weeks and also participated in two weeks of pilot study conducted prior the actual work. The descriptive statistics of mean and standard deviation and inferential statistics of ANCOVA were used to test data collected. The Scheffé post hoc test is preferred when many contrasts are of interest was adopted for specific differences in ANCOVA results [3,10].

### **3. RESULTS**

The mean difference showed slight increase in height of 0.04m and 0.01m in the pre and post-test values of AE and PRE; weight increased by 1.88kg in AE and 2.04kg in PRE. Percent body fat in AE group had a pre-test and post-test mean difference of 0.04% while PRE group had a pre-test and post-test mean difference of 1.85%. The pre-test and post-test mean difference for BMI in the AE group was 0.01kg/m<sup>2</sup> whereas pre-test and post-test mean difference for BMI in the PRE group was 0.57kg/m<sup>2</sup>.

Table 1 showed that significant difference does not exist in the %BF among the primary school children exposed to each of the experimental groups and control group [(F<sub>3,176</sub>) =0.658,  $p>0.05$ ]. This is because at the 5% significance level F-Stats > p-values which showed that significant difference does not exist among the three groups. In order to determine the magnitude and direction of the contribution of the trainings on %BF, MCA as presented below was applied.

**Table 1. ANCOVA to determine the effect of aerobic exercise and progressive resistance exercise on percent body fat of the participants**

Source of Variation	Sum of Squares	df	Mean Squares	F	Sig. of F.	Remark
Covariates	18.487	1	18.487	1.179	.279	
Main Effects of Treatment Groups	20.640	2	10.320	.658	.519	N.S.
Explained	39.127	3	13.042	.832	.478	
Residual	2758.931	176	15.676			
Total	2798.058	179	15.632			

The MCA in Table 2 revealed a pattern similar to ANCOVA in table 1. From the table 2, experimental group of PRE has an adjusted mean score value of 7.89%, experimental group of AE has the adjusted mean score value of 7.17 % and control group has the adjusted mean score value of 7.95%. This indicated that AE was more effective than PRE. The experimental group of PRE in table 2 has an adjusted mean score value of 15.66 (14.94+0.70) kg/m<sup>2</sup>, experimental group of AE has the adjusted mean score value of 14.81(14.94-0.12) kg/m<sup>2</sup> and control group has the adjusted mean score value of 14.39 (14.94-0.58) kg/m<sup>2</sup>. The result indicated that AE enhanced better improvement of %BF than the PRE.

**Table 2. Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean = 7.67**

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
PRE	60	.22		.15	
AE	60	-.50		-.47	
Control	60	.28		.32	
			.09		.09
Multiple R Square					.014
Multiple R					.118

Table 3 revealed that statistically significant difference existed in BMI among the primary school children in Ibadan exposed to each of the experimental groups and control group [(F<sub>3,176</sub>) =6.365, p<0.05]. This indicates that there is significant effect of the trainings on BMI of the children. This is because the F-test at p<0.05 shows a significant difference exist among the three groups. In order to determine the magnitude and direction of the differences as well as the contribution of the trainings on BMI, MCA in table 4 was applied.

**Table 3. ANCOVA to determine the effect of aerobic exercise and progressive resistance exercise on Body Mass Index of the Participants**

Source of Variation	Sum of Squares	df	Mean Squares	F	Sig. of F	Remark
Covariates	18.128	1	18.128	4.572	.034	
Main Effects of Treatment Groups	50.474	2	25.237	6.365	.002	Sig.
Explained	68.602	3	22.867	5.767	.001	
Residual	697.878	176	3.965			
Total	766.480	179	4.282			

**Table 4. Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean = 14.95**

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
PRE	60	.71		.70	
AE	60	-.15		-.12	
Control	60	-.56		-.58	
			.26		.26
Multiple R Square					.090
Multiple R					.299

Detailed explanations of Table 4 were shown in the scheffé post hoc table 5. The mean significant is at the 0.05 level. The significant difference in the Body Mass Index (BMI) as indicated by scheffe was between PRE and control ( $p < 0.05$ ) as well as between control and PRE ( $p < 0.05$ ). However, there is no significant difference between PRE and AE. This was expected because control group did not take part in organized training.

**Table 5. Scheffe post hoc analysis for body mass index**

Variable	Treatment Groups	Treatment Groups	Mean Difference	Sig.
Body Mass Index	PRE	AE	.8525	.070
		Control	1.2688*	.003
	AE	PRE	-.8525	.070
		Control	.4163	.527
	Control	PRE	-1.2688*	.003
		AE	-.4163	.527

\* $p < 0.05$

#### **4. DISCUSSION**

This study investigated the effects AE and PRE on body composition variables measures in terms of %BF and BMI. The results showed a decrease in %BF and BMI due to the trainings which indicate ability of the trainings to attenuate onset of excess accumulation of adipose tissues. However, there was no significant mean difference in %BF of the participants among the training regimes but effect of AE was significantly different from PRE on BMI. This results corroborate earlier studies where it was observed that resistance training have significant or insignificant differences in body weight, lean body weight and percent body fat [32,33,34]. Couple with the reduction in body composition due to trainings, the result may be interpreted to mean that AE and PRE trainings caused the slight decrease in the fat content of the children. Similar results have been reported in the literature [4,35,36]. The explanation for this is based on the fact that the contribution of fat to total energy expenditure is high [37]. Another finding was that PRE was more effective than no intervention, but that when compared with other exercise protocols, such as flexibility and aerobic training, all exercise groups improved in a similar manner [38,39]. Exercise is prescribed to reduce adiposity and overweight of children and adolescent [40]. There is empirical evidence that expressed the hesitation whether energy expenditure, duration or intensity of exercise is most important for positive modifications of the body composition parameters [41]. Another study had also reiterated that the energy expenditure following higher total volume workouts appears to be elevated, with an increase in fat utilization (due to a lower respiratory exchange ratio) during the period of resistance training [42]. The evidence unequivocally supports the combined use of aerobic exercise and progressive resistance trainings for optimal changes in body composition to successfully attain weight management goals in children. Studies also showed improvement in aerobic capacity similar to the current findings and elicit a reduction in both body weight and blood pressure through exercise [15,43]. The study adds to other evidences that increased physical activity decreases weight gain and improves other health outcomes in overweight children and adolescents.

#### **4. CONCLUSION**

In other to make a habit of physical fitness part of the life of the youth, there is need to develop a school and community relationship that ensures the maintenance of a moderate to vigorous lifestyle pattern. This connotes there must be private sector initiatives in the provision of facilities, monitoring of their utilisation and the involvement of both government and non-governmental organisations to help disseminate vital information that would increase awareness of the youths. AE and PRE collectively have positive impact on body composition of children in Nigeria. It is recommended that physical education curriculum in primary school be implemented in such a way that emphasis is laid on enjoyable participation in AE and PRE, with its resultant carryover value in old age.

#### **COMPETING INTERESTS**

The authors declared that no competing interests exist in the study.



## REFERENCES

1. WHO. Global Strategy on Diet, Physical Activity and Health: Childhood overweight and obesity. 2011;17:7. Accessed 08 February 2012. Available: <http://www.who.int/dietphysicalactivity/childhood/en/>.
2. WHO. Media centre: Obesity and overweight. 2011; 32:6. Accessed 08 February 2012. Available: <http://www.who.int/mediacentre/factsheets/fs311/en/>.
3. Anderson MK, Hall SJ. Sports Injury Management. U.S.A., Williams & Wilkins. ISBN 0-683-00175-2; 1995.
4. Talabi AE, Adesina MO, Ajayi-Vincent OE. Relationship between body fat Distribution and Blood Pressure of Sedentary Female workers in Ise Orun Local Government Area of Ekiti State. *Journal of Physical Education and Research*. 2009;XIV(1):2038-2042.
5. Baje AO. Food Crises Hits the World. *Food business International*. 2011;1(5):11-12.
6. Akinpelu AO, Oyewole OO, Oritogun KS. Overweight and Obesity: Does It Occur In Nigerian Adolescents in an Urban Community? 2007;12:8. Accessed 08 February 2012. Available: <http://www.asopah.org/journals/ijbhs/ijbhs4/ijbhs410307072.pdf>.
7. Akesode FA, Ajibode HA. Prevalence of obesity among Nigerian school children. *Social Science and Medicine*. 1993;17(2):107-111.
8. Owa JA, Adejuyigbe O. Fat mass percentage, body mass index and upper arm circumference in a healthy population of Nigerian children. *Journal of Tropical Pediatrics*. 1997;43:13-19.
9. Toroitich-Ruto C. The relationship between reproductive health and family nutrition in Africa. Paper prepared for the regional workshop on Women's reproductive Health and Household Food Security in Rural Africa organized by the ECA Food Security and Sustainable Division (FSSDD), Addis Ababa, October 11th-14<sup>th</sup>; 1999.
10. Shils ME, Young VR. *Modern Nutrition in Health and Disease*. (Seventh ed.). Lea & Febiger. Philadelphia USA. 1988;533-552.
11. Finn SC. In Pursuit of a healthy Diet: Directions and Detours. *Journal of Women's Health and Gender-Based Medicine*. 1999;8(4):455-458.
12. Ayenigbara GO. Optimum Health for all Nigerians by the Year 2020: A focus on Prevention and Management of Obesity through Lifestyle Modification. In J.F. Babalola and A.O. Moronkola (Eds). *Optimal Health Performance: The Basis of Human Movement Education*. Dept of KHE, University of Ibadan. 2010;437-447
13. Epstein LH, Coleman KJ, Myers MD. Exercise in treating obesity in children and adolescents. *Med Sci Sports Exerc*. 1996;28:428-435.
14. Watts K, Jones TW, Davis EA, Green DJ. Exercise training in obese children and adolescents: current concepts. *Sports Med*. 2005;35:375-392.
15. Watts K, Beye P, Siafarias A, O'Driscoll G, Jones TW, Davis EA, Green DJ. Effects of Exercise Training on Vascular Function in Obese Children. *J Pediatr*. 2004;144:620-625.
16. Owen N, Humpel N, Salmon J, Oja P. Environmental influences on physical activity in children and adults. In: Borms J, Oja P. (Eds.), *Health-Enhancing Physical Activity*. Oxford: Meyer & Meyer Sport (UK). 2004;393-426.
17. DeMello-Meirelles C, Gomes PSC. Acute effects of resistance exercise on energy expenditure: revisiting the impact of the training variables. *Rev Bras Med Esporte*, 2004; 10: 131-138. Retrieved on 06/02/2011, from available: [http://www.scielo.br/pdf/rbme/v10n2/en\\_a06v10n2.pdf](http://www.scielo.br/pdf/rbme/v10n2/en_a06v10n2.pdf).
18. Campos GE, Luecke TJ, Wendeln HK. Muscular adaptations in response to three different resistance-training regimens: specificity of repetition maximum training zones. *Eur. J. Appl. Physiol*. 2002;88(1-2):50-60. doi: 10.1007/s00421-002-0681-6.

19. McCarthy JC, Burg MA, Smith K, Burns C. Pediatric Obesity in the Clinical Setting: Epidemiology of Childhood Obesity. 2002. Available online @ <http://priory.com/childobesity.htm> Retrieved 10/02/2012
20. Isaac S, Micheal WB. Handbook in research and evaluation: A collection of principles, methods, and strategies useful in the planning, design, and evaluation of studies in education and the behavioral sciences. (2nd ed). California, San Diego, EDITS Publishers; 1981.
21. Armstrong N, Welsman J. Young People and Physical Activity. Oxford University Press, New York; 1997.
22. Marwick TH, Hordern MD, Miller T, Chyun DA, Bertoni AG, Blumenthal RS, Philippides G, Rocchini A. Exercise Training for Type 2 Diabetes Mellitus: Impact on Cardiovascular Risk: A Scientific Statement from the American Heart Association. *Circulation: Journal of the American Heart Association*. 2009;119:3244-3262.
23. American College of Sports Medicine (ACSM). Strength training helps those with Down syndrome. [white paper]. 2007. Retrieved 17/12/2010, from available: <http://www.acsm.org/AM/Template.c>.
24. Faigenbaum AD, Westcott WL. Strength and Power for Young Athletes. Champaign, IL: Human Kinetics. 2000.
25. Hj-Muhammad-Ismail HI, Phak NH, Thomas T. Paediatric Protocols for Malaysia Hospital. (2<sup>nd</sup> Ed.). Kementerian Kesihatan Malaysia. 2008. Retrieved on 17/08/2011 from available: <http://www.scribd.com/doc/34481330/Paediatric-Protocols-for-Malaysian-Hospitals>.
26. Jackson AS, Pollock ML. Generalized equations for predicting body density of men. *British Journal of Nutrition*. 1978;40:497-504.
27. Jackson AS, Pollock ML, Ward A. Generalized equations for predicting body density of women. *Medicine and Science in Sports and Exercise*. 1980;12(3):175-182
28. Pollock ML, Wilmore H, Fox SM III. Exercise in health and disease: evaluation and prescription for prevention and rehabilitation. Philadelphia: W.B. Saunders; 1984.
29. Freedman DS, Wang J, Thornton JC, Mei Z, Sopher AB, Pierson (Jr) RN, Dietz WH, Horlick M. Classification of Body Fatness by Body Mass Index—for-Age Categories among Pupils. *Arch Pediatr Adolesc Med*. September, 2009;163(9):805–811. doi:10.1001/archpediatrics.
30. Bourbonnais D, Bilodeau S, Lepage Y, Beaudoin N, Gravel D, Forget R. Effect of force-feedback treatments in patients with chronic motor deficits after a stroke. *Am J Phys Med Rehabil*. 2002;81:890-897.
31. Maxwell SE, Delaney HD. Designing Experiments and Analyzing Data: A Model Comparison. Lawrence Erlbaum Associates. 2004;217–218.
32. Oranugo JBC, Igbanugo VC, Agbedara EO. The Influence of Jogging and Circuit Training Programme on Serum lipid levels of college male individuals. *Journal of Nigeria Association of Sports Science and Medicine*. 1992;4:84-94
33. William JK, Nicholas R, Andrew CF, James ML, Steven JK. Influence of Resistance Training Volume and Periodization on Physiological and Performance Adaptations in Collegiate Women Tennis Players. The Human Performance Laboratory, Ball State University Muncie in 47306; 1999.
34. Okely AD, Patterson JW. Relationship of cardiorespiratory endurance to fundamental movement skill proficiency among adolescents. *Pediatric Exercise Science*. 2001;13:380-391.
35. Bray G. Recent Advances in Obesity Research (11), London, Newman Publishers; 2000.
36. Hultman E. Physiological role of muscle glycogen in man in relation to exercise. *Circ. Res*. 1999;10:1-30

37. Sarig-bahat H. Evidence for exercise therapy in mechanical neck physiol. 2001;4:30–37.
38. Liddle SD, Baxter GD, Gracey JH. Exercise and chronic low back training on pulmonary function and performance measures of patients pain: what works? *Pain*. 2004;107:176–190.
39. Adeyanju ES, Venkateswarlu K, Dikki CE. Effects of Interval Training on Body Composition of Adolescent in Nigeria. *West African Journal of Physical and Health Education*. 2005;9(2):25-34.
40. Melby C, Scholl C, Edwards G, Bullough R. Effect of acute resistance exercise on postexercise energy expenditure and resting metabolic rate. *Journal of Applied Physiology*. 1993;75:1847-1853.
41. Watts K, Beye P, Siafarias A, O'Driscoll G, Jones TW, Davis EA, Green DJ. Effects of Exercise Training on Vascular Function in Obese Children. *J Pediatr*. 2004;144:620-625
42. Bennett-Richards KJ, Kattenhorn M, Donald AE, Oakley GR, Varghese Z, Bruckdorfer KR, Deanfield JE, Rees L. Oral L-arginine Does Not Improve Endothelial Dysfunction in Children with Chronic Renal Failure. *Kidney International*. 2002;62:1372-1378.

---

© 2013 Abass and Moses; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:*

<http://www.sciencedomain.org/review-history.php?iid=190&id=21&aid=954>