Influence of Cardiorespiratory Fitness on Academic Performance of Junior Secondary School Students in Benue South Senatorial District, Benue State, Nigeria

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Abstract

This study examined influence of cardiorespiratory fitness (CRF) on academic secondary school (JSS) students in Benue South Senatorial District of Benue State, Nigeria. It focused on English Language and Mathematics performances of JSS students in the Junior Secondary School Certificate Examination (JSSCE) to determine their academy performance, while the Progressive Aerobic Cardiovascular Endurance Run (PACER) test was used to determine the student's aerobic fitness levels. 500-JSS 3 students from a population of 169,349 were drawn from 10-secondary schools where 50 students from each school were assigned to 5- groups for the PACER test with the number of laps run by each subject in the test used to determine their aerobic fitness levels. Four research questions were addressed and four hypotheses tested at P<0.05 level of significance. The data collected were analyzed using frequency counts, percentage scores, mean, standard deviation, t-test and 2- way ANOVA. The findings showed that CRF influenced academic (English Language and Mathematics) performances of JSS students as fit students' English Language(46.9±9.9) were better than unfit students'(37.3±8.9),and fit students' Mathematics (47.5±11.2) better than unfit students'(37.1±10.0). Influence of CRF on English and Mathematics were not the same across gender (F_1,496=27.2, p<.0001) and (F_1,496=22.9, p<.0001) respectively as fit male students' performances were of significance (p<.0001) than fit female students' in both subjects. The study recommends that regular moderate-vigorous aerobic activities be included in JSS curriculum to enhance their English and Mathematics performances, also that remedial fitness activities and studies be organized for unfit male and female students to step up their aerobic fitness and academic performances.

Keywords: Academic Performance, Benue South Senatorial District (Zone C Senatorial District), Cardiorespiratory Fitness, Junior Secondary School Students.

Introduction

The benefit of physical activity participation to human beings cannot be overemphasized. Studies on the positive role of physical activity participation by children revealed numerous benefits gained by participation (Gunen, 1997; Power & Howley, 1997; Wilmore & Costill, 1999). Based on such positive roles, the United State Department of Health and Human Service (USDHHS, 2000), recommends that children should participate in endurance physical activity (Castelli, Hillman, Buck & Erwin, 2007). They pointed out

that for a healthy functioning of the cardiorespiratory system children should engage in Moderate-Vigorous Physical Activities (MVPA).

Participation in MVPA have shown not only to improve motor skills, reduce premature mortality in general, reduce incidences of early onset of degenerative disorders such as obesity, type 2 diabetes mellitus, coronary heart diseases (Plowman & Smith, 2003); hyperlipidemia (Tremble, Inman & Willms, 2000), but also enhances academic performance of students at school (Dwyer, Sallis, Blizzard, Lazarus & Dean, 2001; Coe, Pivanik, Womack, Reeves & Malina, 2006).

Academic performance is how well or badly one does in one's study at school or university. It is also the extent to which students, teachers and institutions progress or retrogress in their academic exercise at school (Ward, Stock and Murray-Ward, 2009). The ultimate goal of student in school is to perform well and achieve good academic results at the end of the course. Good academic performance is always the concern for parents, guardians, administrators, teachers and even students. Apart from university's and other tertiary institutions admission and job opportunities, good academic performance and indeed achievement provides a lifelong security as well as assets and tickets for high positions in life.

Cardiorespiratory fitness (CRF) is an aspect of physical fitness that deals with the supply and utilization of oxygen during intense and prolonged physical activity (Wilmore & Costill, 1999). They stressed that CRF correlates highly with maximum oxygen consumption ($v0_2$max) which they maintained is the greatest amount of oxygen that the body can take in, transport and utilize during heavy exercise per minute. The assessment of vO_2 max provides the means of quantifying the functional capacity of individual's entire cardiovascular system. VO_2 max is thus the single most important variable in describing individual's fitness levels (Plowman & Smith, 2003.)

Studies have shown that participation in physical activities at school by children could improve academic performance. For instance, Dwyer et al (2001), pointed out that physical activity participation at school by students enhance academic performance by increasing cerebral blood flow, enhancing arousal levels, changing hormone secretions and improving self-esteem, but that, none of these have been adequately documented. Similarly, high energy expenditure, change in body build affecting self-esteem and better behaviors are also other ways by which cognitive learning could be achieved through physical activity participation (Coke, 2013).

Tares (2005), further stressed that endurance activity that is strenuous, stressful and regularly performed can raise level of norepinephrine and endorphin which may reduce stress, improve mood and induce a calming effect on participants. In order words, individuals who are stressed up, but calm and have improved mood would concentrate and learn faster and better than those who are tensed and anxious.

Studies conducted to determine relationship between physical fitness and academic performance has shown positive findings. For instance, the California Department of Education (CDE,2001) observed that Reading and Mathematics scores from Standford Achievement Test were positively matched with fitness test scores (Cooper Institute of Aerobic Research,1999) for 5th, 7th and 9th graders (Castelli et al, 2007). Another study conducted by Coe et al (2006) extended the findings of CDE (2001) because they found positive relationship between vigorous physical activity and higher grades in Mathematics and English Language (Castelli et al, 2007).

However, work done by Daley and Ryan (2000); Dwyer, Coonan, Leitch, Hetzel and Baghurst (1983) revealed insignificant relationship between fitness and academic performance, while Tremblay et al (2000) found negative relationship (castelli et al, 2007).

Several studies (Dwyer, 2001; Linder, 2002; Castelli et al (2007), among others suggested that when substantial amount of school time is dedicated to physical activity, academic performance meets and may even exceed that of students not receiving additional physical activity. The rationale behind this idea may not only be to improve the fitness and health status of students but also to meet school required academic standards.

Statement of the Problem

Over the years, public attention was drawn to the poor academic performance of junior secondary school students in the Junior Secondary School Certificate Examination (JSSCE) in Benue South Senatorial District (BSSD) of Benue State. This has been a source of worry and concern for parents, teachers and other stake holders in education in the area.

Studies have recommended regular physical activity participation for children because of the numerous benefits derived for participation. For instance, Kim et al (2003) pointed out that because physical fitness is related with the health of the students, aerobic fitness may be better related with improved academic performance of students at school. Also Coe et al (2006) stressed that physical activities that are moderately–vigorously performed enhance academic performance of students.

To the researcher's knowledge, no study had investigated the relationship between aerobic fitness and academic performance of Nigeria youth. If aerobic fitness can be shown to have positive relationship with academic performance of students, then this could be another method of improving academic performance of students. This study therefore examined influence of cardiorespiratory fitness on academic performance of junior secondary school students in Benue South Sensational District (BSSD) of Benue State.

Purpose of the Study

The main purpose of this study was to examine influence of cardiorespiratory fitness on academic performance of junior secondary school students in Benue South Senatorial District (Zone C Senatorial District) of Benue State. Specifically, the study examined:

1. Influence of cardiorespiratory fitness level on English Language performance of junior secondary school students in Zone C Senatorial District of Benue State.
2. The influence of cardiorespiratory fitness level on Mathematics performance of junior secondary school students in BSSD of Benue State.
3. The gender difference in the influence of cardiorespiratory fitness level on English Language performance of junior secondary school students in Zone C Senatorial District of Benue State.
4. The gender difference in the influence of cardiorespiratory fitness level on Mathematics performance of junior secondary school students in BSSD of Benue State.

Research Questions

The following research questions were addressed in this study

1. Does cardiorespiratory fitness level influence English Language performance of junior secondary school students in Zone C Senatorial District of Benue State?
2. Does cardiorespiratory fitness level influence Mathematics performance of junior secondary school students in BSSD of Benue State?

3. Is there a gender difference in the influence of cardiorespiratory fitness level on English Language performance of junior secondary school students in Zone C Senatorial District of Benue State?

4. Is there a gender difference in the influence of cardiorespiratory fitness level on Mathematics performance of junior secondary school students in BSSD of Benue State?

Research Hypotheses

These hypotheses were formulated for testing in this study

1. Cardiorespiratory fitness level will not significantly influence English Language performance of junior secondary school students in Zone C Senatorial District of Benue State

2. Cardiorespiratory fitness level will not significantly influence Mathematics performance of junior secondary school students in BSSD of Benue State.

3. Gender difference will not significantly influence cardiorespiratory fitness level on English Language performance of JSS students in Zone C Senatorial District of Benue State

4. Gender difference will not significantly influence cardiorespiratory fitness level on Mathematics performance of JSS student in BSSD of Benue State.

Methodology

The area of study was Benue South Senatorial District (BSSD) of Benue State, Nigeria. Population of the study was made up of all junior secondary school students in JSS 3 class in all the secondary schools in BSSD of Benue State, which comprised Ado, Agatu, Apa, Obi, Ogbadibo, Ohimini, OJu, Okpokwu and Otukpo LGAs, in the 2012 /2013 academic session. The students' population was 169,349 registered students for the 2012 /2013 Junior Secondary School Certificate Examination (JSSCE)/ Basic Education Certificate Examination (BECE).Ten secondary school were selected from a total of 309 secondary schools in BSSD using "lucky – dip" technique where all the names of secondary schools which had at least 50 -students (males and females) in JSS 3 class were written on pieces of papers with "Yes" and "No" for the students to pick. The 50 students who picked "Yes" from each of the 10 schools were engaged in the PACER test. In the 10 schools sampled, 50 students (25m and25$_f$) were randomly picked through "lucky- dip" technique and were engaged in the PACER test which determined their aerobic fitness levels.

Participants

Parental informed consents were obtained from the 500 JSS 3 students who registered for the JSSCE across the 10 secondary schools in the area of study. Students with disabilities, illnesses and those who did not write the mock – JSSCE were excluded from the study.

The study sampled 500 students (participants) out of 169,349 with mean score in English Language (46.9± 99) for fit students and unfit students (37, 3 ±8.8); while in Mathematics, fit students' mean score (47.5± 11.2) and unfit students(37.1±10.0).

Measurement

Fitness Testing: The participants completed the test which assessed their aerobic fitness levels. The PACER is a multistage 20m shuttle run test that progressively increases in difficulty. The Cronbach Alpha Coefficient of correlation was used to ascertain the reliability

of the test item which showed a reliability coefficient of 0.98 which was found reliable thus, was used for this study.

Academic Performance Testing: The students final JSSCE results in English Language and Mathematics for 2012/2013 academic session were used to determine their academic performance. The JSSCE is criterion reference examination which is administered annually on students in JSS 3 class across the country. The results of the examination is used to place those who passed in Senior Secondary class one (SS1). Students' scores (raw and grade) obtained in English Language and Mathematics in the JSSCE for the 2012/2013 academic session from the 10 schools sampled were collated and used to determine the students' academic performance.

The test item showed a Cronbach Alpha Coefficient of correlation of 0.88 which was reliable thus was used for the study.

Data Analyses and Result

Descriptive statistics were used to calculate each of the variables as shown on Table 1

Table 1: Physical and performance characteristics of participants (n=500)

Variables	Combined (n=500)	Male (n=268)	Female (n=232)
Age (yrs)	14.1±0.9	14.1±0.9	14.1 ±0.9
Stature (cm)	153.6±8.5	153.9±8.7	153.2±8.3
Body Mass (kg)	50.0±7.0	49.7±7.2	50.4±6.9
BMI (kg-m-2)	21.1±1.6	20.9±1.5	21.4±1.6
PACER (Laps)	33.6±11.6	38.1±12.3	28.5±8.2
Eng Lang (90)	41.5±10.4	45.0±10.8	37.4±8.3
Mathematics (%)	41.6±11.8	45.8±12.1	36.8±9.2

± = Mean and Standard Deviation

Table 1 above showed that out of a combined total of five hundred (500) subjects sampled, two hundred and sixty eight (268) of them representing 53.6% were males while two hundred and thirty-two (232) 46.4% were females. The subjects had a combined mean age of 14.1(±0.9) years with male's means age also 14.1(±0.9) years. This indicates that the males and females subjects involved in the PACER test were of the same age bracket. The combined stature of the participants was 153.6(±8.5) cm with the male subjects slightly taller 153.9(±8.7) cm than the females 153.2(±8.3) cm who weighed more 50.4(±6.9) with more body fat 21.4(±1.6) kg than males 49.7(±7.2) kg and 20.9(±1.5) kg –m^{-2} weight and body fat respectively.

In the performance characteristics, the subjects had a combined mean score of 33.6(±11.6) laps with males having better mean score of 38.1(±12.3) laps than females 28.5(±8.2) laps in the PACER test. In the academic performance the subjects had a combined mean score of 41.5(±10.4) % in English Language with the male performing better with 45.0(±10.8) % than the females with 37.4 (±8.3) %. The performance in Mathematics

showed a combined mean score of 41.6(±11.8) % with males performing better with
45.8(±12.1) % as against females' 36.8(±9.2) %.

Table 2: Post-test mean scores and standard deviations of JSS students' English Language
performance in relation to CRF levels

CRF Level		N	Mean	SD	Stand. Error
English Language	Fit	217	46.9	9.9	.671
	Unfit	283	37.3	8.8	.523

Table 2 above presented the mean scores and standard deviations of students English
Language performance according to CRF level, which showed that fit students had a mean
score of 46.9(±9.9), and the unfit students had a mean score of 37.3(±8.8). This means that
CRF level influenced English Language performance of JSS students in BSSD of Benue
State.

Table 3: Post- test mean scores and standard deviations of JSS students' Mathematics
performance in relation to CRF levels.

CRF Level		N	Mean	SD	Stand.Error
Maths	Fit	217	47.5	11.2	.762
	Unfit	283	37.1	10.0	.596

Table 3 above presented the mean scores and standard deviations of students' Mathematics
performance in relation to students CRF levels which showed that fit students had mean
score of 47.5 (±11.2), while the unfit students had a mean score of 37.1(±10.0). This
indicated that CRF level influenced Mathematics performance of JSS students in the area of
study.

Table 4 : post- test difference in mean scores and standard deviations of males and females
students' performance in English Language and Mathematics in relation to **CRF**

Gender	CRF level		Mean	SD	N
English Language	Male	Fit	55.8	5.4	86
		Unfit	39.9	5.9	182
		Total	44.9	10.8	268
	Female	Fit	41.1	7.6	131
		Unfit	32.5	6.4	101
		Total	37.4	8.3	232
	Total	Fit	46.9	9.9	217
		Unfit	37.3	8.8	283
		Total	41.5	10.4	500
Maths	Male	Fit	57.5	5.7	86
		Unfit	40.3	10.3	182
		Total	45.8	12.1	268
	Female	Fit	40.9	8.8	131

	Unfit	31.4	6.4	101
	Total	36.8	9.2	232
Total	Fit	47.5	11.2	217
	Unfit	37.1	10.0	283
	Total	41.6	1 1.8	500

Table 4 above presented the post-test difference in mean scores and standard deviations of male and female JSS students' performances in English Language and Mathematics in relation to CRF levels. It showed that in English Language fit male students had mean scores of 55.8(±5.4) while the fit female students had mean scores of 41.1(±7.6). This means that in English Language the performances of fit male students were substantially better than the performances of fit female students, while the performances of unfit male and female students were both weak in the subject with mean scores of 39.9(±8.9) for unfit male students and 32.5(±6.4) for unfit female students respectively.

The Table 4, also showed that in Mathematics, fit male students performed substantially better with mean score of 57.5(±5.7) than their fit female counterparts with 40.9(±8.8) mean score. The performances of unfit male and female students were both weak, although the unfit male performed slightly better with mean score of 40.3(±10.3) than the unfit female students with mean score of 31.4(±6.4) in the subject. These mean that there were gender differences in the influence of CRF levels on English Language and Mathematics performances of JSS students in BSSD of Benue State.

T- test of independence sample was used to test hypotheses 1 and 2 in tables 5and 6, while hypotheses 3and 4 were tested using analysis of variance 2- way (ANOVA 2-Way) in tables 7 and 8

Table 5: Influence of CRF level on English Language performance among participants (n=500)

Group	N	Mean	SD	df	t-value	Sign.
Fit	217	46.9	9.9			
Unfit	283	37.3	8.8	498	11.4	0.0001

Table 5 above indicated that independence samples t- test was used to test the hypothesis that CRF levels will not significantly influence English Language performance of JSS students of BSSD, Benue State. The result showed statistically significant (<0.0001) influence of CRF level on English Language performance among participants with fit subjects' mean score of 46.9(±9.9) substantially better than their unfit counterparts with mean score of 37.3(±8.8) the hypothesis was therefore rejected, meaning that CRF level influenced English Language performance of JSS students in the area of study.

Table 6: Influence CRF level on Mathematics Performance among Participants (n=500)

Group	N	Mean	SD	df	t-value	Sign
Fit	217	46.9	9.9			
Unfit	283	37.3	8.8	498	11.4	0.0001

Table 6 above indicated that the independent samples t- test was used to test the hypothesis, that CRF level will not significantly influence Mathematics performance of JSS students in

BSSD, Benue State. The results above indicated a statistically significant (<0.0001) influence of CRF

level on Mathematic performance among the subjects with fit subjects' mean score of 47.5 (±11.2) outperforming their unfit counterparts' mean score of 37.1 (±10.0), meaning that CRF level influenced Mathematics performance of JSS students in the area of study.

Table 7: Analysis of variance (ANOVA 2- Way) of students' performance scores in English Language by CRF level and gender (n=500)

Source of Variation	Type III Sum of Squares	df	Mean	F. ratio	Sign level
Sex	14001.022	1	14001.022	246.509	.0001
PACER	17330.108	1	17330.108	305.123	.0001
Sex& PACER	1544.852	1	1544.852	27.199	.0001
Error	28171.364	496	56.797		
Total	914085.000	500			
Corrected Total	54370.422	499			

R squared = .482(Adjusted R Squared= 479)

In Table 7 above, the ANOVA 2-way was used to test the hypothesis, that gender difference will not significantly influence CRF level on English Language performance of JSS students in BSSD of Benue State. The results indicated significant gender main effect (F_1, 496=246.51, p < .0001) ; significant fitness main effect (F_1, 496=305.12, p < .0001) and a significant sex CRF interaction effect (F_1, 496= 27.20, p < .0001). The significant sex CRF interaction effect indicated that the influence of CRF level on English Language performance of students is not constant across gender. That is, fit male subjects performed substantially better than their fit female counterparts in the subject. In other words, the difference in performance between fit males and fit females is larger in favour of the fit males than it is in fit female subjects. But in the unfit males and unfit females, the difference in their performances showed no difference, meaning that their weak performances are the same. This means that there were gender differences in the influence of CRF level on English Language performances of JSS student in the area of study.

Table 8: Analysis of variance (ANOVA 2-way) of students' performance scores in Mathematics by CRF level and gender (n=500)

Source of Variation	Type III sum of squares	df squares	mean	F. Ratio	Sign level
Sex	18794.479	1	18794.479	258.120	.0001
PACER	20783.976	1	20783.976	285.444	.0001
Sex & PACER	1174.113	1	1674.113	22.992	.0001
Error	36115.207	496	72.813		
Total	936105.000	500			
Correct Total	68910.342	499			

R squared =.476(Adjusted R squared = .473)

In Table 8 above, the 2-way analysis of variance (ANOVA 2 -way) was used to test the hypothesis, that gender differences will not significantly influence CRF level on Mathematics performance of JSS students of BSSD, Benue State. The result showed significant gender main effect (F_1, 496 = 258.1, $p < .0001$); significant fitness main effect (F_1, 496 = 285.4, $p <.0001$) and significant sex CRF interaction effect (F_1, 496 = 22.9, $p < .0001$). The significant sex CRF interaction effect showed that the influence of CRF level on Mathematics performance of JSS students was not constant across gender. That is, fit male subject performed substantially better than fit female subjects. It means that the difference in performances between fit males and fit females is larger in fit males than it is in fit females subjects. But the performances of unfit males and unfit females subjects showed no difference, indicating, that their weak performances are the same, meaning that gender difference exist in the influences of CRF level on Mathematics performance of JSS students in the area of study.

Discussion of the Findings

This study examined influence of cardiorespiratory fitness level on academic performance of junior secondary school students in Benue South Senatorial District of Benue state, Nigeria. This study found that cardiorespiratory fitness levels influenced English Language and Mathematics performances of junior secondary school students in Benue South Senatorial District of Benue State, Nigeria.These findings support the general notion that children who are physically active and fit are more likely to perform better on standardized academic performance test than inactive and unfit children, thus corroborating the findings of CDE (2001) study on relationship between physical fitness and academic performance where Reading and Mathematics scores from Standard Achievement Test were matched with fitness scores Cooper Institute for Aerobic Research, 1999) of 353,000 5th graders, 322,000 7th graders, and 279,000 9th graders. These findings showed positive relationship between physical fitness and academic performance across the three grade levels, such that higher fitness levels were associated with higher academic performance.

The Findings of this study equally agrees with that of Srikanth et al (2012) who in their study of physical fitness and academic performance of children used the PACER to assess the effect of CRF on academic performance of students, found, among others, that students with strong heart and lungs makes better grades academically. stressed that having stronger healthy and lungs may be one of the most important factors for middle school students to make better grades in English and Mathematics than students with weak hearts and lungs. This study's findings are also consistent with those by Hillman, Castelli and Bulk (2005); Castelli et al (2007) Coe et al (2006), among others, whose findings specifically stated that greater aerobic fitness is associated with changes in neurocognitive function (learning process) of children and that fit children learn faster and better than their unfit counterparts.

On the other hand, the findings from this study did not totally agree with the findings from studies by Railo (1969) in Trudeau and Shepherd (2008); Tremblay et al (2000), whose findings on the relationships between physical activity, self-esteem and academic achievement in 12 year old children showed weak relationship. Daley and Ryan (2000) and in Dollman, Boshoff and Dodd (2006)   in their study of 232 English boys and girls (13-16 years old) found no relationship between physical activity and grade point average. They concluded that there were no linkage between physical fitness and academic performance.

The inconsistencies in these findings may be as result of the age, gender or environment of the students used in these studies. For instance, Dollman et al (2006) used grades 3, 5 and 7 primary school pupils, while Tremblay et al (2000) used only 12 years old primary school pupils in their studies, and found that the performances of 12 years old children in physical activity and their academic performances will differ from those of 14-16 years old secondary school students; female students has significantly lower scores in physical activities thus lesser academic performances than their male counterparts.

The findings in this study that there are gender differences in the influence of CRF levels on English Language and Mathematics performances of JSS students are consistent with the findings of New Zealand Council for Educational Research (NZCER,1988) and Middleton (1990), who in their separate studies found that fit female students performs less well than fit male students in Sciences and Mathematics, but that fit female student tend to do slightly better than fit male students in non-sciences subjects. However, in addressing the possibility of females' educational superiority over males', Ferguson, Lloyd and Horwood (1991) pointed out that there were no evidence to suggest that males were of lesser cognitive ability than females, stressing that in no comparison were mean intelligent quotients (IQ) score for males poorer than those of females even in English Language. They concluded that in nearly all cases reported, male students outperformed their female counterparts in both subjects following fitness, a finding which totally agrees with the present findings.

Conclusion

This study concludes that cardiorespiratory fitness levels influence academic performances of JSS students in Benue South Senatorial District of Benue State as fit students performed substantially better than unfit students in English Language and Mathematics. Also, that gender difference influence cardiorespiratory fitness levels on English language and Mathematics performances of JSS students as fit male students perform much better than fit female students in both subjects and also that the performances of unfit males and females students were weak in the two subjects.

Recommendations

1. Compulsory regular moderate-vigorous aerobic fitness activities and sports programmers be included in the curriculum of JSS students to enhance their fitness and academic performances.

2. School authorities should encourage cardiorespiratory fitness development by organizing early morning road-walk every Saturday, inter-class, inter-house sport competitions, etc , to enhance students' aerobic fitness to boost their performances in both subjects.

3. Remedial aerobic fitness programmers and studies be mounted for the unfit male and female students to step up their performances to be at par with the fit male and female students in both subjects.

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