Influence of cardiorespiratory fitness on blood pressure among teenagers in Kano, North Western Nigeria

Saratu Umar Aliyu[1], Aishat Shittu[2], Farida Garba Sumaila[2]

[1] Department Of Physiotherapy, Rasheed Shekoni Specialist Hospital In Dutse, Jigawa State, Nigeria.
[2] Department Of Physiotherapy, Faculty Of Allied Health Sciences, College Of Health Science, Bayero University Kano, Nigeria.

Abstract

This study investigated the influence of cardiorespiratory fitness (CRF) on blood pressure (BP) among teenagers in Kano state. A cross-section study design was used. A total of five hundred and twenty (520) teenage students aged 13 – 19 years were randomly recruited from twelve (12) public secondary schools in Kano state. Weight, height, and BP of all the subjects were measured using a weighing scale, a calibrated wall meter and a mercury sphygmomanometer, respectively. CRF was determined using the PACER (tape) fitness test and the test scores were converted to peak VO2 scores using the regression equation by Leger et al. Based on the individual peak VO2 values, the subjects were divided into two groups - the fit group with peak VO2 values ≥ 39.4ml/kg/min and the unfit group with peak VO2 values < 39.4ml/kg/min. Data were summarized using descriptive statistics and analyzed using inferential statistics of the independent t-test and Pearson product-moment correlation at an alpha level of 0.05 with Statistical Package for Social Science (SPSS) version 15.

The study findings demonstrated a significant influence of CRF on systolic BP (SBP) ($t=7.783$, $df=518$, $p<0.05$) and on diastolic BP (DBP) ($t=16.679$, $df=518$, $p<0.05$). Moreover, a significant relationship between CRF and SBP ($r= -0.317$, $P<0.05$) as well as between CRF and DBP ($r=0.583$, $P<0.05$) was found. It is therefore recommended that CRF be considered while assessing teenage patients.

Key words: cardiorespiratory fitness, blood pressure, teenagers

Introduction

Blood pressure (BP), also referred to as arterial blood pressure, is the pressure exerted by circulating blood upon the walls of blood vessels [1]. High blood pressure (HBP) or hypertension, is sustained systolic blood pressure (SBP) ≥ 140mmHg or sustained diastolic blood pressure (DBP) ≥ 90mmHg [2]. Worldwide, HBP is regarded as a "silent killer" (because it usually causes no symptoms until it reaches the life-threatening stage) [3] and is the leading risk factor for stroke, cardiovascular diseases, renal diseases, and death [4]. Hypertension is considered a major public health problem [3] which complicates other diseases, increases the surgical risk and disturbs the growth of adolescents [5]. Hypertension has been reported to change from a minor cause of mortality and disability to a major cause of diseases worldwide [6]. The risk factors for hypertension include alcohol drinking, obesity, and sedentary life style [7].

HBP is measured as SBP (numerator) and DBP (denominator). When the SBP or DBP measurement is higher than the age-adjusted accepted values, it is considered pre-hypertension or hypertension [8]. It is found easier to diagnose

HBP in children by considering their age, gender, and height percentiles [9]. According to Balogun, Obajuluwa, Olaogun, and Abereojo, who studied children aged 8 to 20 years, the 95th percentile BP of children is 133/92mmHg, thus they postulated that Nigerian children with sustained BP ≥ 133/92mmHg should be considered hypertensive [10]. The prevalence of hypertension is higher in developed countries as compared to developing countries [4]. In Nigeria, high prevalence of hypertension was reported in Ibadan, Lagos, Enugu, and Kano [11] [12], and the highest rate of hypertension and high levels of plasma cholesterol among teenagers were found more commonly in Kano [12]. The study by Mijinyawa et al. (2008) has showed that the prevalence of hypertension in teenagers is 72% [13].

Cardiorespiratory fitness (CRF) is the ability to perform dynamic moderate-to-high intensity exercise that involves large muscle groups for prolonged periods of time [14]. CRF is an independent predictor of hypertension, and maximal oxygen consumption (or VO_2max) is an important measure of CRF [15]. Measuring VO_2max involves a physical effort (a graded exercise) in which the intensity is progressively increased while measuring the ventilation, oxygen, and carbon dioxide concentration of inhaled and exhaled air; VO_2 max is reached when the oxygen consumption remains at a steady state despite an increase in workload [14]. It has been documented that regular physical activity leads to CRF and is an effective way to reduce the relative risk of developing hypertension by 19% to 30% [16]; low CRF in middle age is associated with a 50% greater risk of hypertension in both males and females [15]. Furthermore, Blair et al, (1984) have demonstrated that the risk of developing hypertension is associated with the fitness level of individuals; less active or unfit individuals have 30-50% higher risk of developing hypertension [17]. According to another study performed in Nigeria comparing BP of children from urban and rural areas, both SBP and DBP of children living in urban areas have been found to be consistently higher compared to children from rural areas; the differences in BP between the two groups was attributed to the environmental factors and fitness levels[18].

Materials and method

Subjects

Male and female teenagers students aged 13-19 years from day public secondary schools in Kano state participated in the study. A total of five hundred and twenty (520) were enrolled.

Research Design

A cross-sectional research design was used.

Data Collection Instruments

- A mercury sphygmomanometer and stethoscope: KBK SM-300 (made in Japan) to measure blood pressure in mmHg.
- A height scale: calibrated wall meter to measure height in meters (m).
- A weighing scale: orbit bathroom scale (model: supreme, serial number 0399104033) to measure weight in kilograms (kg).
- A PACER tape to assess cardio respiratory fitness (CRF)

Sampling Technique

The study subjects were drawn from twelve (12) public day secondary schools using a simple random sampling technique. Twelve schools were randomly selected from fourteen educational zones in Kano State.

Data Collection Procedure

Firstly, an **introductory letter** was obtained from the Department of Physical and Health Education, Bayero University, Kano and sent to management boards of Kano state secondary schools for approval.. The informed consent forms were sent to the selected schools and the students enrolled in the study. A total of 520 students returned their written consent forms (signed by their parents/guardians) and participated in the study. The following measurements were taken:

- *Height*: The height of each participant was measured using a calibrated wall meter as stated by the American College of Sports Medicine [14]. Each participant was asked to stand on the base of the wall meter bare footed with the head upright and the eyes facing forward. The back was straight against the calibrated wall and the hands by the sides. The measurement was taken by placing a ruler on the participant head to point the exact number on the calibrated wall meter, and the reading was recorded in meter (m).
- *Weight*: The weight of each participant was measured using an orbit weighing scale, where each participant stood bare footed on the scale (after removing any heavy object) with the head looking straight and hands by the sides [14]. The reading was recorded in kilograms (kg).
- *Body Mass Index*: Body mass index (BMI) was measured by computing the weight and height of an individual as weight/height^2. The reading was recorded in kg/m^2.
- *Blood Pressure*: The blood pressure (BP) of each participant was measured using a stethoscope and sphygmomanometer according to the procedure by the American College of Sports Medicine [14]. Each individual was asked to sit for 10 minutes, then the deflated cuff of sphygmomanometer was wrapped round the right hand approximately 2.5cm to 5cm above the cubital fossa, and inflated gradually. The diaphragm of the stethoscope was placed over the brachial artery and the air piece inserted into the ears. The valve of the sphygmomanometer was gradually released until the first sound was heard (systolic BP) and when the sound disappeared (diastolic BP). The reading was recorded in mmHg. BP readings≥ 133/92mmHg were considered high blood pressure or hypertension.
- Cardiorespiratory fitness (CRF) was assessed using the 20 meter multi-stage shuttle run test (20-MST), also called progressive aerobic cardiovascular endurance run (PACER). A 20-meter course was marked on the students' playground with two restraining lines at the beginning and end of the 20 meter interval. The PACER test was performed using a PACER tape according to the one-minute protocol by Leger and Lambert [19]. The participants lined up behind the start line and the tape was switched on; subsequently they ran forth and back between the start and finishing line. As the subjects ran between the lines, a beep sounded that indicated when to turn around and ran back to the other line. They continued until they could no longer reach the line before the beep sounded. Scores were the numbers of laps completed and were converted to peak VO_2 scores using the regression equation :

Peak VO_2 = 31.025 + 3.238 (final speed in km/hr) – 3.248 (age in years) + 0.1536 (final speed x age)

Participants with scores ≥ 39.4ml.kg/min were categorized as fit, and those with scores below 39.4ml.kg/min were categorized as unfit.

Data Analysis

Descriptive statistics of mean, standard deviation, and tables were used to summarise the data. The data were analyzed by inferential statistics of independent t-test to compare BP between

the two CRF groups (fit and unfit) and Pearson product moment correlation (PPMC) to determine any possible significant relationship between CRF and BP (SBP and DBP). The statistical analysis was carried out at an alpha level of 0.05 with Statistical Pace for Social Science (SPSS) version 15.

Results

The study results are presented in the tables below.

The physical and physiological characteristics of participants are listed in table 1 (mean (X) and standard deviation (SD) .

Table 1. Physical and physiological characteristics of participants (N=520)

Variables	X±SD
Age	15.94±1.992
Weight	48.58±9.689
Height	1.55±0.103
Body mass index	20.10±3.030
Systolic blood pressure	121.33±12.607
Diastolic blood pressure	81.20±13.453
Cardiorespiratory fitness	39.43±1.309

X ±SD = mean ±standard deviation

The physical and physiological characteristics of participants according to the CRF group are presented in table 2 (mean and standard deviation)

Table 2. Physical and Physiological characteristics of participants according to the CRF group

Variables	CRF group	N	X±SD
Age (13-19years)	Unfit	282	15.99±2.046
	Fit	238	15.89±1.929
Weight (kg)	Unfit	282	49.21±10.22
	Fit	238	47.84±8.983
Height (m)	Unfit	282	1.54±0.108
	Fit	238	1.55±0.097
Body Mass Index	Unfit	282	20.34±3.044
	Fit	238	19.81±2.994
Systolic BP	Unfit	282	125.00±13.346
	Fit	238	116.97±10.244
Diastolic BP	Unfit	282	88.40±12.047
	Fit	232	72.67±9.454

Key: CRF = Cardiorespiratory fitness, BP= blood pressure.

To compute for effects of CRF on blood pressure (systolic and diastolic BP), the independent t-test was used (table 3).

Table 3. SBP and DBP according to the CRF group - t-test

Variables	CRF group	N	X±SD	t	P
Systolic BP	Unfit	282	125.00±13.246	7.783*	0.05
	Fit	238	116.97±10.244		
Diastolic BP	Unfit	282	88.40±12.047	16.679*	0.05
	Fit	238	72.67±9.454		

t(518)=1.972; P<0.05.
Key: BP= blood pressure, CRF=Cardiorespiratory fitness

The findings presented in table 3 demonstrated a significant difference in mean systolic and diastolic BP between the study groups (t = 7.783, df=518, p<0.05).

The results of Pearson product-moment correlation are presented in table 4.

Table 4. CRF according to BPs (Pearson product-moment correlation)

Blood Pressure	Variable	R	P
Systolic BP	CRF	-0.317*	0.05
Diastolic BP	CRF	-0.583*	0.05

R(518)=0.062; p<0.05.

The table 4 findings revealed negative relationships between CRF versus SBP (R=-0.317, p<0.05) and CRF versus DBP (r= -0.583, p<0.05), implying that increases in SBP and DBP result in decreases in CRF.

Discussion

The objective of our study was to determine the influence of cardiorespiratory fitness (CRF) on blood pressure (BP) among teenagers in Kano state. A total number of 520 students from 12 selected public secondary schools in Kano were

enrolled; 282 (54.2%) of them were found to be unfit whereas 238 (45.8%) - fit.

Our findings demonstrated a **significant** negative **relationship between CRF and BP (SBP and DBP) among teenagers in Kano**, which is consistent with the data reported by Kwee and Willmore (1990 [20] and by Barlow (2006), who found CRF an independent predictor of hypertension among initially normotensive women; unfit women had higher BP than fit women [15]. Similar data were presented by Blair et al. (1984), showing that the risk of developing high BP was associated with the fitness level; less active or unfit individuals had a 30-50% greater risk of developing hypertension [17].

Conclusion

The study findings reveal that cardiorespiratory fitness affects blood pressure (systolic blood pressure and diastolic blood pressure) among teenagers in Kano state. Increases in cardiorespiratory fitness correlate with decreases in blood pressure.

Recommendation

It is recommended that CRF should be considered while assessing teenage patients.

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Corresponding Author: Farida Garba Sumaila
(Lecturer/Physiotherapist)
Address
Farida Garba Sumaila
Department of physiotherapy,
Faculty of Allied Health Science,
College of Health Science,
Bayero University,Kano
P.M.B 3011, Kano.
Nigeria.
Email: fareedat2006@gmail.com fgsumaila.pth@buk.edu.ng
Phone Number: +234-8036164228