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Assessment of Aerobic Fitness and Body Mass Index of Officers of the Nigerian Police Force in Enugu State, South East Nigeria

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Abstract

This study assessed the aerobic fitness and body mass index of officers of the Nigerian Police Force in Enugu State, Nigeria. It was a cross-sectional study and a total number of 343 police officers participated. Aerobic fitness was evaluated with a 20-metre shuttle run also known as Progressive Aerobic Cardiovascular Run (PACER) test which was used to estimate maximal oxygen uptake (VO_2max) of participants. Body Mass Index (BMI) was also measured and a proforma was used to record PACER performance, gender, age and years of service. Mean, Standard Deviation and Linear regression were used for analyses. The Statistical Package for the Social Sciences (SPSS) version 25 was used for the data analysis. The findings revealed that the police officers had a mean VO_2max of 46.01±8.644 ml/kg -1 ·minute -1. The police officers had a mean BMI of 25.68kg/m^2, which was significantly associated (<0.001) with their VO_2max. The study concluded that higher BMI is associated with decrease in VO_2max. Gender had a significant relationship with the BMI of police officers, as female officers had higher BMI while male officers had lower BMI. Age had a significant relationship with the BMI of police officers, as their higher age is associated with their higher BMI. However, officers of both genders particularly females need to engage more in physical activities to have improved aerobic capacity and have their BMI within a healthy range.

Keywords: *aerobic fitness, maximal oxygen uptake, body mass index, police officers, health, PACER*

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Introduction

Aerobic fitness and body mass index (BMI) are crucial physiologic indicators of health in human population. Globally, aerobic fitness has been on the decline, while obesity seems to be on the increase among various populations. Across nations, aerobic endurance has been reduced by about 5 per cent each decade (American Heart Association [AHA], 2013) while cases of obesity have increased worldwide over the past decades (Ortega et al., 2016). In 2013, about 50 per cent of the adult population in various nations in Oceania, North Africa and the Middle East had obesity (Ortega et al., 2016). In addition, high cases of obesity were recorded in North Ameri-

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ca and Western Europe (Ortega et al., 2016). Aerobic fitness which is an element of physical fitness is vital for daily living. It is the ability of the heart and lungs to reliably dispense oxygenated blood to working muscles, as well as the capacity of the muscles to use the oxygen delivered by the blood supply as a source of energy for physical activities (Cheng et al., 2019). To determine aerobic fitness, it is important to measure maximal oxygen uptake (VO_2max) (Mahar et al., 2018). Maximal oxygen uptake is the peak rate of oxygen utilization obtainable during an activity of growing intensity (Dlugosz et al., 2013). VO_2max is denoted either as an absolute rate in litres of oxygen per minute (L/min) or as a relative rate in millilitres of oxygen for every kilogram of body mass per minute (mL/(kg·min) (Dlugosz et al., 2013).

Maximal oxygen uptake (VO_2max) may have a negative association with BMI (Mahar et al., 2018). BMI is a ratio of an individual's weight and height (Williams et at., 2013). The formula is BMI = kg/ m2 where kg is the individual's weight in kilograms and m2 is their height in metres squared (Williams et al., 2013). The score obtained is used to determine whether an individual has a healthy weight or not. Based on World Health Organization (WHO) classification, scores of 18.5kg/m2 and below are regarded as underweight, between 18.5-24.9kg/m2 is regarded as normal weight, 25kg/m2 - 29.9kg/m2 is overweight, while scores of over 30kg/ m2 are regarded as obese (WHO, 2021). The BMI is extensively used and welcomed by scientists and researchers for prognosticating health risks. However, Luiz et al. (2016) opined that BMI does not evaluate the difference in lean weight and fat mass, but is a good tool for determining weight in a sizeable adult population. This shows that BMI may have a high degree of validity.

Various determinants may influence the BMI and aerobic fitness of individuals including police officers. According to Kind et al. (2019), BMI and aerobic fitness are influenced by several determinants, such as hereditary, gender, body weight, health status, habits, physical activity (PA) levels and age. Yi et al. (2015) had earlier reported that BMI increases with age while Forrester-Knauss and Zemp (2012) reveal that men tend to have a higher BMI than women. In support of this revelation, Vijayalakshmi et al. (2017) reported that men have an appreciable BMI than women. In terms of differences in aerobic capacity between men and women, Kenny et al. (2012) posited that male and female adults may vary in aerobic potentials as female estimates of VO_2max is about 70-75 per cent of that of the male after puberty. Libby (2021) suggests that aerobic fitness diminishes with age. This according to the author is partly a result of variation in maximal heart rate (MHR) and muscle loss associated with aging. However, the magnitude of aerobic fitness can be determined by one's PA patterns. In adults, there is a positive correspondence between equitably calculated PA and aerobic fitness, even though little is known about how PA intensity affects the magnitude of one's aerobic fitness (Bradley et al., 2019).

Research (Kind et al., 2019; Kumar, 2016) has shown that excellent aerobic fitness and BMI values are associated with buoyant health in adults. In other words, poor aerobic fitness is correlated with illness and the occurrence of diverse medical conditions, such as heart disease, diabetes, high blood pressure, and obesity (Jekal et al., 2010). In addition, Kumar (2016) posited that BMI affects aerobic fitness and that evaluating and monitoring aerobic fitness and body fat in adults is of public health significance. This is chiefly crucial for security personnel including officers of the Nigerian police force. The fitness and vigour of the security workforce including police officers may affect their performance (Friedl, 2012).

Recently, there have been increasing cases of criminality and insecurity in different parts of Nigeria, including Enugu State. This increasing incidence of insecurity in Nigeria has caused curiosity about the operation and capability of the Nigerian police force. The basic objective of BMI and aerobic fitness evaluation in the drafting of security forces is to spot individuals that are adequately adapted to the dictates of armed forces (Friedl, 2012). However, aerobic fitness and body mass are dynamic and recruited police officers may have reduced or improved indices over time in the course of their career. A study (Strauss et al., 2021) assessed the effect of aerobic fitness on lessening cardiovascular risk factors among police officers and office workers in Germany. The study found that most police officers (60%) and office workers (58%) had low levels of aerobic fitness. Furthermore, the study discovered that police officers and office workers with higher aerobic fitness levels had significantly lower values in waist circumference, body fat percentage and BMI. Unfortunately, there are currently no aerobic fitness standards for officers of the Nigerian Police Force. Therefore, given the need to obtain baseline data to better understand the BMI and the aerobic fitness standards of officers of the Nigerian police force, the study was designed to assess the BMI and the aerobic fitness standards of officers of the Nigerian police force in Enugu State, Nigeria. Specifically, the objectives were to assess the aerobic fitness, BMI, and the relationship between BMI and aerobic fitness of Nigerian Police Officers. The study hypothesized that there is no significant association between aerobic fitness status and age, gender and years of service of police officers in Enugu State, Nigeria. Also, there is no significant relationship between BMI and age, gender and years of service of police officers in Enugu State, Nigeria. This study findings would help exercise professionals, police administrations and health agencies to initiate intervention/programmes for police officers for improved aerobic fitness status and healthy BMI range.

Methods

Study design and setting

A cross-sectional study was conducted between January and March 2022 at the selected police formations in the three Senatorial Districts (Enugu North, Enugu West and Enugu East) that make up Enugu State, Nigeria. The senatorial districts are made up of Local Government Areas (LGAs). In the various LGAs, there are autonomous communities and villages.

Participants

The study participants comprised police officers. All the participants are officers under the employ of the Nigerian police force in different formations in Enugu State, Nigeria. The study included female (40.8%) and male (59.2%) officers with mean age (M = 36.50). Age was further grouped as follows; 20-29 years, 30-39 years, 40-49 years, and 50-60 years.

Sampling procedures

The sample size for the study was determined using (Yamane, 1967) sample size determination formula. We calculated a sample size of 396. The multi-stage sampling procedure was used to draw the study sample. The police formation in Enugu state was first stratified into 22 operational divisions. The second stage involved the use of a simple random sampling technique of balloting without replacement for the se-

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lection of 18 officers from each of the 22 police divisions in Enugu State. This brought the sample size to 396. However, police officers who were sick or could not make it to the test venue were excluded from the study.

Material and measures

Following the participants' consent, they were subjected to the instruments for data collection. The instrument for data collection were the 20-metres shuttle run also called Progressive Aerobic Cardiovascular Endurance Run (PACER) test, stadiometer and weighing scale. Also, a proforma was used for collection of performance data and demographic data of the participants. The PACER also known as the 20m Shuttle Run Test is a running test originated by (Leger et al., 1988) and is utilized in evaluating VO_2max which estimates aerobic fitness. Candidates of the test were first of all subjected to warm-up exercises to prepare them for the PACER test. In performing PACER, the candidates ran a 20-meter shuttle signaled by a beep sound. The test gets progressively faster until they can no longer keep up with the pace. After the test, the participants were also subjected to warm-down exercises to help them recover from the activity. This test was conducted in the morning when the participants were still alert and not exhausted from their daily activities. The tally from the PACER is the total laps perfected before voluntary fatigue. The raw tally was recorded on the scoring sheet developed by Cooper Institute. Also, the Body BMI was used to estimate the participants' weight with respect to their height. The BMI was calculated by measuring the height and weight of the police officers. The height was measured with a stadiometer while the weight was measured using a weighing scale. The weight and height measurements were taken with the participants wearing light clothing and without footwear.

Data collection procedure

The current research was developed following the Ethical Principles of the World Medical Association Declaration of Helsinki for medical research involving human subjects (World Medical Association, 2013), and the research was approved by the Research Ethics Committee of the Ministry of Health, Enugu State Nigeria (MH/MSD/REC21/234).

To obtain the participation of the officers, the research team met with the Assistant Commissioner of Police in Enugu State. After an agreement with the Assistant Commissioner of Police and Divisional Police Officers, informed consent was obtained from the officers, and it was explained to them how and when the data would be taken. Also, the research team explained the objectives of research to the participants and the latter were assured about the privacy of their data. After their consent was gotten, the researchers, engaged the officers in the PACER test, also the height and weight of the officers were measured, and they filled out the proforma to show their gender, age and years of service in the Nigerian Police. The administration protocol of PACER required that two researchers were present on every test lane and ensured that all steps of the protocol were followed. The participants engaged in the protocols they were exposed to. Out of the 396 officers drawn for the study, only 343 participated. Data of 343 participants were gotten and used for the study analyses.

Data analysis

The IBM Statistical Package for Social Sciences (SPSS) version 25.0 was used for all the statistical analyses. The standard descriptive statistics were applied to describe data patterns. Mean and standard deviation were used to analyse the VO_2max and BMI scores. The details of age, gender, BMI, and laps covered by each participant were used to calculate the VO_2max; which is a reflection of the aerobic fitness of each participant. The VO_2max values were calculated using the Quadratic Model formula developed by (Mahar et al., 2011):

VO_2max = 41.76799 + (0.49261 x PACER) – (0.00290 x PACER2) – (0.61613 x BMI) + (0.34787 x gender x age)

Where, PACER is the number of laps completed; for gender, 1 = male and 0 = female; and age is in years. The VO_2max scores were rated very poorly, poor, fair, average, good, very good and excellent. VO_2max < 35.0 (Very poor); VO_2max 35.0 – 38.3 (Poor); VO_2max 38.4 – 45.1 (Fair); VO_2max 45.2 – 50.9 (Good); VO_2max 51.0 – 55.9 (Excellent); VO_2max > 55.9 (Superior) using grading format developed by (Cooper Institute, 2005). For the BMI, the height and weight of the participants were calculated and graded using (WHO, 2021) BMI classification, where a BMI value less than 18.5kg/m2 is Underweight, BMI of 18.6-24.9kg/m2 is Normal weight, BMI of 25-29.9kg/m2 is overweight while a BMI of 30kg/m2 and above is Obese.

The normality of the data was checked through skewness, kurtosis and the Kolmogorov–Smirnov (K-S) test. Normal distribution was considered if the skewness showed values between -2 and +2, and the KS test is not significant (Bryne, 2010). The predictive capacity of VO_2max and BMI as well as their covariates (gender, age and year of service) was assessed by linear multiple regression analyses. All the tests were 2-tailed, and the probability values less than 0.05 ($p<0.05$) were considered significant.

Results

Table 1 shows the characteristics of the study participants. They included 203 male and 140 female police officers. The mean age, BMI and VO_2max of 36.50(SD=6.109),

Table 1. Characteristics of the Participants

Characteristics of Participants	n (%) M(SD)
Male	203 (59.2%)
Female	140 (40.8%)
Age	36.50(SD=6.109)
BMI (kg/m^2)	25.68(SD=3.325)
VO_2Max	46.01(SD=8.644)

Note. Aerobic fitness status (VO2max) categorization by Cooper Institute for Aerobics Research (CIAR, 2005), VO2max < 35.0 (Very poor); VO2max 35.0 – 38.3 (Poor); VO2max 38.4 – 45.1 (Fair); VO2max 45.2 – 50.9 (Good); VO2max 51.0 – 55.9 (Excellent); VO2max > 55.9 (Superior). Body Mass Index Categorization by World Health Organization (WHO, 2021), BMI<18.5(Underweight); BMI 18.5-24.9 (Normal weight); BMI 25-29.9 (Overweight); BMI > 30 (Obese).

25.68(SD=3.325) and 46.01(SD=8.644), respectively were obtained (Table 1).

Between BMI and VO_2max, the result (β= -.557 p= .000), indicates that BMI had moderate negative effect on VO_2max. which is significant. This implies that as BMI increases, VO_2max decreases (Table 2).

Table 2. Relationship between BMI and VO_2Max

Model		Standardized Coefficients (β)	Standard Error (S. E)	T	p-value
1	Constant	83.199	3.028	27.475	< .001
	BMI	-.557	0.117	-12.382	< .001

R = .557; R2 = .310; Adjusted R2 = .308; F = 153.302; Sig = < .001; a= Dependent Variance: VO_2Max; b=Independent Variance (constant): BMI

Table 3 shows that only gender had a significant relationship with the VO_2max of Police Officers. The prediction between gender and VO_2max (β = .871, p<.001) indicates that gender had a strong positive effect on V02max. which is significant. This implies that as females' V02max increases, males' VO_2max increases, though males (mean = 52.26, SD =4.05) had higher VO_2max than the females (mean = 36.96, SD =4.53) (Table 3).

Table 3. Multiple Regression of VO_2Max and Covariates

Model		Standardized Coefficients (β)	Standard Error (S. E)	T	p-value
1	Constant	38.086	.826	46.131	< .001
	Gender	.871	.468	32.661	< .001
	Years of Service	-.495	.571	-.866	.387
	Age Group	-.198	.408	-.486	.627

R = .872; R2 = .761; Adjusted R2 = .759; F = 359.195; Sig = < .001; a= Dependent Variance: VO_2Max; b=Independent Variance (constant): Gender, Years of Service, Age Group

Table 4 shows that regression between gender and BMI was obtained thus (β = -.278, p <.001), indicating that gender had low negative effect on BMI. This implies that as females' BMI which is higher (mean 26.79, SD = 3.44) increases, males' BMI (mean = 24.92, SD = 3.02) decreases. Age (B = .809, p = 0.008 < 0.05) had a significant relationship with the BMI of police officers, as their higher age is associated with their higher BMI (Table 4).

Table 4. Multiple Regression of BMI and Covariates

Model		Standardized Coefficients (β)	Standard Error (S. E)	T	p-value
1	Constant	24.815	.611	40.586	< .001
	Gender	-.278	.346	-5.209	< .001
	Years of Service	.131	.423	.309	.757
	Age Group	.809	.302	2.678	< .001

R = .336; R2 = .113; Adjusted R2 = .105; F = 14.374; Sig = < .001; a= Dependent Variance: BMI; b=Independent Variance (constant): Gender, Years of Service, Age Group

Discussion

This study was undertaken to assess the aerobic fitness and BMI of officers of the Nigerian Police Force in Enugu State South-East Nigeria. Table 1 shows that the police officers had a mean VO_2max of 46.01±8.644 ml/kg -1 ·min -1. Our finding is higher than those of Strauss et al. (2020) who observed a mean VO_2max of 34.1 ± 8.0 ml/kg -1 ·min -1 in male police officers from North Rhine-Westphalia, Germany. This shows that the police officers in Enugu state Nigeria demonstrated higher aerobic capacity than police officers in North Rhine-Westphalia, Germany. Our study also shows that police officers in Enugu state had a mean BMI of 25.68kg/m2. Our finding although similar is lower than those of Strauss et al. (2020) who observed a mean BMI of 28.0±3.2 in a German male police population. The BMI score in our finding is overweight according to WHO (2021) rating. This finding is not surprising but expected. The finding agrees with Ortega et al. (2016) who reported that more adults are becoming overweight globally. However as noted by (Luiz et al., 2016), BMI does not differentiate between lean weight and fat mass, as such does not define the composition of the body contributing more or less to the overall body weight. It is therefore important to note that the BMI scores of the police officers in our study may be due to high lean mass, as we did not measure their body composition which is a major limitation of our study. However, scientists think that adults should strive to maintain a normal weight range of 18.5kg/m2 - 24.9kg/m2 and that BMI value is a good pointer to the health of humans.

Table 2 shows that BMI has a significant relationship with the aerobic fitness status of the police officers, as their higher BMI is associated with a decrease in their maximal oxygen uptake. This finding is expected and not surprising because excess body weight has been shown to harm maximal oxygen uptake in humans. This is in line with Kind et al. (2019) assertion that maximal oxygen uptake (VO_2max) reflects an individual's aerobic fitness and may be affected by BMI. Similarly, Mahar et al. (2018) had reported earlier that there is a negative association between VO_2max and BMI. In healthy participants, the major factors that affect VO_2max includes the strength of respiratory muscles which initiate the force of contraction, the size of the airway and the elastic pressure of the lungs (Shah et al., 2022). In case of participants with high BMI, the function of respira-

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tory muscles may be impaired from the heightened resistance they must overcome and from the decreased capacity of these muscles (Shah et al., 2022).

Table 3 shows that there is a strong relationship between independent variables (gender, years of service, age group) and the dependent variable (VO_2max). The results however revealed that only gender had a significant relationship with the VO_2max of police officers. This finding is expected and is in line with the assertion of Kenny et al. (2012) that aerobic fitness can be affected by gender. The author further disclosed that men are likely to have more efficient aerobic capacity than women. Since muscle is the highest user of oxygen during physical activity, higher muscle mass in men may be partly responsible for their higher VO_2max when compared to women (Mahar et al., 2011).

Table 4 shows that the gender of police officers had a significant relationship with their BMI, as female officers had higher BMI while male officers had lower BMI. This finding is surprising because it differs from the finding of Forrester-Knauss and Zemp (2012) which reveal that men tend to have higher BMI than women in Swiss. It is also contrary to Vijayalakshmi (2017) who had reported in their findings that men have significantly higher BMI than women in India. The reason for this difference may have to do with geographical location or lifestyle and could be investigated further. This study revealed a significant relationship between age and BMI of police officers, as their higher age is associated with their higher BMI This finding is in line with Yi et al. (2015) who asserted that BMI tends to increase as one gets older in Korea. This may be due to age-related decrease in metabolic rate. However, no matter one's age, keeping a healthy weight is important and this underscores the importance of engagement in physical activities regardless of one's age. The findings of this study show that the number of years the officers have been in service does not have a significant association with their BMI.

One of the limitations of the study is that this study did not assess the daily activities of the officers which could have guided us to understand if it affected their aerobic fitness status and BMI. As such, we cannot tell if their aerobic fitness status and BMI has any association with their daily activities. Future studies should consider using a larger, randomized and more representative sample size while considering other associated factors that could have affected maximal oxygen uptake and BMI of participants. A small number of variables is another major limitation of this study. Future studies should explore anthropometric, motoric and functional parameters in a similar population. Furthermore, other means of measuring body composition, such as skinfold measurement should also be explored.

Conclusion

The findings have shown that police officers in Enugu State Nigeria had a 'good' aerobic fitness status and 'overweight' BMI. Because we did not measure body composition, we cannot categorically state that the high BMI found in the study is a result of high body fat among the population. Higher BMI is associated with a decrease in aerobic fitness. Male officers had better aerobic fitness status than female officers. Female police officers had a higher mean BMI than their male counterparts. Age and years of service did not have a significant association with aerobic fitness as represented by maximal oxygen uptake. Older officers had higher BMI values. Given the results obtained, one can conclude that this study adds data to the current database on aerobic fitness and BMI, and also on the relationship between aerobic fitness and BMI. The result indicates that more needs to be done to improve the maximal oxygen uptake (VO_2max) and BMI of police officers. Police administration and physical trainers need to do more and devise better training strategies that will impact positively the aerobic fitness and BMI of police officers. The findings indicates that it would be of high importance to encourage rigorous physical activity among police officers to increase aerobic fitness. In addition, the study results indicate that it is crucial to incorporate health-advancing initiatives, such as nutritional classes and exercise promoting programs in police training. Other physical fitness components like agility, power and flexibility are also important for police officers and should be explored.

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