DIGIT RATIO (2D:4D), SOCIODEMOGRAPHIC CHARACTERISTICS, ANTHROPOMETRIC AND ADIPOSITY MARKERS OF MILITARY PERSONNELS IN JAJI, KADUNA STATE, NIGERIA

BY

Ahmad Umar SHEHU

DEPARTMENT OF HUMAN ANATOMY,
FACULTY OF BASIC MEDICAL SCIENCES,
COLLEGE OF MEDICAL SCIENCES,
AHMADU BELLO UNIVERSITY,
ZARIA

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BY

Ahmad Umar, SHEHU
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FACULTY OF BASIC MEDICAL SCIENCES,
COLLEGE OF MEDICAL SCIENCES,
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

MAY, 2025

DECLARATION

I Ahmad Umar SHEHU hereby declare that the work in this Dissertation titled "Digit Ratio (2d:4d), Sociodemographic Characteristics, Anthropometric and Adiposity Markers of Military Personnels in Jaji, Kaduna State, Nigeria" was carried out by me in the Department of Human Anatomy, Faculty of Basic Medical Sciences, Ahmadu Bello University, Zaria. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this work has been presented for another degree at any institution.

_____ _____

Ahmad Umar SHEHU **Date**

CERTIFICATION

The Dissertation entitled "Digit Ratio (2d:4d), Sociodemographic Characteristics, Anthropometric and Adiposity Markers of Military Personnels in Jaji, Kaduna State, Nigeria" by Ahmad Umar SHEHU meets the regulations governing the award of the degree of Master of Science in Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literacy presentation.

Prof. B. Danborno (BSc, MSc, PhD, FASN) _____ _____
Chairman, Supervisory Committee Signature Date
Department of Human Anatomy,
Faculty of Basic Medical Sciences.
Ahmadu Bello University, Zaria.

Prof. W.O. Hamman (BSc, MSc, PhD) _____ _____
Member, Supervisory Committee Signature Date
Department of Human Anatomy,
Faculty of Basic Medical Sciences,
Ahmadu Bello University, Zaria.

Dr. S.A. Musa (BSc, MSc, PhD) _____ _____
Head of Department, Signature Date
Department of Human Anatomy,
Faculty of Basic Medical Sciences,
Ahmadu Bello University, Zaria.

Prof. M.N. Shuaibu _____ _____
Dean, School of Postgraduate Studies Signature Date
Ahmadu Bello University, Zaria

DEDICATION

This dissertation is dedicated to God Almighty who made this work a reality by giving me the strength and wisdom to complete this work.

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ABSTRACT

Physical characteristics and body composition have been known to be fundamental to excellence and performance. However, comprehensive studies to assess anthropometry, body composition parameters and aggression across military men in Nigeria are generally scanty. Therefore, the present study was designed to investigate the relationship between 2D:4D and anthropometric variables, body composition and aggression amongst military personnel in Jaji, Kaduna State, Nigeria. A total number of 402 apparently healthy military men of the Nigerian army in Jaji cantonment (officers n=189 and soldiers n=213) were randomly selected and recruited for the study. All anthropometric measurements were done according to the protocol of International Society for the Advancement of Kinanthropometry and body composition variables were computed. Aggression was assessed with the use of aggression questionnaire. Mann-Whitney test, Kruskal Wallis test followed by pair wise comparison with the Bonferronni corrections, discriminant function analysis and Spearman's correlation were used and $P < 0.05$ was set as the level of significance. The soldiers had significantly higher mean values for R2D, R2D:4D physical aggression and fat mass compared with the officers ($P<0.05$) while the officers on the other hand had significantly higher values for bicep skin fold thickness and fat free mass index ($P<0.05$). However, other anthropometric, body composition and aggression parameters did not differ significantly between the soldiers and officers ($P>0.05$). The anthropometric and body composition parameters showed significant changes based on the length of stay of military men in service ($P<0.05$). With regards to the effect of cigarette smoking, non-cigarette smokers had significantly higher mean values for height, weight skin fold thicknesses compared with smokers ($P<0.05$) while smokers on the other hand had higher values for R2D and L2D:4D ($P<0.05$). Body composition and aggression parameters were not significantly different between smokers and non-smokers ($P>0.05$). Similarly on the influence of alcohol consumption, alcohol drinkers had significantly higher mean values for body mass index, mid upper arm circumference and aggression parameters compared with non-alcohol drinker ($P<0.05$). However, body composition parameters did not differ significantly between alcohol and non-alcohol drinkers ($P>0.05$). Furthermore, the discriminant function analysis proved effective in the identification of military cadres with overall accuracy being 59.5%, in 62% of soldiers and 56.6% of officers were correctly classified. Lastly, 2D:4D showed significant correlations with physical aggression, verbal aggression, total aggression, anger, waist circumference, waist-hip-ratio, body fat%, fat free mass, biceps and subscapular skinfolds in the soldiers while in the officers body composition and aggression parameters did not show significant correlations with 2D:4D. In conclusion, the relationship between 2D:4D and some anthropometric, body composition and aggression parameters have been established. Length of stay of military men in service, cigarette smoking and alcohol consumption showed varying effects on the anthropometric parameters, body composition and aggression components. The study also revealed that some anthropometric and body composition variables gave a moderate to good (59.5%) military cadre discrimination accuracy, which emphasizes its utility as an adjunct for screening military men in the Jaji Military Cantonment, Kaduna, Nigeria. Future studies can compare various military cantonments across the country using a larger sample size and ensure gender sensitivity in their design.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of Study

Military anthropometry is not a new or even recent development, since anthropometric data on military personnel have been in use for at least 100 years or more. Some information on the body size of Civil War soldiers is available in the literature (White and Churchill, 1971). Efforts in anthropometry as a field of research were renewed in the early years of World War II (Little, 2012). In the Army and Air Force, both men and women were measured as early as 1942 and the anthropometric data were utilized in human engineering (White and Churchill, 1971; Robinson *et al.*, 1988; Karwowski, 2006). Following the end of World War II, the collection, analysis, and applications of anthropometric data have been carried on as an integral part of military research and development programs, and anthropometry has become a recognized part of human factors engineering (Robinson *et al.*, 1988; Hendrikse *et al.*, 2002).

Design of military machinery, weapons, and equipment should thus be according to soldiers' body dimensions and ergonomic principles (Driscoll and Ackermann, 2012; Pourtaghi *et al.*, 2014). The standard program to measure physical dimensions of the US military force dates back to 1775. Thereafter, a database of the anthropometric dimensions of the military force was developed in 1970 and has been in use as a standard for the physical dimensions for designing the required equipment and accessories of the army (Pourtaghi *et al.*, 2014). These standards have been modified constantly over the past 200 years. Each sector of the US army has declared a number as the maximum allowable weight to height ratio for employment and recruitment. The military sectors are obliged to pay attention to these ratios. In 1995, almost 5000

American military forces were dismissed from the army because of weight to height mismatch (Pierre and Shi, 2000; Pourtaghi *et al.,* 2014). In studies by Kaufman *et al.,* 2000; Henderson *et al.,* 2000 and McNulty, 2001 on the physical dimensions of the US military personnel, it was asserted that most of the injuries and damages which occurred during military trainings happened to those who suffered from inappropriate body dimensions or unfit physical dimensions and hence their consequent mismatch with tools and equipment.

Many countries measure the anthropometric dimensions of their military personnel on alternate years to be able to design their work settings and tools and equipment based on anthropometrically updated information (Johnson, 1997). In a study on a large sample of 17–20 year-old American population, Rochelle *et al.*, 2002 found that 13%–56% of participants were not fit for military standards with regard to their gender and age, and that most of the mismatch was among the Afro-Americans. It is possible for various people with different dimensions to work properly with tools and equipment suitable for their physical characteristics by employing anthropometry to equipment and work setting design. Designing based on anthropometric data leads to eliminating awkward postures and their subsequent complications for the body (Bolstad *et al.*, 2001). Therefore, being informed of body characteristics and individuals' anthropomorphic dimensions is essential for having an effective work setting, even for those with physical disabilities (Das and Kozey, 1999).

Physical characteristics and body composition have been known to be fundamental to excellence and performance (Mathur and Salokun, 1985). Anthropometric data have been used for some years in order to provide body size information in military research and development (Salvendy, 2012). Knowledge of body size and proportions is

essential for the design, sizing, and tariffing of military clothing, protective, and personal equipment of even greater importance is the fact that anthropometric data are required as a basic input in the human factors engineering of military equipment systems: aircraft, vehicles, tanks, submarines, and many other types of weapons systems (Robinson *et al.,* 1988; Shih and Liang, 2014). The anthropometric measurement of the military population provides a standard, statistical description of that population. In order to provide an adequate definition of a body dimension for a specific population, descriptive statistics such as mean, standard deviation, and standard error are used to describe the variation for that body dimension (Robinson *et al.,* 1988; Marriott and Grumstrup-Scott, 1990). Researchers and designers then use this information (anthropometric data) to achieve accommodations, compatibility, integration, safety, improved performance and logistic efficiency in human equipment systems.

Digit ratios are determined while the embryo forms and will then remain the same without change during individual development (Manning *et al.,* 2004). The foetus grows quickly from the 9th week of pregnancy, and this is the sensitive period for foetal development. The major feature of the foetal period is cell differentiation, which is sensitive to external environmental changes. So during this period, if the foetus encounters changes in the intra-uterine environment, such as intra-uterine under-nutrition or hormone level changes, not only will the foetal structures of the organs and organism be changed, but also the development of fetal fingers and toes will be affected (Manning *et al.,* 2004). Exposure to different levels of sex hormones *in-utero* leaves effects on human fingers (Manning *et al.,* 1998). People exposed to elevated levels of testosterone tend to have ring fingers (the fourth digit: 4D) longer than their index fingers (the second digit: 2D). Oestrogen exposure has the opposite effect; the index

finger tends to be longer than the ring finger. Therefore, the ratio between the length of second and fourth manual digits (2D:4D) is a sexually dimorphic trait-males tend to have lower 2D:4D values than females (Manning *et al.,* 1998) and it is a cross-cultural trait (Manning *et al.,* 2003; Manning *et al.,* 2004).

Different works exist showing the relationship of different anthropometric variables with different variables across different populations, such as 2D and 4D ratio with height, weight, chest, waist and hip circumferences in Nigerians by Danborno *et al.* (2007), 2D:4D ratios of the Ebira ethnic group of Nigeria by Ibegbu *et al.* (2012), some studies on the anthropometric measurements and body composition of obese students (Ismail and Chi, 1987), university students (Ismail and Zawiah, 1988), university staffs (Ismail and Zawiah, 1989) and Malaysian soldiers (Ismail and Zawiah, 1996) have been carried out in Malaysia.

2D:4D has recently come of interest because of the predictive power the ratio has for hormonal exposure in utero and the subsequent effect that this has on psychological traits (Williams *et al.,* 2000; Putz *et al.,* 2004; Lippa, 2006). Androgen exposure has been the most commonly implicated hormonal difference when discussing the sexual dimorphism of the 2D:4D ratio, causing men to have an aggregate mean ratio lower than that of women (Manning, 2002a; Danborno *et al.*, 2007). The sexual dimorphism in 2D:4D is influenced by prenatal secretion of testosterone and oestrogen (Zheng and Martin, 2011). Testosterone negatively correlates with 2D:4D while oestrogen correlates positively with 2D:4D (Manning, 2002; Putz *et al.,* 2004).

The researchers had found the relationship between 2D:4D ratio with traits like cardiovascular heart diseases (Manning and Bundred, 2000; Fink *et al.,* 2006; Wu *et al.,* 2013). Moreso, psychological characteristics have also been associated with the 2D:4D

ratio. Male homosexuality is negatively predicted by the 2D:4D ratio, as the amount of prenatal testosterone exposure goes up, males are more likely to be homosexual (Robinson and Manning, 2000). The 2D:4D ratio has also been studied in the context of reproductive success (Manning and Bundred, 2000), adult personality characteristics (Austin *et al.,* 2002; Fink *et al.,* 2003; Bailey and Hurd, 2005b), and more recently in the context of psychopathology (Walder *et al.,* 2006). Generally, digit ratios show positive correlations with female-typical behaviours and negative correlations with male-typical behaviours (Putz *et al.,* 2004).

1.2 Statement of Research Problem

Physical characteristics and body composition have been known to be fundamental to emotions, behaviour, character, excellence and performance as a result this, many countries measure the anthropometric dimensions of their military personnel on alternate years to be able to design their work settings, tools and equipment based on anthropometrically updated information. Comprehensive studies to assess anthropometry, body composition parameters and aggression across military men in Nigeria are scanty. Since the Nigerian government is also very keen on military excellence, then the need to carry out this study in Jaji military cantonment cannot be overemphasized.

1.3 Justification/Significance of the Study

There is a need for baseline anthropological data on second to fourth ratio, anthropometry, body composition as well as aggression traits among military men of Jaji cantonment. Extraction of various form of anthropometric variables, will enrich the information regarding the profiles, hence serve as database and reference information as the need may arise. Data from the present study will provide useful information for ergonomics (i.e. design of equipment) for military.

1.4 Aim and Objectives of the Study

1.4.1 Aim of the study

To study the relationship between 2D:4D and anthropometric variables, body composition and aggression amongst military personnel in Jaji, Kaduna State, Nigeria

1.4.2 Objectives of the study

The objectives of the study were to:

i. compare the anthropometric characteristics (2D:4D ratio, height, weight, BMI, waist and hip circumference, bicep skin fold), body composition (body fat, fat mass, fat free mass, fat mass index and fat free mass index) and aggression between officers and soldiers.

ii. determine the influence of some socio-demographic characteristics (duration of service, alcohol consumption and cigarette smoking) on the anthropometric variables, body composition and aggression.

iii. determine the influence of length of service on the anthropometric variables of military personnel.

iv. determine which anthropometric and body composition variables discriminates best between officers and soldiers.

v. examine the relationship between 2D:4D ratio and anthropometric variables, body composition and aggression.

1.5 Research Hypothesis

There will be relationship between second to fourth digit ratio and anthropometric variables, body composition and aggression amongst military personnel in Jaji, Kaduna State, Nigeria.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 History of Digit Ratio Research

Digit ratio is the ratio of the length of different digits or fingers typically measured from the midpoint of bottom crease (where the finger joins the hand) to the top of the finger (Mayhew *et al.,* 2007). The ratio of two digits in particular, the 2^{nd} (index finger) and 4^{th} (ring finger) is affected by exposure to androgens, e.g., testosterone while in the uterus and that this 2d:4d ratio can be considered a crude measure for prenatal androgen exposure, with lower 2d:4d ratios pointing to higher prenatal androgen exposure. (Honekopp *et aI.,* 2007).

That a greater proportion of men have shorter index fingers than ring fingers than do women was noted in the scientific literature several times through the late 1800s (Ecker, 1875; Baker, 1888). With the statistically significant sex difference in a sample of 201 men and 109 women established by (George, 1930) after which time the sex difference appears to have been largely forgotten or ignored. Wilson (1983) published a study examining the correlation between assertiveness in women and their digit ratio. This was the first study to examine the correlation between digit ratio and a psychological trait within members of the same sex. Wilson, (2010) proposed that skeletal structure and personality were simultaneously affected by sex hormone levels in utero. Manning *et al.* (1998) reported that sex difference in digit ratios was present in two-year-old children and further developed the idea that the index was a marker of prenatal sex hormones. Since then, research on the topic has burgeoned around the world. A 2009 study in *Biology Letters* argues: Sexual differences in 2D:4D are mainly caused by the shift along the common allometric line with non-zero intercept, which means 2D:4D

necessarily decreases with increasing finger length, and the fact that men have longer fingers than women (Kratochvil & Flegr, 2009) which may be the basis for the sex difference in digit ratios and/or any putative hormonal influence on the ratios.

Zheng and Martin, (2011) reports the 2D:4D ratio in mice is controlled by the balance of androgen to oestrogen signalling during a narrow window of digit development. The formation of the digits in humans, in utero, is thought to occur by 13 weeks, and the bone-to-bone ratio is consistent from this point into an individual's adulthood (Garn *et al.,* 1975). During this period if the foetus is exposed to androgens, the exact level of which is thought to be sexually dimorphic, the growth rate of the 4th digit is increased, as can be seen by analysing the 2D:4D ratio of opposite sex dizygotic twins, where the female twin is exposed to excess androgens from her brother in utero, and thus has a significantly lower 2D:4D ratio (Anders *et al.,* 2006). Importantly, there has been no correlation between the sex hormone levels of an adult and the individual's 2D:4D (Honekopp *et al.,* 2007) which implies that it is strictly the exposure in utero that causes this phenomenon. A major problem with the research on this topic comes from the contradiction in the literature as to whether the testosterone level in adults can be predicted by the 2D:4D ratio (Honekopp *et al.,* 2007) but male sexual traits that are stereotypically attributed to testosterone levels have been found in correlation with the 2D:4D. So, there should either be a correlation with one or the other but not both.

2.2 Evaluation of Digit Ratio

Digit ratio is the ratio of the lengths of different digits or fingers typically measured from the midpoint of bottom crease where the finger joins the hand to the tip of the finger. It has been suggested by some scientists that the ratio of two digits in particular, the 2nd (index finger) and 4th (ring finger), is affected by exposure to androgens e.g., testosterone while in the uterus and that this 2D:4D ratio can be considered a crude

measure for prenatal androgen exposure, with lower 2D:4D ratios pointing to higher prenatal androgen exposure. Mayhew *et al.* (2007) shows that male and female digit proportions are determined by the balance of sex hormones during early embryonic development. The 2D:4D ratio is calculated by dividing the length of the index finger of the right hand by the length of the ring finger of the right hand. A longer index finger will result in a ratio higher than 1, while a longer ring finger will result in a ratio of less than one. The 2D:4D digit ratio is sexually dimorphic: while the second digit is typically shorter in both females and males, the difference between the lengths of the two digits is greater in males than in females (Manning *et al.*, 1998). A number of studies have shown a correlation between the 2D:4D digit ratio and various physical and behavioural traits.

2.3 Distribution of Digit Ratio

Digit ratio distribution is generally sexually dimorphic with the females having higher digit ratio. Fig. 1. Below shows a visualization of the distributions: Men (blue), women (green), and the whole population (red). From a study of 136 males and 137 females (Bailey & Hurd, 2005a, 2005b) Males: mean 0.947, standard deviation 0.029. Females: mean 0.965, standard deviation 0.026. Assuming a normal distribution, the 95% confidence interval for average length is 0.889-1.005 for males and 0.913-1.017 for females.

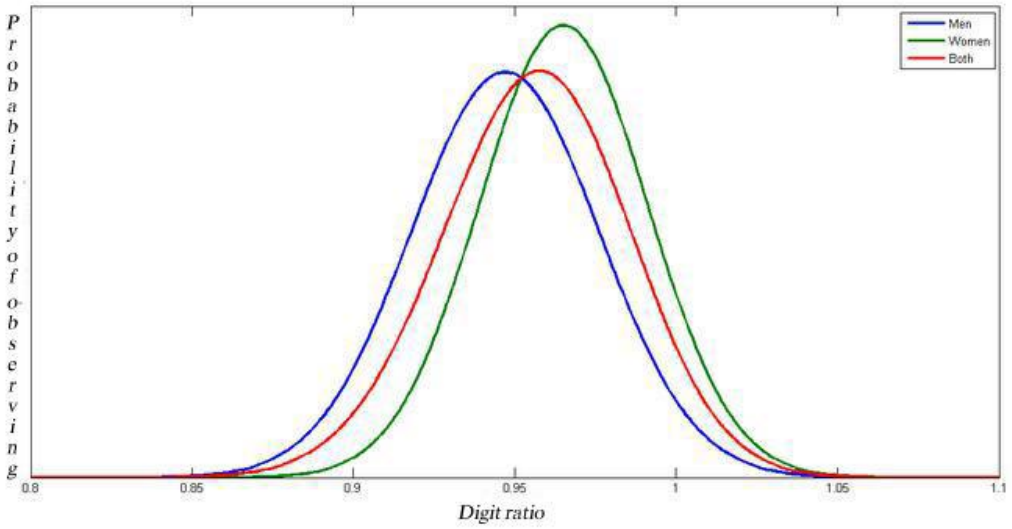


Fig.2.1: Distributions of Men (blue), women (green), and the whole population (red). From a study of 136 males and 137 females (Bailey and Hurd, 2005a,2005b)

2.4 Evidence and Effect of Androgen on Digit Ratio

Males develop a lower 2D:4D than females by the end of the first trimester of gestation (Malas *et al.,* 2006). Because of the early foetal development of sexual dimorphism in 2D:4D ratio, it is suggested that 2D:4D ratio may serve as a biomarker for prenatal androgen exposure (Manning *et al.,* 1998; Lutchmaya *et al.,* 2004; Gallup *et al.,* 2008). Women with congenital adrenal hyperplasia (CAH), which results in elevated androgen levels before birth, have lower, more masculinized 2D:4D on average (Brown, 2008; Okten *et al.,* 2002; Ciumas *et al.,* 2009). Other possible physiological effects include an enlarged clitoris and shallow vagina. Males with CAH have more masculine (smaller) digit ratios than control males (Brown, 2008, Okten *et al.,* 2002) which also suggests that prenatal androgens affect digit ratios, since amniocentesis samples show that prenatal levels of testosterone are in the high normal range in males with CAH, while levels of the weaker androgen and prostenedione are several fold higher than in control males (Pang *et al.,* 1980, Dorr & Sippell, 1993; LWudy *et al.,* 1999) These measures indicate that males with CAH are exposed to greater prenatal concentrations of total androgens than are control males. Digit ratio in men with Klinefelter's syndrome, who have reduced testosterone secretion throughout life compared to control males, are greater (i.e., more feminine) than in their fathers or control males (Manning *et al.,* 2013). Digit ratio in men correlates with genetic variation in the androgen receptor gene (Manning *et al.,* 2003). Men with genes that produce androgen receptors that are less sensitive to testosterone (because they have more CAG repeats) have greater, more feminine, digit ratios. However, men carrying an androgen receptor with more CAG repeats compensate for the less sensitive receptor by secreting more testosterone (Crabbe *et al.,* 2007), probably as a result of reduced negative feedback on gonadotropins. Thus, it is not clear that 2D:4D would be expected to correlate with

CAG repeats, even if it accurately reflects prenatal androgen. XY individuals with androgen insensitivity syndrome (AIS) due to a dysfunctional gene for the androgen receptor present as women and have feminine digit ratios on average, as would be predicted if androgenic hormones affect digit ratios. This finding also demonstrates that the sex difference in digit ratios is unrelated to the Y chromosome per se (Berenbaum *et al.,* 2009).

The sex difference in 2D:4D is present before birth in humans (Malas *et al.,* 2006) which rules out any social influences that might affect digit growth differentially in the two sexes. Because all somatic sex differences in mammals to date have been found to be due to either androgenic masculinization or effects of the sex chromosomes, and as the AIS finding rules out a role for sex chromosomes in the sex difference in digit ratios, the prenatal sexual dimorphism also indicates that androgens act before birth to affect digit ratios. The ratio of testosterone to estradiol measured in 33 amniocentesis samples correlates with the child's subsequent 2D:4D ratio (Lutchmaya *et al.,* 2004). Studies in mice indicate that prenatal androgen acts primarily by promoting growth of the fourth digit (Zheng & Martin, 2011). There is evidence that this reflects foetal exposure to the testosterone and oestrogen (McIntyre *et al.,* 2006). Several studies present evidence that digit ratios are heritable (Paul *et al.,* 2006). The level of oestrogen in the amniotic fluid is not correlated with higher 2D:4D, and when examined researchers found no difference in oestrogen levels between males and females (Lutchmaya *et al.,* 2004). It is not clear why digit ratio ought to be influenced by prenatal hormones. There is evidence of other similar traits, e.g., otoacoustic emissions and arm-to-trunk length ratio, which show similar effects *(*Mayhew *et al.,* 2007*).* Hox genes responsible for both digit and penis development (Dickman, 1997), have been implicated in affecting these multiple traits (pleiotropy). Direct effects of sex hormones

on bone growth might be responsible, either by regulation of Hox genes in digit development or independently of such genes. Likewise, it is unclear why digit ratio on the right hand should be more responsive than that on the left hand, as is indicated by the greater sex difference on the right than the left (Honekopp & Schuster, 2010).

2.5 Correlation between 2D:4D with Anthropometric Variables

Association exists between 2D:4D ratio and birth weight which could be predicted most especially from the left hands (Danborno *et al.,* 2010). In a study conducted among the Nigerian population, males have a significant negative relationship between right and left 2D:4D ratio with birth weight, while females show positively significant relationship in both right and left hands. 2D and 4D ratio showed significant relationship with height, weight, chest, waist and hip circumferences in a study of sexual dimorphism in Nigerians (Danborno *et al.,* 2007). The study strongly confirms the sexually dimorphic nature of 2D:4D ratio. Even though it failed to show relationship between 2D:4D, BMI, chest, waist and hip circumferences as reported in other studies (Danborno *et al.,* 2007). The result of the 2D:4D ratios of the Ebira ethnic group showed that the 2D:4D ratio of females was greater than the digit ratio of the males and also the digit ratios have no relationship with either height, weight or BMI of an individual and represents the original data for the people of the Ebira tribe of Nigeria (Ibegbu *et al.,* 2012). Danborno *et al.* (2007) provided the first data in Nigerians demonstrating sexual dimorphism in 2D, 4D and 2D:4D ratio and relationship between 2D, 4D, and 2D:4D ratio to height, weight body circumferences (chest, waist and hip).

Since digit ratio is associated with levels of sex hormones, study by Danborno *et al.* (2007) also reported the relationship of 2D:4D with chest, waist and hip circumferences and waist-hip ratio. These relationships have been established in other populations

(Manning *et al.,* 2003: Manning *et al.,* 2004). The results of Danborno *et al.* (2007) showed significant relationship between 2D and 4D lengths in right and left hands with chest, waist and hip circumferences in males but not in females. The relationship with 2D:4D was stronger in males than in females, which reflects that the relationship between 2D:4D is stronger in males than females.

Other studies Neave *et al.* (2003) have established relationship between height, weight and BMI. The result did not show any significant relationship between 2D:4D either in right or left hands, which agrees with the report of Neave *et al.* (2003) and Vehmas *et al.* (2006) but it is in contrast to that of Manning *et al.* (2003), who reported relationship between 2D:4D with Waist, hip circumferences and BMI. When considering digit lengths as entities both right and left 2D and 4D showed significant correlation with weight and height.

Early studies describing 2D:4D ratios have indicated that the strong difference and relationship with traits putatively link to testosterone is more significant in the right than the left hand (Lutchmaya *et al.,* 2004). The present study is the first to the best knowledge of the authors to show that the left 2D:4D is stronger than the right, which may be due to ethnic and geographical location as earlier reported that latitude have effect on 2D:4D (Manning *et al.,* 2003).

2.6 Digit Ratio and Aggression

Aggression in humans is strongly sex dependent, such that men tend to show more same-sex physical aggression compared to women (Campbell & Muncer, 2008). Therefore, this would suggest that 2D:4D is negatively related to physical aggression. However, such a relationship is controversial. The first examination of the association reported that 2D:4D did not correlate with aggression (Austin *et al.,* 2002). Other

studies have reported both significant and non-significant findings in links between 2D:4D and aggression. For example, Hurd *et al.* (2011) found a significant negative relationship between 2D:4D and physical 2D:4D aggression in a sample of Canadian men, but Butovskaya *et al.* (2012) reported no association between 2D:4D and physical aggression in a sample of Hadza men. A recent meta-analysis (Honekopp & Watson, 2011) has not resolved these differences, reporting only a small but significant, negative relationship between 2D:4D and aggression in men (r = -0.06). These discrepancies in literature concerning 2D:4D and aggression in men may be resolved, to some extent, if aggression is influenced by testosterone induced by an aggressive challenge and such influence is additionally moderated by 2D:4D.

There is evidence for an aggression-testosterone-2D:4D link in the presence of a challenge. Millet and Dewitte (2007) reported no relationship between 2D:4D and physical or provoked aggression in a sample of 45 men, but a significant negative correlation with both physical and provoked aggression, and 2D:4D was noted immediately after exposure to an aggressive video. Although testosterone was not measured in this study, there are reports of increases in testosterone after watching an aggressive video clip (Millet, 2010; Cook &Crewther, 2012) for general discussion of the link between aggressive stimuli and testosterone production), which, in turn, may influence the expression of such behaviours as aggression. Furthermore, a study of Italian football players in "Series A" showed low 2D:4D and high testosterone were linked to the number of fouls during games (Perciavalle *et al.,* 2013). This correlation is to be expected if low 2D:4D predicts high physical aggression during the challenge of a competitive game of football. Therefore, studies that address any association between 2D:4D and aggression would benefit from experimentally manipulating testosterone levels using a "challenge" stimulus such as an aggressive video.

Kilduff *et al.* (2013) examined the relationship between 2D:4D, testosterone responsiveness, and provoked aggression in men in relation to an aggressive video stimulus. In this study they manipulated testosterone levels by exposing the participants to an aggressive challenge video and also a control video. Aggression was measured after each video and free testosterone was measured before and after exposure to each video. The hypothesis of Kilduff *et al.* (2013) was that the aggressive video would raise testosterone levels and, in this context, 2D:4D would be negatively related to aggression. In contrast, they expected testosterone would not be raised by the control video and, in this context, 2D:4D would not be associated with aggression.

The results of Millet and Dewitte (2007), revealed a significant negative correlation between 2D:4D and aggression after an aggressive stimulus. The effect was related to an increase in testosterone concentrations, in so far as it was greatest in the sub-group that showed the greatest increase in testosterone. This suggests that low 2D:4D men are likely to show high aggression in conditions of challenge (such as aggressive encounters, including aggressive sports), which is consistent with the challenge hypothesis. Most of the significant associations they found were for left 2D:4D. In general, 2D:4D correlations with target traits tend to be strongest for right 2D:4D. However, for links with sports performance the left 2D:4D is of equal importance (Honekopp & Schuster, 2010). Performance in sports involves a challenge which may be similar to an aggressive situation. This may explain the link with left 2D:4D and aggression in their findings. There was no correlation between 2D:4D and aggression after the control video. This suggests that in the absence of an aggressive challenge a low 2D:4D is not a strong biomarker for aggression. Thus, with regard to the relationship between 2D:4D and aggression, it is possible to see negative or null correlations, as have been reported by Hurd *et al.* (2011) and Butovskaya *et al.* (2012).

The 2D:4D ratio is connected with a number of traits associated with sex hormones, such as fertility, sexual attraction, sexual orientation, spatial imagination, aggression and sport (Dogan *et al.,* 2008). Digit length ratio has suggested to correlate with several psychological traits. Benderlioglu and Nelson (2004) found that masculinized low 2D:4D ratio was correlated with high reactive aggression as measured by letters in females under high provocation. Bailey and Hurd (2005a) suggested that males with lower, more masculine, digit length ratio and any form of aggression score. They also found no correlation between digit length ratio and any form of aggression in females. One of the factors that constitute aggression and expressed anger are hormones and neurotransmitters (Dogan *et al.,* 2008). In many studies and observation involving animals and humans, it has been shown that there is a relationship between androgen level and aggression (Marco *et al.,* 2005). Generally, in normal people and athletes there is positive correlation between free testosterone level and aggressive/hostile behaviour, which can be measured by plasma and saliva. Clinical research has shown that free testosterone level increases especially in people committing antisocial violence crimes. Following the hypothesis of Dogan *et al.* (2008) androgen level affects both digit development, aggression and anger.

2.7 Skinfold

Skinfold Technique by way of definition a way of assessing body composition utilizing the measurement of various fat folds on the body. The development of human skinfold thickness (subcutaneous fat) is affected by genetic factors, sex hormones and neuroendocrine activity. In addition, there are obvious regional difference, ethnic differences, eating habits, nutrition and physical exercise (Huang *et al.,* 2010). The skinfold thickness provides an estimate of the thickness of subcutaneous fat (Onimawo and Cole, 2000). Onimawo *et al.* (2004) reported that skinfold thickness is useful in

assessing the degree of malnutrition. Jellife (1996) also reported that triceps skinfold thickness can serve as an indicator of nutritional status in man. Borkan and Norris, (1980) reported that a decline in skinfold thickness at the biceps and triceps skinfold can be attributed to a decrease in subcutaneous fat as a result of reduced energy intake, as fat content is dependent on nutrition intake and energy expenditure of the individual. The difference in the value of the skinfold thickness in people of the same age would reflect the status of energy reserve (Bhardwaj & Kopoor, 2007). Ye *et al.* (2012) gave two possible reasons for the difference in skinfold thickness: agricultural based activities and high physical exertion reduces skinfold thickness while meat, egg and high fat to protein in a diet increases skinfold thickness. Another measure for assessing body fat is skinfold thickness. This technique estimates body fat at various sites throughout the body, most commonly the triceps and subscapular site (Power *et al.,* 1997). The sum of two skinfold thickness utilizes the two most common skinfold measurement sites the triceps and subscapular skinfolds, while avoiding a compounding of measurement error that would be present if a ratio was used (Power *et al.,* 1997).

Sarria *et al.* (1998) reported that predicting high body fatness in adult is better accomplished via adolescent skinfold thickness than adolescent BMI. The thickness of a skin allows researchers to distinguish between an individual's body mass and body fat, which is critical in regards to the potential negative impact on health status (Himes & Dietz, 1994).

2.8 Body Composition and Digit Ratio

Many years ago, German paediatricians performed the first quantitative studies of body composition on children who had died of malnutrition (Garrow & Webster, 1985). Cadavers were used for measurements of body composition in adults as early as 1945

(Garrow & Webster 1985). The use of body density to estimate body composition goes back to the 1930s when the U.S. Navy was interested in the body composition of test divers (Wilmore, 1983). The ability to measure body composition has improved substantially since using cadavers. There are several ways to determine body composition (e.g., bioelectrical impedence, skinfolds etc.).

Body Composition is the percentage of a body's total weight which is fat tissue, as compared to the amount of total body weight from lean body mass. A frequently used field technique for determining body composition is skinfolds (Fletcher & McNaughton, 1987). There are many ways to measure body composition. Most methods have at least some merits but many methods are either too difficult to administer or too expensive to use. Skinfold measure as a tool for estimating body composition is based on two assumptions: (1) thickness of subcutaneous fat represents a constant proportion of total fat, and (2) the sites selected for skinfold measurements represent the average thickness of the subcutaneous fat (Lukaski, 1987).

The correlative interdependence between the typically masculinizing features of body composition and 2D:4D, found in female subjects, and their absence in the males, suggests that the sex dependent 2D:4D ratio has a limited prediction in men (Cabric *et al.,* 2012). Similar conclusions were drawn by Neave *et al.* (2003) and Putz *et al.* (2004), when they examined other sex dependent features. The hypothesis that the type of body constitution may correspond to the 2D:4D ratio, appeared to be erroneous.

The evaluation of body composition is used in several areas of health science to gain important information on the gross morphology (Komuya *et al.,* 1992). Thus, the most common technique used for body composition estimation have been isotope dilution and underwater weighing with exception of skinfold thickness. This technique has not

been easy to apply to many subjects due to the requirements of special equipment, technician's skill and subject discomfort.

Assessment of body composition, particularly the estimation of fat-free mass and total body fat forms part of the nutritional assessment process. It offers more information than body mass index, because changes in body weight may be a result of changes in either the fat-free mass or total body fat. Researches on the body composition of individuals are very important because body fat is related to blood pressure and other cardiovascular risk (Berchtold *et al.*, 1981), glucose intolerance (Wilson *et al.*, 1981) and insulin resistance (Bonnadonna *et al.*, 1990).

Zamboni *et al.* (1992) reported that the body composition of human changes with advancing age. This is because with age the fat free mass decreases as the fat mass increases. It has been well established that central obesity is associated with several metabolic disturbances such as dyslipidemia, glucose intolerance, hypertension, peripheral hyperinsulinemia Zamboni *et al.* (1992). Upper body fat measured by waist hip ratio is known to increase with aging in women as well as in men (Zamboni *et al.*, 1992).

Military and physical fitness trainers are keenly aware that specific types of physical performance are associated with specific body size and composition characteristics (Fleck, 1983). An obvious example is the contrast between the massive muscularity of a power lifter and the extreme thinness and leanness of a marathon runner. Body size, body composition, and military bearing (appearance) have always been important to the military because of real and perceived associations with physical performance capabilities (Friedl, 2004). Despite associations, there is low specific predictive value of

body size or composition to soldier performance within the wide range of healthy weights and adiposity (Harman & Frykman, 1992).

With consideration to a normal curve distribution in body composition, this suggested that desirable body fat limits for active young men and women should fall around 20 and 30%, for men and women. Individuals above this level would have to engage in remedial training and weight loss or be separated from the military. Body weight or BMI only started an individual into the process and body fat became the standard. The report recommended acknowledgment of an aging effect on body composition relationships to fitness, with additional leeway for older service members. These recommended thresholds ranged up to 37% body fat for the oldest age group of women (US Department of Defense, 1981). Height and weight and the combination, usually in the form of the Quetelet Index, or body mass index (BMI, kilograms per meter squared), has long been used in soldier selection criteria (Friedl, 1992).

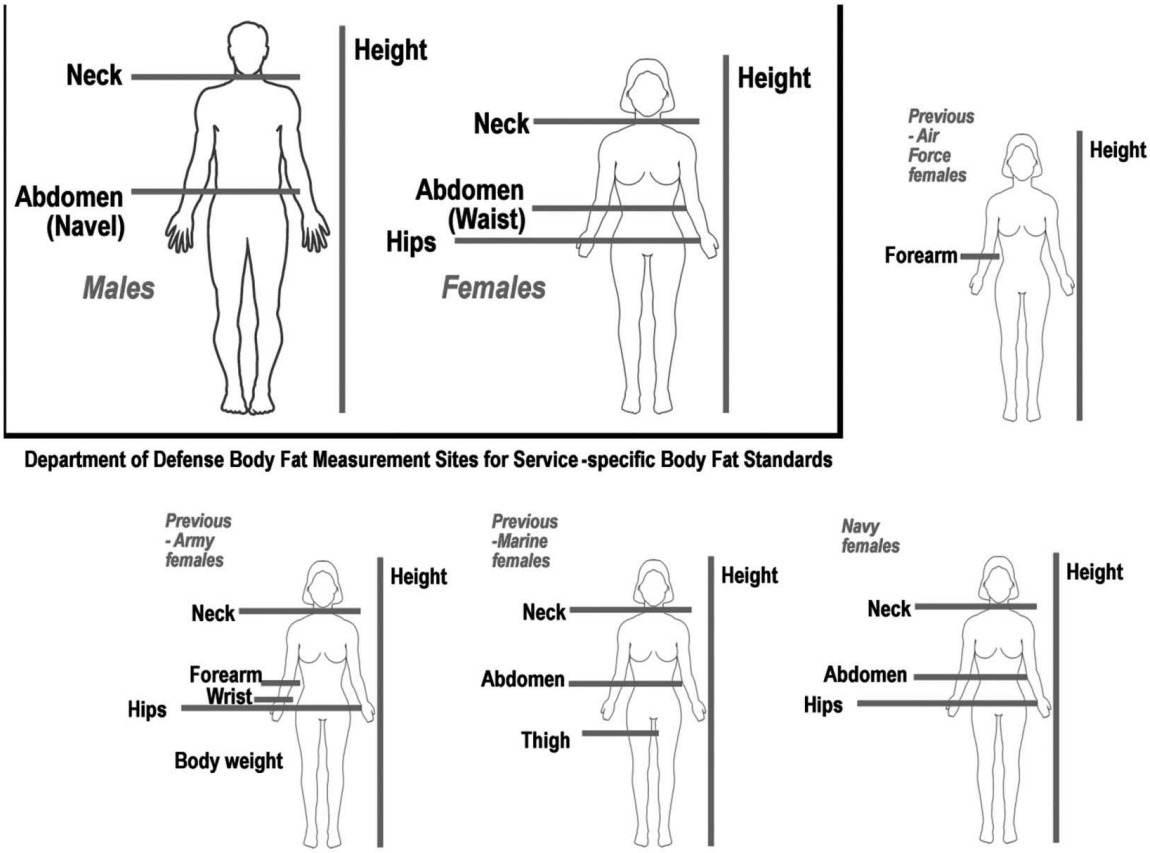


Figure 2.1: The variety of measurement sites for circumference-based body

Composition equations that were originally developed by each of the military services for assessment of body fat in women. This highlights the greater complexity of regional fat distribution in women compared with the intraabdominal fat deposition that predominates in men. Ultimately, a focus on the waist circumference in both sexes proved to be the most relevant to DoD goals and to be the most accurate in estimating overfat individuals.

The Waist Circumference-based military equations are relatively sensitive to changes in criterion-measured body fat for male and female soldiers during basic training and male soldiers during Ranger training (Friedl *et al.,* 1994; Friedl *et al.,* 2000; Friedl *et al.,* 2001; Santtila *et al.,* 2008*).* In any case, WC-based body fat estimation is much better

associated with male and female chronic health risks than total body fat, body weight, or body size (BMI) (Friedl, 2004). Even for women, intraabdominal fat becomes an issue above a certain threshold of adiposity. Kvist *et al.* (1988) demonstrated a linear increase in intraabdominal fat with increasing adiposity in men.

In women, intraabdominal fat remained at a minimal level with increasing fatness until an accumulation of 30 L or 27 kg) of total body fat, at which point a steady increase in intraabdominal accumulation began. Fat deposition in other subcutaneous sites in women, including arms, legs, buttocks, and breast are not generally associated with health risks and in some cases may reflect an association with reduced cardiovascular and other health risks. Intraabdominal fat (detected by WC), on the other hand, is strongly associated with increasing health risks in women as it is with men (Friedl, 2009).

2.9 Correlation between Digit Ratio and Muscular Endurance

Relationship between digit ratio (2D:4D) and dynamic muscular endurance has been analyzed to study the indirect effects of some physiological variables on dynamic muscular endurance. Many sport scientists and coaches believed that talent identification is a critical component of elite sports development programs (Mohamed *et al.,* 2010). The study of relationships between physical characteristics and sport performance can help to identify a set of limitations and abilities in sport. Hand parameters, especially digit ratio, are a rich resource of stable and valuable information about the abilities of people. Meanwhile, the second to fourth digit ratio (2D:4D) is a calculable and powerful variable for predicting the talents and abilities of athletes (Honekopp *et al.,* 2006; Paul *et al.,* 2006).

Moreover, 2D:4D ratio is a biological marker for assessing sport performance which is mostly affected by genetics (Del Vecchio *et al.,* 2011). Whereas, the results of the studies on women don't show a meaningful relationship between this ratio and physical fitness test results and physical activity of women (Bailey and Hurd, 2005a). Nevertheless, there is a positive relationship between digit ratio (2D:4D) and the level of serum estradiol (Manning, 2002a, 2002b; Lutchmaya *et al.,* 2004; Fink *et al.*, 2006). Many researchers are interested in the relationship between different hand dimensions with sport abilities and physical fitness components. Visnapuu and Jurimae (2007) found that there is a significant relationship between hand grip and the ratio of digits in male basketball and volleyball players of 10-17 years old. Experimental research results show that digit ratio (2D:4D) can predict some sport behaviours. Manning and Taylor (2001) and Honekopp *et al.* (2006) showed that this ratio is very low in people with a more tendency to compete. The negative relationship between digit ratio (2D:4D) and sport performance of men in soccer, speed running and skiing is reported in many researches (Manning and Taylor, 2001; Manning, 2002a, b; Honekopp *et al.*, 2006).

Muscular endurance as an important component of health and physical fitness plays a key role in injuries related to sudden movements in the workplace and other work-related musculoskeletal disorders (Nicolay and Walker, 2005). People with more endurance are less in danger of tiredness and injury (Brown *et al*.,2008). They also can be resistant to musculoskeletal disorders caused by stress and pressure. Muscular endurance is extremely affected by biochemical and tissue features of cells in the muscles and also physiological processes in the cellular level (Nicolay and Walker, 2005). Different fibres in a muscle have different histochemical features. A number of previous studies indicated that women have more endurance than men at sub maximal levels, using less glycogen and more fat as fuel than men (Brown *et al*., 2008).

There is an insufficient information about effects of genetic and inside uterine factors on muscular endurance. Since, anthropometric measures play a key role in predicting success in sport talent (Mohamed *et al.,* 2010), and because the muscular endurance is the most necessary condition for doing sport activities with a good physical and mental fitness, it seems that the digit ratio (2D:4D) can predict the success without any of expensive lab experiments. Studying the literature shows that researchers have emphasized the muscular strength in studying the relationship between digit ratio (2D:4D) and muscular variables (Nicolay and Walker, 2005; Schaap *et al.,* 2005; Jurimae *et al.,* 2009). Although muscular endurance is very important in health and physical fitness, but there are a few studies about the correlation between digit ratio and muscular endurance. Meanwhile, in most of the daily activities muscular endurance which is the ability of contraction or continuous of contraction is extremely important. Generally, comparing to the muscular strength, there has been a few studies on the relationships between anthropometric dimensions and muscular endurance. For example, lots of studies reported a significant relationship between muscular strength and digit ratio (Nicolay and Walker, 2005; Schaap *et al.,* 2005; Jurimae *et al.,* 2009). However, there are a limited number of studies on the relationship between hand dimensions and muscular endurance. The methodologies of previous studies showed that they've used hand grip through measuring it by manual dynamometer. Since the method of grasping the dynamometer is similar as grasping the bar in pull-ups, the hypothesis of existence of a relationship between digit ratio (2D:4D) and the scores from a pull ups test were assessed. Despite the fact that muscular endurance is highly related to muscular strength, no significant relationship was reported in a study between the digit ratio (2D:4D) and muscular endurance in girl students (Rahimi *et al.,* 2013). Rahimi results are in contrast to Honekopp *et al.* (2006) findings who reported a

negative significant relationship between digit ratio (2D:4D) with the scores of physical education of teenagers and the results of physical fitness tests in adults (including push-ups, repetitive jumping over more than one barrier, swimming, running, repetitive rope picking and repetitive ball throwing in basketball). Moreover, the acquisitive nature of muscular endurance, gender differences and subsequently the difference in sex hormones level and muscle fibre type distribution are the factors affecting the relationship between digit ratio (2D:4D) and muscular endurance. Muscular endurance is an acquisitive variable, but digit ratio formed in prenatal phase of development and doesn't change after birth and during the life time (Lutchmaya, *et al.,* 2004; Honekopp *et al.,* 2006).

2.10 Correlation between Digit Ratio and Male Ability in Sports

Many studies showed that low 2D:4D ratios correlated with athletic ability (Manning & Taylor, 2001; Manning *et al.,* 2007). Ability in many sports and athletic disciplines may act as a proxy for ability in male-fighting because they demand good visual-spatial judgement, speed, endurance and strength. Football (soccer) is one such sport. Striking the ball with foot, head and fist (in the case of goalkeepers) and directing it towards fellow players or the goal requires spatial judgement. Playing competitive football for 90 min is a sustained demonstration of cardiovascular efficiency and a test of speed and sometimes strength. Testosterone, particularly prenatal testosterone, has many extragenital influences (Bardin & Catterall, 1981; McEwen, 1981). Androgens are critical for sexual differentiation of the nervous system and the development of abilities such as spatial judgement (Geschwind & Galaburda, 1985; Kimura, 1996, 1999), and in males the formation of an efficient cardiovascular system (Manning & Bundred, 2000).

In his report Manning and Taylor, (2001) found that low 2D:4D ratio is associated with a high level of attainment across a number of sports and also with high mental rotation

scores. Professional football players had lower 2D:4D ratios than controls; 1st team players had lower ratios than youth team members or reserves; international players had lower 2D:4D ratios than those who have not yet represented their country; and in a one-tailed test, 2D:4D ratio was negatively related to number of international appearances after the effect of country was removed. He suggested that low 2D:4D ratio in men is a correlate for high ability in many sports, including football. The relationship between low 2D:4D ratio and ability in sports may arise in two ways. First, it has been suggested that high prenatal testosterone promotes the growth of the right hemisphere and facilitates visual-spatial ability (Geschwind & Galaburda, 1985). Testosterone is also an important prophylactic against malfunction of the vascular system in men (Rosano, 2000). It reduces the effects of exercise-induced myocardial ischemia in men with coronary heart disease (Rosano *et al.,* 1999); men with coronary artery disease have lower testosterone levels than controls (English *et al.,* 2000) and survivors of heart attack have lower testosterone and higher estradiol levels than controls (Aksut *et al.,* 1986; Swartz and Young, 1987; Sewardson *et al.,* 1990; Phillips *et al.,* 1994). It has been suggested that the formation of the cardiovascular system is sensitive to testosterone and estradiol and that low 2D:4D ratio is a marker for high prenatal testosterone and an efficient vascular system in males (Manning and Bundred, 2000). Low 2D:4D ratios in men have now been found to be associated with ability in sports, high sperm counts and testosterone concentrations (Manning *et al.,* 1998), and a possible male display trait, i.e., musical ability (Sluming and Manning, 2000). Manning and Taylor, (2001) therefore suggest that 2D:4D ratio is a negative correlate of male competitiveness, fertility and attractiveness.

2.11 Digit Ratio, Cognitive Styles and Facial Emotion Recognition

Sexual dimorphism is observed across both humans and other animals. Among humans, obvious morphological variations between the sexes such as height and brain size (Hines, 2006) with men being taller and having greater brain volumes compared to women. Scientists have observed sexual dimorphism in a number of domains including interpersonal interaction, academic ability, psychomotor ability and (Baron Cohen, 2002, Hamilton, 2009; Kimura *et al.,* 2000). Generally, these studies have shown that men demonstrate better performance in mathematics, generate more complex systems of classification, obtain higher scores on the mathematics component of the Scholastic Aptitude Test and perform better in the interception of balls.

Conversely, women generally show superior abilities in verbal memory, memory of objects location in an array and the recognition of facial emotions (Kate *et al.,* 2015). In human cognitive psychology, visual spatial tasks possibly demonstrate one of the biggest sex differences with male advantage particularly for the mental rotation task and spatial perception skills (Voyer *et al.,* 1995). On the other hand, a meta-analytic study confirm that facial emotion processing demonstrates female advantage (McClure, 2000). In addition, this observation is possibly related to brain structural differences between male and female (Gur *et al.,* 2002). Evolutionary psychologists postulate that sexual dimorphism in human cognition is consequential of our evolutionary origins. Particular to spatial cognition, men tend to adopt a bird's eye view of the topography while women remember landmark details better due to the evolutionary pressures of long distance travelling by men in search of food and mates, while women are postulated to have paid attention to nearby children and foraged within a small area (Dabbs & Chang, 1998). Similarly, men's enhanced performance of the mental rotation task has been attributed to their role in tool making (Kimura *et al.,* 2000). With respect

to social cognition, women scored better than men on measures of empathy considering that ancestral women were more involved as caregivers, and women predominantly made use of relational aggression while men tend to use physical aggression (Loon, 2009). Albeit, the myriad of sexual dimorphic attributes described in cognition literature, some evidence suggest that such sex differences might be exaggerated and the magnitude of such differences reduced over time (Voyer *et al.,* 1995). Sexual dimorphism in cognitive performance has prompted scientists to explore the potential underlying factors in greater depth. Two important factors arose from studies looking at sexual dimorphism cognitive styles (Baron-Cohen, 2002) 2D:4D finger digit length (Mayhew *et al.*, 2007). In addition, sexual dimorphism for functional asymmetry is commonly observed (Kimura *et al.*, 2000; Hines, 2006).

CHAPTER THREE

3.0 MATERIAL AND METHODS

3.1 Materials

The following anthropometric tools/equipment were used for this study: stadiometer, measuring tape and skinfold caliper. All body measurements were obtained with subjects in anatomical position, except otherwise specified. The study location was Jaji military cantonment, Kaduna State, Nigeria.

3.1.1 Geographical location of the study population

Kaduna State was originally part of the Northern region in the three-region structure of 1954. In 1967, with the creation of twelve federal states by General Yakubu Gowon's Military Government, Kaduna State became part of North-Central State. The 1976 Military Government of General Murtala Muhammed created nineteen states from the existing twelve and North Central State was renamed Kaduna State. In 1987, General Ibrahim Babangida's Military Government brought the number of states to twenty-one and Kaduna was divided into Kaduna and Katsina States. The state has a population of 6,113,503 (National Buraeu of Statistics, 2012)

Kaduna State occupies almost the central position of the Northern part of Nigeria and shares common boundaries with Zamfara, Katsina, Kano, Bauchi, Plateau, Nasarawa and Niger State as well as Federal Capital Territory. This state occupies an area of about 46,053 square Kilometers. This state has three senatorial districts, 23 local governments and 255 political wards (Fig 3.1). The global location of kaduna state is between longitude 06^0 15 E and 08^0 38 E east of the Greenwich meridian and also between latitude 09^0 02 N and 11^0 32 N North of the equator (Abaje *et al.,* 2015).

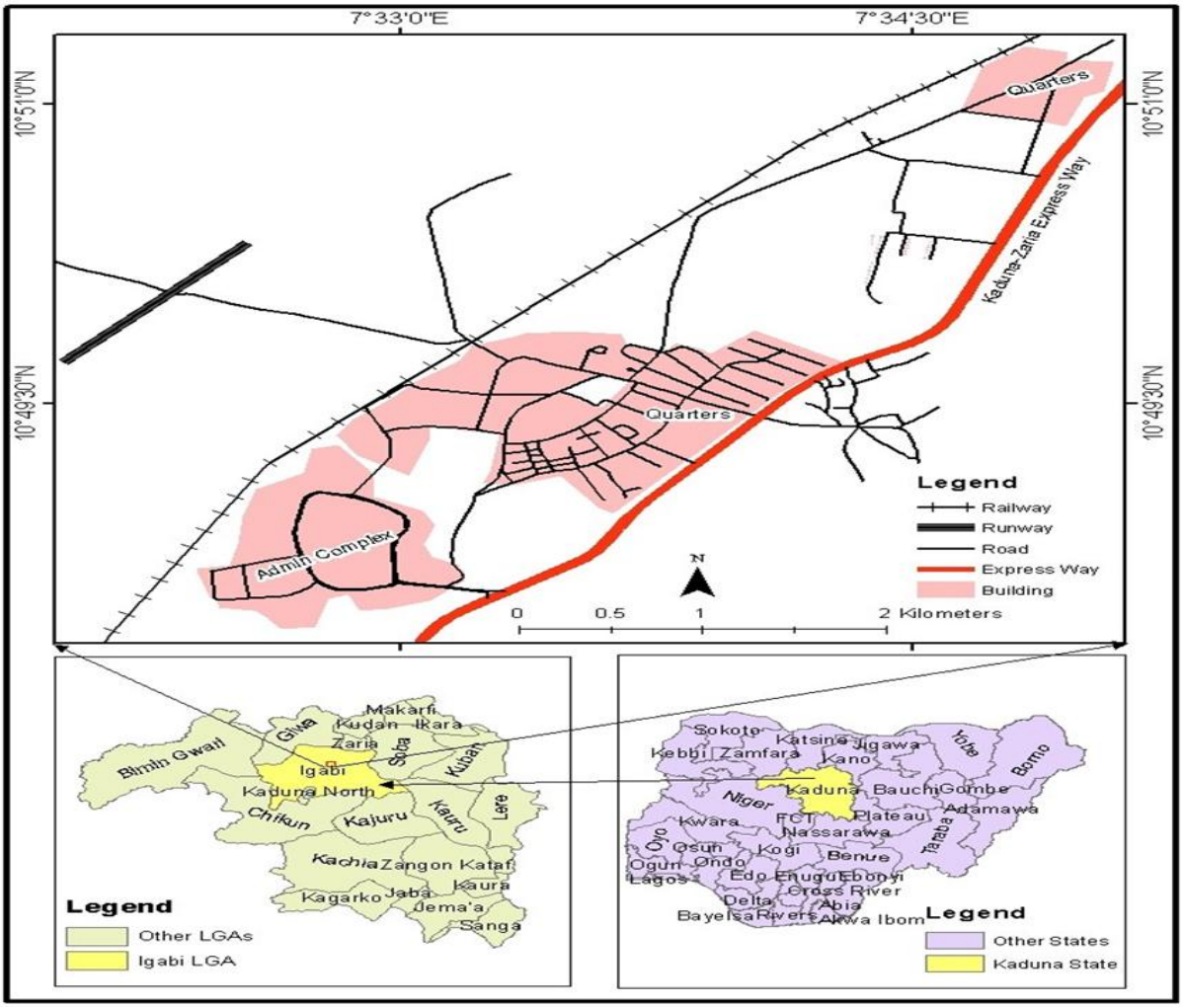


Fig. 3.1: The map showing location of Jaji military cantonment *(Adapted from google map.com)*

3.1.2 Climatic condition

The state is located in a tropical rain forest zone and has a tropical savannah climate. The climate is humid and the humidity is at its highest between March and November. For the whole of Kaduna State the mean daily temperature is 32.7°C (80.1 °F). As in the rest of West Africa, there are only two types of weather periods, rainy season and dry season. The average annual rainfall in the area is around 1,500 millimetres (79 in), which arrives intermittently and becomes very heavy during the rainy season. Other weather conditions affecting the state include Harmattan, a dusty trade wind lasting a few weeks of December and January. Like the rest of Nigeria, the state is hot all year round. Located at an elevation of 585.86 meters (1922.11 feet) above sea level, Kaduna has a Tropical wet and dry or savanna climate (Classification: Aw). The city's yearly temperature is 28.46ºC (83.23ºF) and it is -1.0% lower than Nigeria's averages. Kaduna typically receives about 92.56 millimeters (3.64 inches) of precipitation and has 132.0 rainy days (36.16% of the time) annually. (Weather and Climate, 2023 - The Global Historical Weather and Climate Data, https//:tcktcktck.org/ Nigeria>kaduna).

3.1.3 Vegetation

Kaduna State falls within the vegetation cover of Sudan Savannah type, characterized by woodland, scattered short trees, shrubs and grasses. The soil is mostly loamy to sandy. A substantial amount of clay is found also (en.wikipedia.org/wiki/kaduna-state/ geography)

3.2 Methodology

3.2.1 Sample size determination

The sample size of the study was obtained using the formula, as described by (Naing *et al.,* 2006).

$[n = z^2pq/d^2]$

Where; n = the desired sample size per ethnic group

z = the standard normal deviation, usually set at 1.96 (≈2.0),

p = the proportion in the target population within the desired age range (when no estimate 50% is used; i.e. 0.5), q= 1-p, d= degree of accuracy desired, usually set at 0.06,

Therefore, $n= (1.96)^2(0.5)\ (0.5)/\ (0.05)^2 = 384$.

For this study a total number of 403 soldiers were used: these was conducted in Jaji Military Cantonment, Kaduna State.

3.2.2 Sampling technique

The subjects who participate in this study were randomly selected soldiers of Jaji military cantonment, Kaduna State (n = 402 and mean age = 33.31± S.D).

3.2.3 Measuring tape

i. **Arm circumference (cm):** Tape was wrapped around the biceps, half way between the shoulder and the elbow (ISAK, 2001)
ii. **Chest circumference (cm):** Tape was wrapped around the chest at the level of of the middle of the sternum (breast-bone), with the tape passing under the arm. The arms were relaxed by the side, and the measurement taken at the end of a normal expiration (ISAK, 2001).
iii. **Hip circumference (cm):** The tape was wrapped over the maximum circumference of the buttocks (ISAK, 2001).

iv. **Thigh circumference (cm):** Tape was wrapped around the thigh at the level of the mid-point on the lateral (outer side) surface of the thigh, midway between trochanterion (top of the thigh bone, femur) and tibiale lateral (top of the tibia bone) (ISAK, 2001).

v. **Waist circumference (cm):** Tape was wrapped around the waist at the midpoint between the lowest rib and iliac crest. The subject was asked to stand erect while measurement were taken (ISAK, 2001).

3.2.4 Stadiometer

Stadiometer was used to measure the height and weight of the subjects.

i. **Height (cm):** Standing height was measured taking the maximum distance from the floor to the highest point on the head, when subjects were standing in anatomical position. Shoes were put off, feet together and arms by the sides. Heels, buttocks and upper back were also in contact with the wall when the measurement is made (ISAK, 2001).

ii. **Weight (kg):** Weight was measured to the nearest 0.1 kg when the subject is standing and putting on light indoor clothes using the inner scan (ISAK, 2001).

3.2.5 Skinfold calliper

The skinfold thickness was taken at the left side of the body (Moreno *et al.,* 2002) to the nearest 0.1 mm using a skinfold calliper. Once affirm grip is placed the skinfold, the caliper was applied perpendicular to the site. After the release of the trigger, the measurement was read.

i. **Triceps:** A vertical pinch of skin fold was taken on triceps midway between the shoulder and elbow. The measurement was taken when the person is standing upright, with arms hanging down loosely (ISAK, 2001).

ii. **Illiac skinfold**: Immediately above the iliac crest (top of hip bone), on the most lateral aspect (side). The fold is directed anteriorly and downward in line with the natural fold of the skin (ISAK, 2001).

3.2.6 Experimental design

This is a prospective study and data was collected with predesigned questionnaire. Out of four hundred and twenty (420) questionnaires distributed, four hundred and three (403) were retrieved and the information contained in each were analysed and presented in a tabular form. A total of seventeen (17) questionnaires were returned incomplete or not returned or blank. These questionnaires were distributed randomly to soldiers of Jaji military cantonment, Kaduna State.The following was included in the questionnaire: age, number of siblings, weight, height, BMI, waist-hip ratio, waist circumference, hip circumference, waist-hip ratio, mid upper arm circumference, chest circumference.

3.3 Inclusion and Exclusion Criteria

3.3.1 Inclusion criteria

The following were used as inclusion criteria:

i. Subjects who are certified soldiers and civilians in Jaji Military cantonment.
ii. Subjects who were apparently mentally and physically fit.
iii. Respondent must be between ages 18-50 years old.
iv. Not on any centrally acting drugs.

3.3.2 Exclusion criteria

The following were used as exclusion criteria

i. Subjects who do not have certification (i.e. Identity card or any means of identification).
ii. Subjects who are not physically and mentally fit.

iii. Subjects who are not within the designated age range stated above.

iv. Structural deformity in any of the measured parts.

3.4 Ethical Approval

Ethical approval was obtained from Ahmadu Bello University Research Ethics Subcommittee (see Appendix I) and permission to conduct this study was also obtained from Jaji military cantonment. Only subjects who gave informed consent were included in this study.

3.5 Data Analyses

Data were presented as descriptive statistics (Mean ± SD) and percentages. Mann-Whitney test was used to compare mean of values, Kruskal Wallis followed by pair wise comparison with adjusted Bonferroni corrections to compare means across groups, discriminant function analysis was used for military cadre discrimination and Spearman's correlation were used for relationship between each of the measured anthropometric parameters. $P < 0.05$ was deemed significant. Statistical analysis was conducted using Statistical Product and Service Solutions (SPSS) version 23.0

CHAPTER FOUR

4.0 RESULTS

4.1 Descriptive Statistics of the Study Population

The mean, standard deviation, minimum and maximum of aggression scores, anthropometric variables and body composition of the whole study population and based on cadre. The overall subjects were 402 comprised of 189 Officers and 213 Soldiers as presented in Tables 4.1, 4.2 and 4.3.

Fig. 4.1 is a chart showing the distribution of military personnel's according to length of service. 204 (50.7%) were between 0-9 years, 124 (30.8%) 10-19 years and 74 (18.4%) were greater than 20 years in service. Of the officers 77 (40.7%) were between 0-9 years, 101 (53.4%) and 11 (>20 years), while for the soldiers 127 (59.6%) were between 0-9 years, 23 (10.8%) 10- 19 years and 63 (29.8%) greater than 20 years (Fig. 4.2).

The distribution of the study population based on alcohol consumption is shown in Figure 4.3. 48 (11.9%) consumed alcohol while 354 (88.1%) did not ingest alcohol. In the cadre of officers 26 (13.8%) consumed alcohol while 163 (86.2%) answered in the negative. Whereas in the soldiers cadre 22 (10.3%) responded in the affirmative to alcohol ingestion while 191 (89.7%) did not consume alcohol (Fig. 4.4).

The distribution of the study population based on cigarette smoking is presented in Figure 4.5. 34 (8.5%) are cigarette smokers while 368 (91.5%) are non-smokers. In the cadre of officers 17 (9.0%) are smokers while 172 (91.0%) are non-smokers. Whereas in soldiers cadre 17 (8.0%) responded in the affirmative to cigarette smoking while 196 (92.0%) are non-smokers (Fig. 4.6).

Table 4.1: Descriptive statistics of age and aggression scores of the whole study population and based on cadre

	Overall (n=402)		Officers (n=189)		Soldiers (n=213)	
Parameters	**mean ± SD**	**Min-Max**	**mean ± SD**	**Min-Max**	**mean ± SD**	**Min-Max**
Age (Yrs)	33.31 ± 8.07	20.00-56.00	33.08 ± 5.60	21.00-45.00	33.52 ± 9.76	20.00-56.00
Anger score	17.36 ± 5.49	7.00-28.00	17.25 ± 5.36	7.00-28.00	17.45 ± 5.61	7.00-28.00
Physical Aggression Score	15.43 ± 5.19	7.00-29.00	14.85 ± 4.97	7.00-27.00	15.95 ± 5.34	7.00-29.00
Hostility Score	15.11 ± 6.36	7.00-67.00	14.97 ± 6.16	7.00-56.00	15.24 ± 6.54	7.00-67.00
Verbal Aggression Score	16.92 ± 5.50	8.00-35.00	16.67 ± 5.02	8.00-32.00	17.15 ± 5.90	8.00-35.00
Total Aggression Score	64.83 ± 19.28	29.00-115.00	63.74 ± 18.25	29.00-115.00	65.79 ± 20.14	29.00-114.00

Table 4.2: Descriptive statistics of anthropometric variables of the whole study population and based on cadre

	Overall (n=402)		Officers (n=189)		Soldiers (n=213)	
Parameters	**mean ± SD**	**Min-Max**	**mean ± SD**	**Min-Max**	**mean ± SD**	**Min-Max**
Weight (kg)	73.91 ± 11.50	49.00-164.50	74.70 ± 12.70	50.00-164.50	73.22 ± 10.31	49.00-110.00
Height (m)	2.97 ± 14.42	1.58-174.00	4.37 ± 20.97	1.58-174.00	1.72 ± 0.06	1.58-1.89
Body Mass Index (kgm-^{2})	24.74 ± 4.05	0.00-49.66	24.92 ± 5.01	0.00-49.66	24.58 ± 2.95	16.56-33.91
Waist Circumference (cm)	82.03 ± 8.77	61.00-112.00	82.10 ± 8.48	67.00-109.00	81.97 ± 9.04	61.00-112.00
Hip Circumference (cm)	96.01 ± 6.91	80.00-130.60	96.39 ± 7.04	82.00-130.60	95.68 ± 6.80	80.00-120.00
Waist Hip Ratio	0.85 ± 0.05	0.68-1.03	0.85 ± 0.05	0.68-0.99	0.86 ± 0.05	0.73-1.03
Mid Upper Arm Circumference (cm)	29.99 ± 2.74	23.00-39.00	30.09 ± 2.69	23.00-38.00	29.90 ± 2.79	24.00-39.00
Chest Circumference(cm)	89.49 ± 7.08	6.50-108.00	89.70 ± 5.97	78.00-108.00	89.31 ± 7.95	6.50-106.00
Bicep Skin Fold (mm)	5.55 ± 2.23	2.00-17.20	5.64 ± 2.03	3.00-14.60	5.47 ± 2.41	2.00-17.20
Tricep Skin Fold (mm)	12.7 ± 69.79	2.30-14.04	16.88 ± 101.56	2.40-14.04	9.13 ± 6.26	2.30-64.40
Sub Scapular Skin Fold (mm	15.69 ± 7.73	3.80-53.00	16.23 ± 8.00	3.80-51.30	15.21 ± 7.46	5.40-53.00
Suprailiac Skin Fold (mm)	4.53 ± 2.64	2.20-30.60	4.74 ± 3.04	2.20-30.60	4.35 ± 2.23	2.20-22.00

U: Mann Whitney **U Test**

Table 4.3: Descriptive statistics of anthropometric variables of the whole study population and based on cadre

	Overall (n=402)		Officers (n=189)		Soldiers (n=213)	
Parameters	**mean ± SD**	**Min-Max**	**Min-Max**	**mean ± SD**	**mean ± SD**	**Min-Max**
Right 2D (mm)	72.57 ± 6.20	22.40-94.20	71.83 ± 6.39	22.40-94.20	73.23 ± 5.96	56.42-90.37
Right 4D(mm)	75.05 ± 5.61	61.63-94.67	74.84 ± 4.88	62.17-86.12	75.24 ± 6.19	61.63-94.67
Left 2D(mm)	73.19 ± 5.89	53.92-91.00	72.77 ± 5.54	53.92-91.00	73.56 ± 6.18	54.69-89.57
Left 4D (mm)	75.94 ± 6.90	7.32-92.77	75.37 ± 7.90	7.32-8.94	76.45 ± 5.85	58.10-92.77
Right 2D:4D Ratio	0.97 ± 0.07	0.31-1.19	0.96 ± 0.07	0.31-1.19	0.98 ± 0.06	0.80-1.19
Left 2D:4D Ratio	0.99 ± 0.43	0.71-9.35	1.01 ± 0.62	0.71-9.35	0.96 ± 0.07	0.78-1.26

U: Mann Whitney U Test

Table 4.3: Descriptive statistics of body composition of the whole study population and based on cadre

	Overall (n=402)		Officers (n=189)		Soldiers (n=213)	
Parameters	**mean ± SD**	**Min-Max**	**mean ± SD**	**Min-Max**	**mean ± SD**	**Min-Max**
Body Fat (%)	16.16 ± 5.20	6.22-29.58	16.48 ± 4.86	6.35-28.00	15.87 ± 5.48	6.22-29.58
Fat Mass (kg)	63.68 ± 7.30	48.96-82.25	62.91 ± 7.65	48.96-80.47	64.37 ± 6.91	49.25-82.25
Fat Free Mass (kg)	18.21 ± 12.25	-12.25-56.23	18.89 ± 12.74	-11.51-56.23	17.61 ± 11.80	-12.25-50.75
Mass Index (kgm^{-2})	21.42 ± 3.40	0.00-30.58	21.06 ± 3.83	0.00-29.16	21.74 ± 2.93	14.79-30.58
Fat Free Mass Index (kgm^{-2})	3.32 ± 4.64	-8.59-32.79	3.85 ± 4.88	-7.37-32.79	2.84 ± 4.37	-8.59-16.33

4.2 Comparison of Anthropometric Variables, Aggression and Body Composition between Officers and Soldiers

The comparison of anthropometric variables between officers and soldiers is presented in Table 4.4. The bicep skin fold thickness was statistically significantly higher in the officers than in the Soldiers ($U = 17834.5$, $p = 0.05$). The soldiers on the hand had statistically significantly higher values for R2D and R2D:4D values respectively compared with the officers counterpart ($U = 17824.5$, $p = 0.05$ and $U = 17729.5$, $p = 0.04$ respectively). The other anthropometric variables (weight, height, waist circumference, hip circumference, triceps SF, subscapular SF, supraspinal SF, R4D, L2D, L4D and L2D:4D) were not statistically significantly different between the two groups ($p>0.05$).

Figure 4.5 is a chart comparing components of aggression between officers and soldiers. The soldiers had statistically significantly higher scores for physical aggression compared with the officers ($U = 17371$, $p = 0.02$). The other components of aggression (anger, hostility and verbal aggression) and total aggression were not statistically significantly different between the two groups ($p>0.05$).

Figure 4.6 is a chart comparing body composition between officers and soldiers. The soldiers had statistically significantly higher values for fat mass compared with the officers ($U = 17624.5$, $p = 0.03$). The officers on the hand had statistically significantly higher values for FFMI compared with the soldiers counterpart ($U = 17851$, $p = 0.05$). The other body composition variables (BF%, FMI and FFM were not statistically significantly different between the two groups ($p>0.05$).

Table 4.4: Comparison of anthropometric variables between officers and soldiers

	Officer	Soldier			
Parameters	**Mean Rank**	**Mean Rank**	**U**	**z value**	**p value**
Weight (kg)	206.95	196.67	19099.00	-0.89	0.38
Height (m)	196.39	206.04	19162.50	-0.83	0.41
Body Mass Index (kgm^{-2})	209.57	194.34	18603.00	-1.31	0.19
Waist Circumference (cm)	204.13	199.17	19632.00	-0.43	0.67
Hip Circumference (cm)	205.93	197.57	19291.50	-0.72	0.47
Waist Hip Ratio	198.74	203.95	19607.50	-0.45	0.65
Mid Upper Arm Circumference (cm)	206.62	196.96	19161.00	-0.83	0.40
Chest Circumference(cm)	201.82	201.22	20068.00	-0.05	0.96
Bicep Skin Fold (mm)	213.64	190.73	17834.50	-1.97	0.05
Triceps Skin Fold (mm)	212.81	191.47	17991.50	-1.84	0.07
Subscapular Skin Fold (mm)	208.57	195.23	18792.50	-1.15	0.25
Supraspinal Skin Fold (mm)	209.46	194.44	18624.00	-1.29	0.20
Right 2D (mm)	189.31	212.32	17824.50	-1.98	0.05
Right 4D (mm)	200.20	202.65	19883.00	-0.21	0.83
Left 2D (mm)	193.08	208.97	18537.50	-1.37	0.17

Table 4.4: Comparison of anthropometric variables between officers and soldiers

	Officer	Soldier			
Parameters	Mean Rank	Mean Rank	U	z value	p value
Left 4D (mm)	195.77	206.58	19046.00	-0.93	0.35
Right2D:4D Ratio	188.81	212.76	17729.50	-2.06	0.04
Left 2D:4D Ratio	200.69	202.22	19975.50	-0.13	0.90

U: Mann Whitney U test

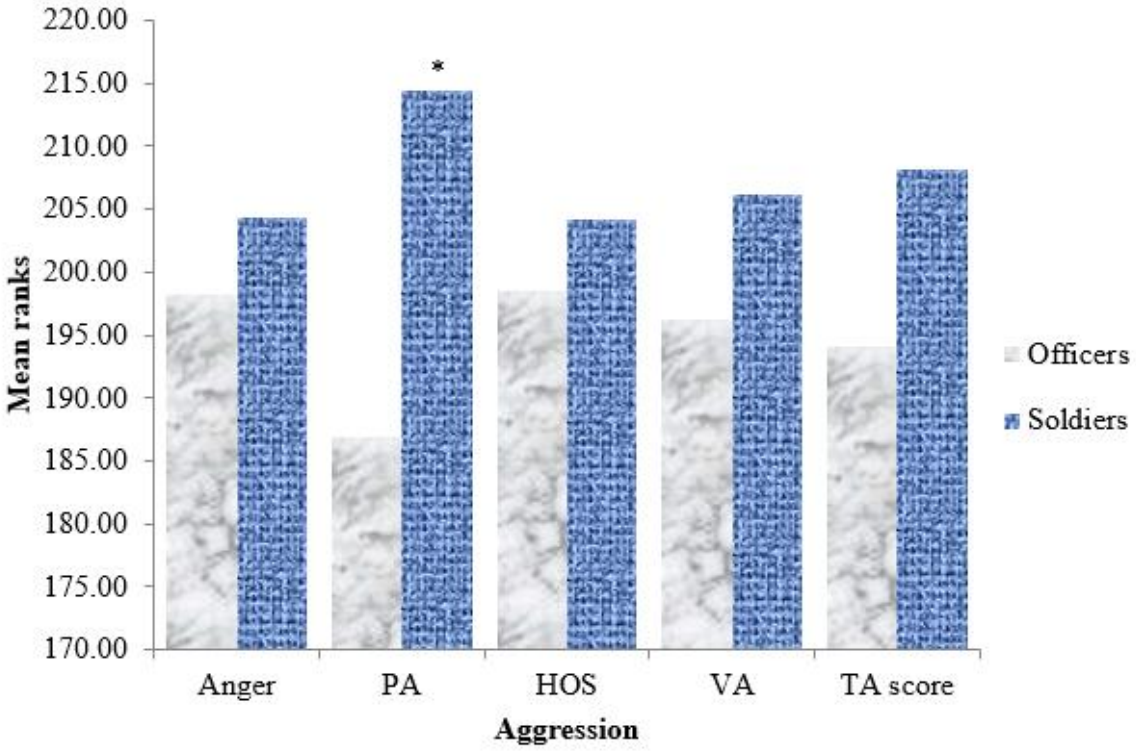


Figure 4.1: Comparison of components of aggression between Officers and Soldiers (*: p<0.05). (PA: Physical aggression; HOS: Hostility; VA: Verbal aggression; TA: Total aggression)

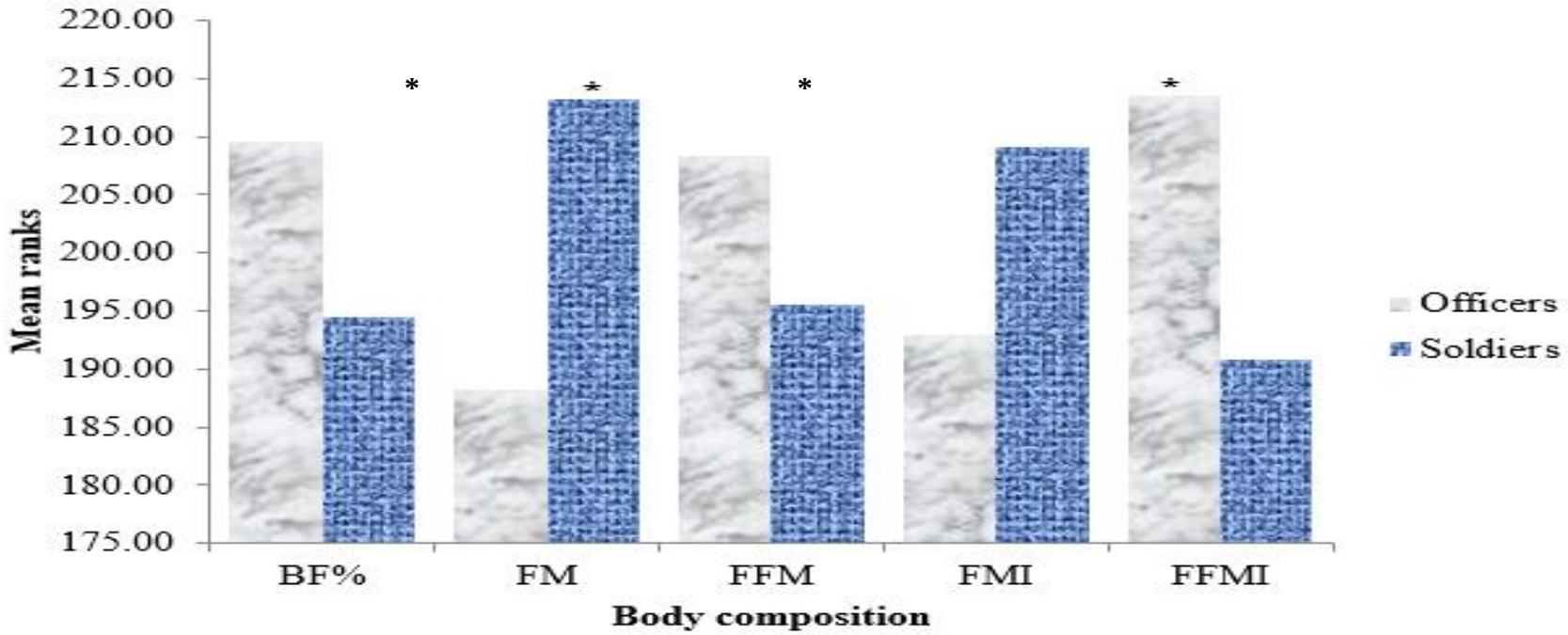


Figure 4.2: Comparison of body composition between Officers and Soldiers (*: p<0.05). (BF: Body fat; FM: Fat mass; FFM: Fat free mass; FMI: Fat mass index; FFMI: Fat free mass index).

4.3 The Influence of Some Socio-Demographic on the Anthropometric Variables, Aggression and Body Composition

Table 4.5 depicts the results of the influence of length of service on the anthropometric variables of military personnel. Weight and MUAC are significantly different between the groups 0-9 and 10-19 years while between groups of 0-9 and >20 years and 10-19 and >20 years, no significant differences were observed. WC, WHR, supraspinal skin fold and R2D were significantly different across the three groups. HC, CC, biceps, triceps and subscapular skin fold were significantly different between the groups 0-9 and 10-19 years and 10-19 and >20 years but no difference was observed between 0-9 and >20 years group. The L2D and L2D:4D were significantly different the groups >20 and 0-9 years and 10-19 and 0-9 years while no difference was observed between >20 and 10-19 years group. In the case of the R2D:4D significant difference was only observed between >20 and 0-9 years group. The height, BMI, R4D and L4D were not significantly different across the three groups ($p>0.05$).

The influence of length of service on the aggression components of Military Personnel is presented in Figure 4.7. The components of aggression were not significantly different across the groups ($p>0.05$).

Fig. 4.4 is a chart showing the influence of length of service on the body composition variables of Military Personnel. BF% was significantly different across the groups. The FM, FFM and FMI were significantly different between the groups 0-9 and 10-19 years and 10-19 and >20 years but no difference was observed between 0-9 and >20 years group. The FFMI was significantly different between the groups 0-9 and 10-19 years while between the groups of 0-9 and >20 years and 10-19 and >20 years, no significant differences were observed.

The influence of cigarette smoking on the anthropometric variables of military personnel is presented in Table 4.6. Non cigarette smokers had statistically significantly higher mean ranks for height, weight, triceps, subscapular and supraspinal skin folds compared with the cigarette smokers ($p<0.05$). On the hand, cigarette smokers had statistically significantly higher mean ranks for R2D and L2D:4D compared with the non cigarette smokers ($p<0.05$). There was no statistically significantly difference in the mean ranks of BMI, WC, HC, WHR, MUAC, CC, bicep skin fold, R4D and R2D:4D between the cigarette smokers and non-cigarette smokers ($p>0.05$).

Fig. 4.5 is a chart showing the influence of cigarette smoking on the aggression components of Military Personnel. There was no statistically significant difference in mean ranks of total aggression and components of aggression between the cigarette smokers and non cigarette smokers ($p>0.05$). Similarly, there was no statistically significantly difference in the mean ranks of body composition variables between the cigarette smokers and non-cigarette smokers ($p>0.05$) (Fig. 4.6).

The influence of alcohol consumption on the anthropometric variables of Military Personnel is presented in Table 4.7. Alcohol drinkers had statistically significantly higher mean ranks for BMI and MUAC compared with the non alcohol drinkers ($p<0.05$). However, there was no statistically significantly difference in the mean ranks of height, weight, biceps, triceps, subscapular and supraspinal skin folds, BMI, WC, HC, WHR, MUAC, CC, R2D, R4D, R2D:4D, L2d, L4D and L2D:4D between the alcohol drinkers and non-alcohol drinkers ($p>0.05$).

Fig. 4.7 is a chart showing the influence of alcohol consumption on the aggression components of Military Personnel. Alcohol drinkers had statistically significantly higher mean ranks for total aggression and components of aggression compared with

the non alcohol drinkers ($p<0.05$). However, there was no statistically significant difference in the mean ranks of body composition variables between the alcohol drinkers and non-alcohol drinkers ($p>0.05$) (Figure 4.8).

Table 4.5: Influence of length of service on the anthropometric variables of Military Personnel

	Length of service					
	0-9 years (n=204)	10-19 years (n=24)	>20 years (n=74)			
Parameters	Mean Rank	Mean Rank	Mean Rank	Chi square	Df	p value
Weight (kg)	186.39[a]	219.42[b]	213.14[ab]	7.15	2.00	0.03
Height (m)	188.28	212.01	220.34	5.62	2.00	0.06
Body Mass Index (kgm^{-2})	193.86	213.51	202.45	2.21	2.00	0.33
Waist Circumference(cm)	161.32[a]	226.85[b]	269.77[c]	55.91	2.00	0.00
Hip Circumference (cm)	175.45[a]	227.10[b]	230.[43bc]	20.90	2.00	0.00
Waist Hip Ratio	161.72[a]	214.08[b]	290.09[c]	68.39	2.00	0.00
Mid Upper Arm Circumference (cm)	184.79[a]	219.79[b]	216.93[ab]	8.63	2.00	0.01
Chest Circumference (cm)	179.81[a,c]	216.05[b,d]	236.91[d]	15.95	2.00	0.00
Bicep Skin Fold (mm)	174.50[a,c]	224.38[b,d]	237.59[d]	22.98	2.00	0.00

Table 4.5: Influence of length of service on the anthropometric variables of Military Personnel

	Length of service					
	0-9 years (n=204)	10-19 years (n=24)	>20 years (n=74)			
Parameters	Mean Rank	Mean Rank	Mean Rank	Chi square	Df	p value
Tricep Skin Fold (mm)	178.24[a,c]	218.28[b,d]	237.52[d]	17.88	2.00	0.00
Subscapular Skin Fold (mm)	178.50[a,c]	217.04[b,d]	238.87[d]	17.87	2.00	0.00
Supraspinal Skin Fold (mm)	169.45[a]	217.68[b]	262.74[c]	38.53	2.00	0.00
Right 2D (mm)	227.57[a]	178.76[b]	167.74[c]	21.27	2.00	0.00
Right 4D (mm)	214.69	189.77	184.80	5.42	2.00	0.07
Left 2D (mm)	227.02[a,c]	179.91[d]	167.32[b,d]	20.52	2.00	0.00
L eft 4D (mm)	205.27	196.73	199.08	0.46	2.00	0.80
Right 2D:4D Ratio	217.83[a]	187.47[a,d]	180.01[d]	8.37	2.00	0.02
Left 2D:4D Ratio	226.22[a,c]	185.55[d,b]	160.09[b]	20.97	2.00	0.00

(a.b.c and d superscripts: Dissimilar superscripts means significantly different from each other while similar superscripts means not different from each other)

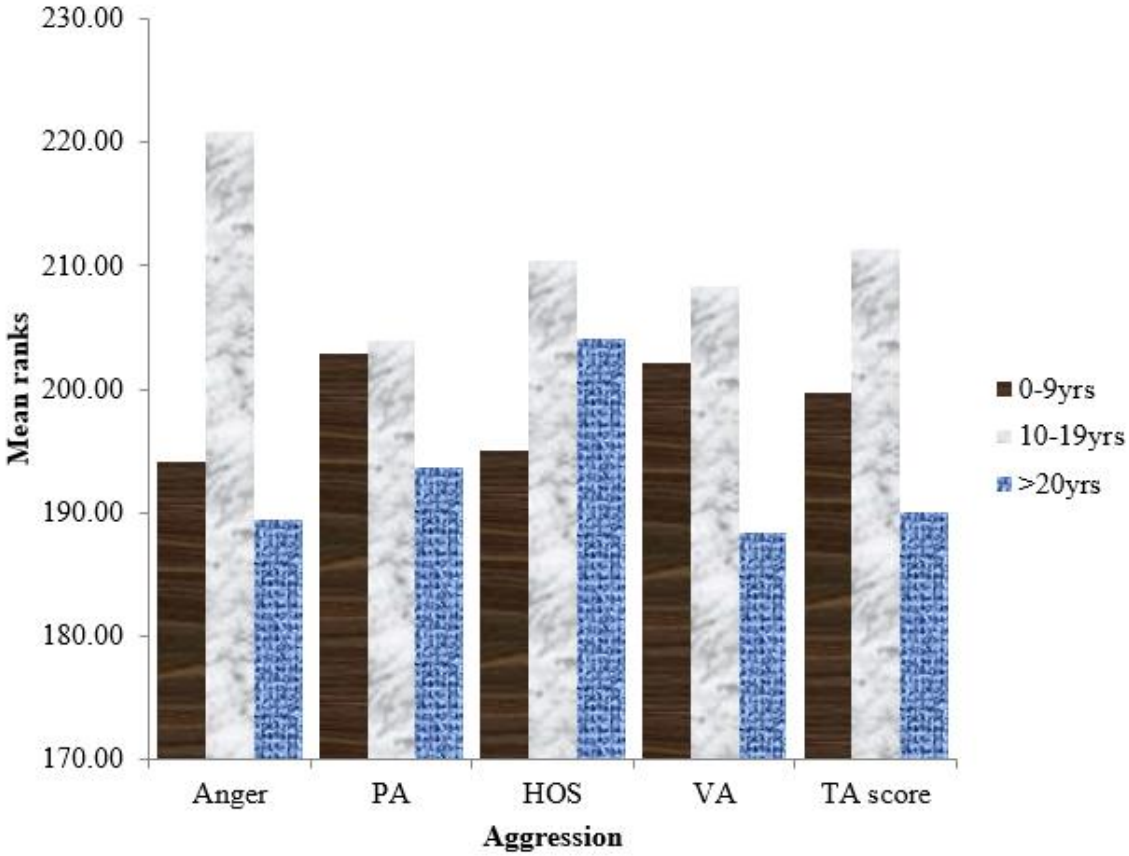


Figure 4.3: Influence of length of service on the aggression components of military personnel

($p>0.05$) (PA: Physical aggression; HOS: Hostility; VA: Verbal aggression; TA: Total aggression)

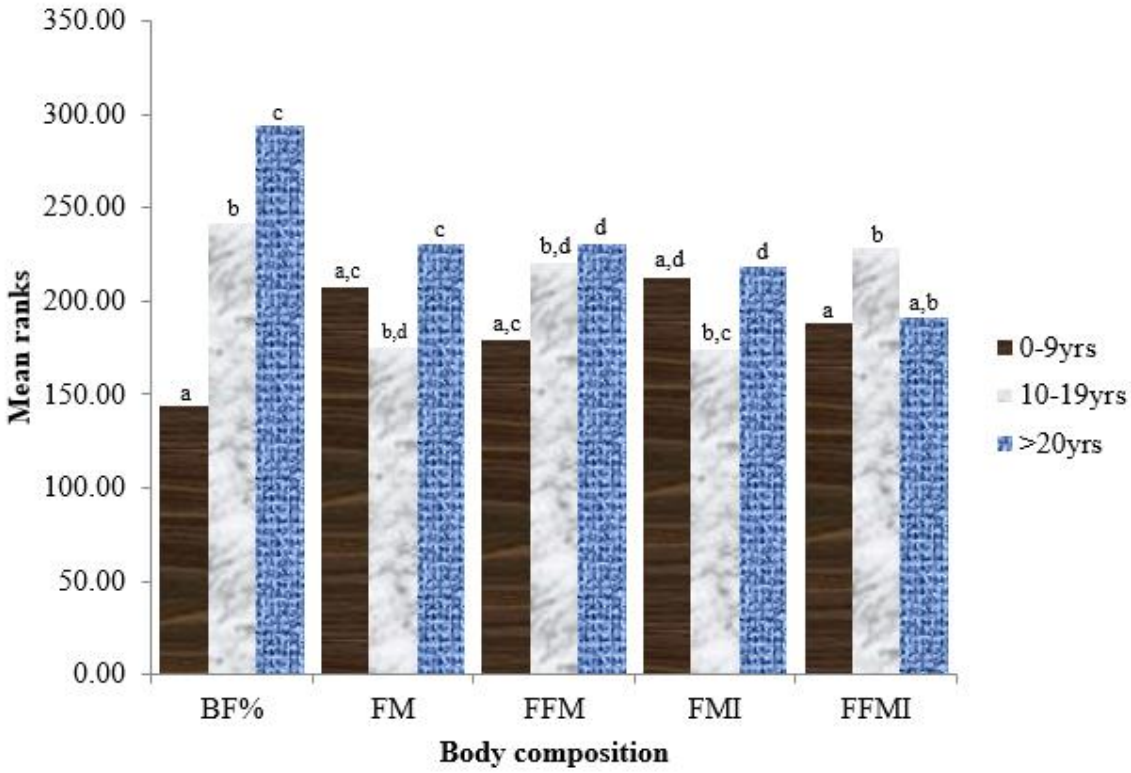


Figure 4.4: Influence of length of service on the body composition variables of military personnel ($p<0.05$)

(a,b,c superscripts: Dissimilar superscripts means significantly different from each other while similar superscripts means not different from each other). (BF: Body fat; FM: Fat mass; FFM: Fat free mass; FMI: Fat mass index; FFMI: Fat free mass index)

Table 4.6: Influence of cigarette smoking on anthropometric variables of military personnel

	Cigarrete smokers (n=34)	Non cigarette smokers (n = 368)			
Parameters	Mean Rank	Mean Rank	U	z value	p value
Weight (kg)	177.85	203.68	5452.00	-1.24	0.21
Height (m)	198.21	201.80	6144.00	-0.17	0.86
Body Mass Index (kgm^{-2})	169.53	204.45	5169.00	-1.68	0.09
Waist Circumference (cm)	154.76	205.82	4667.00	-2.45	0.01
Hip Circumference (cm)	164.40	204.93	4994.50	-1.95	0.05
Waist Hip Ratio	172.53	204.18	5271.00	-1.52	0.13
Mid Upper Arm Circumference (cm)	178.18	203.65	5463.00	-1.23	0.22
Chest Circumference (cm)	174.63	203.98	5342.50	-1.41	0.16
Biceps Skin Fold (mm)	170.90	204.33	5215.50	-1.61	0.11
Triceps Skin Fold (mm)	162.62	205.09	4934.00	-2.04	0.04
SubScapular Skin Fold (mm)	162.62	205.09	4934.00	-2.04	0.04
Supraspinal Skin Fold (mm)	154.37	205.85	4653.50	-2.47	0.01
Right 2D (mm)	239.35	198.00	4969.00	-1.99	0.05
Right 4D (mm)	216.84	200.08	5734.50	-0.80	0.42
Left 2D (mm)	232.18	198.67	5213.00	-1.61	0.11
Left 4D (mm)	204.49	201.22	6154.50	-0.16	0.88
Right 2D:4D Ratio	226.19	199.22	5416.50	-1.30	0.20
Left 2D:4D Ratio	240.44	197.90	4932.00	-2.04	0.04

U: Mann-Whitney U test

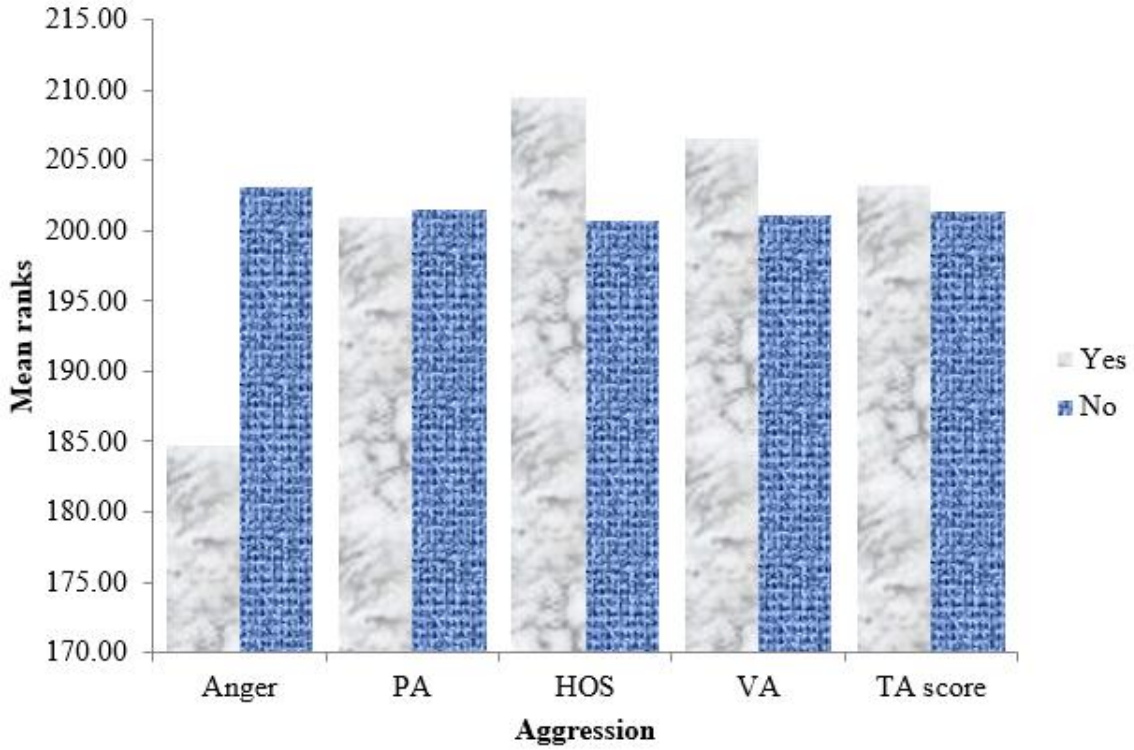


Figure 4.5: Influence of cigarette smoking on the aggression components of military personnel (p>0.05).
(PA: Physical aggression; HOS: Hostility; VA: Verbal aggression; TA: Total aggression; Yes: Cigarrete smokers; No: Non cigarette smokers)

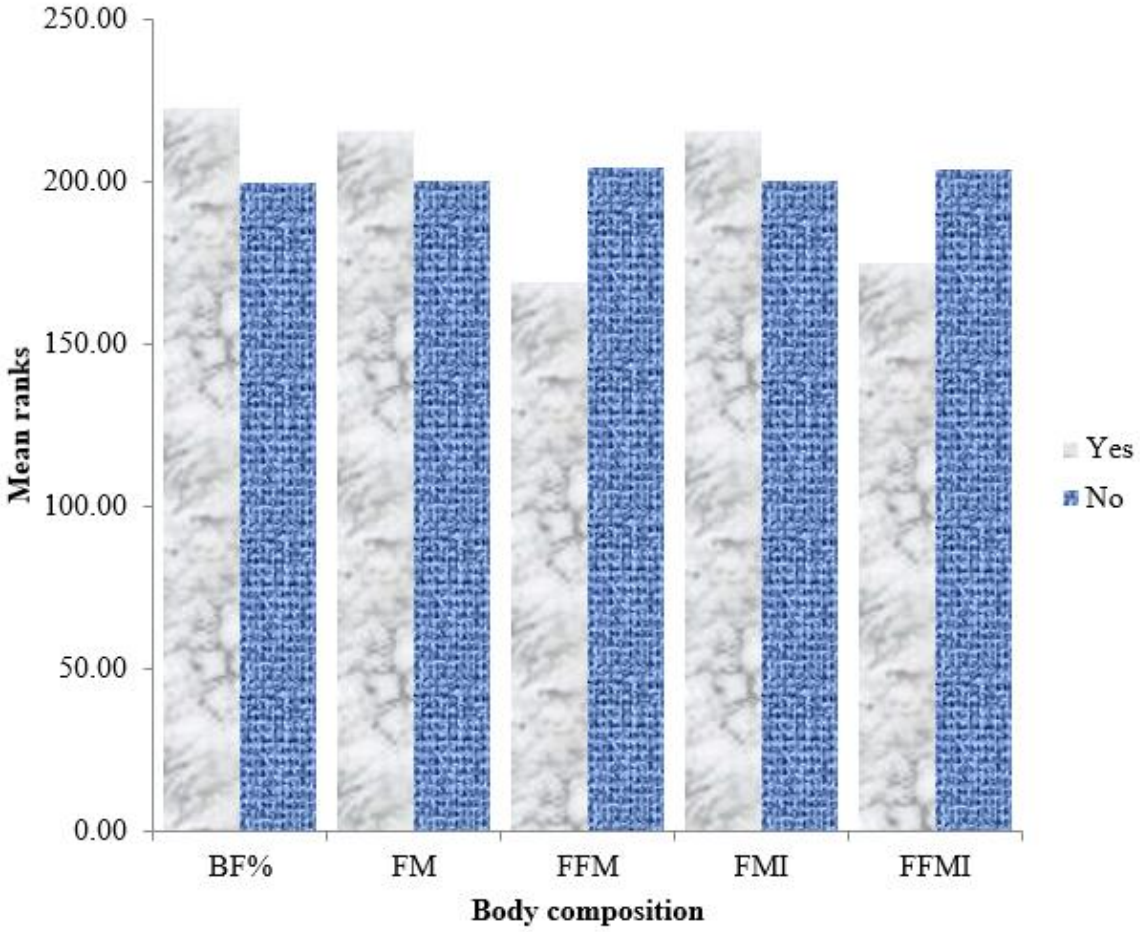
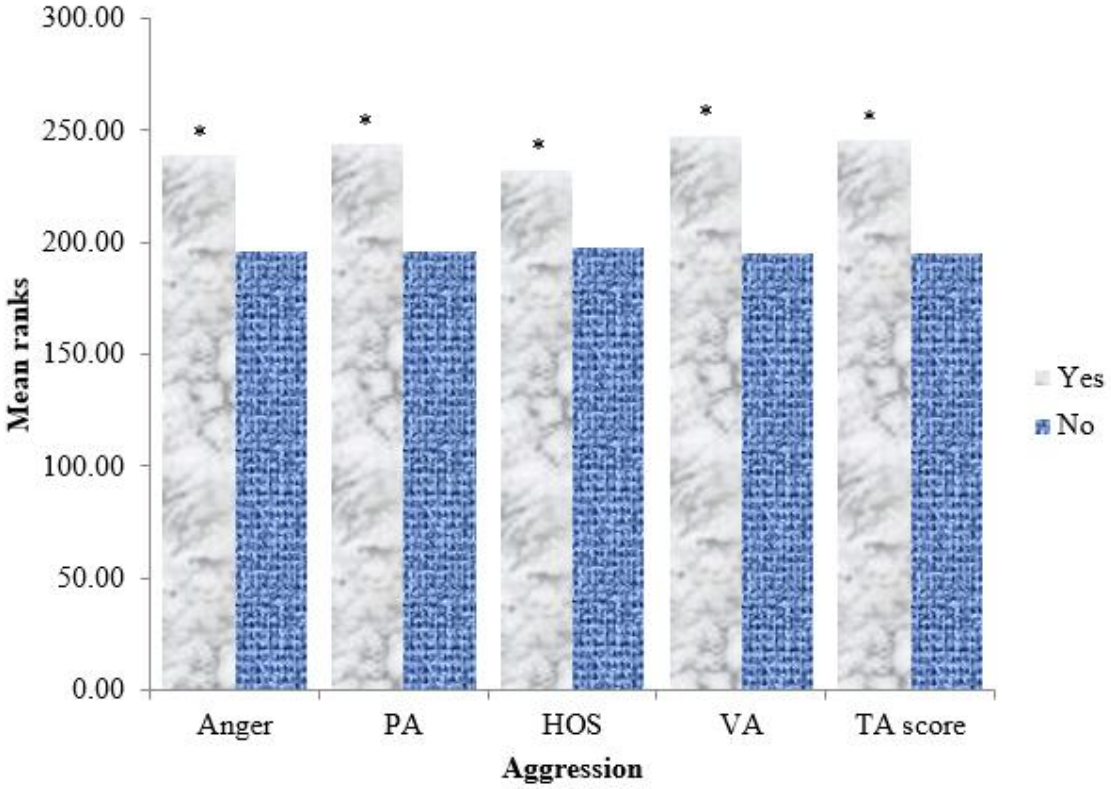


Figure 4.6: Influence of cigarette smoking on the body composition variables of military personnel (p>0.05).
(BF: Body fat; FM: Fat mass; FFM: Fat free mass; FMI: Fat mass index; FFMI: Fat free mass index; Yes: Cigarrete smokers; No: Non cigarette smokers)

Table 4.7: Influence of alcohol consumption on the anthropometric variables of military personnel

	Alcohol drinkers (n=48)	Non-alcohol drinkers (n=354)			
Parameters	Mean Rank	Mean Rank	U	z value	p value
Weight (kg)	222.71	198.62	7478.00	-1.35	0.18
Height (m)	179.77	204.45	7453.00	-1.38	0.17
Body Mass Index (kgm^{-2})	234.31	197.05	6921.00	-2.08	0.04
Waist Circumference (cm)	225.80	198.20	7329.50	-1.55	0.12
Hip Circumference (cm)	229.25	197.74	7164.00	-1.76	0.08
Waist Hip Ratio	217.29	199.36	7738.00	-1.00	0.32
Mid Upper Arm Circumference (cm)	239.76	196.31	6659.50	-2.44	0.01
Chest Circumference (cm)	229.70	197.68	7142.50	-1.79	0.07
Bicep Skin Fold (mm)	219.61	199.04	7626.50	-1.15	0.25
Triceps Skin Fold (mm)	218.78	199.16	7666.50	-1.10	0.27
Subscapular Skin Fold (mm)	226.32	198.13	7304.50	-1.58	0.11
Supraspinal Skin Fold (mm)	184.33	203.83	7672.00	-1.09	0.28
Right 2D (mm)	207.26	200.72	8219.50	-0.37	0.71
Right 4D (mm)	195.77	202.28	8221.00	-0.36	0.72
Left 2D (mm)	201.43	201.51	8492.50	0.00	1.00
Left 4D (mm)	175.69	205.00	7257.00	-1.64	0.10
Right 2D:4D Ratio	216.00	199.53	7800.00	-0.92	0.36
Left 2D:4D Ratio	228.42	197.85	7204.00	-1.71	0.09

U: Mann Whitney U test



\Figure 4.7: Influence of alcohol consumptionon the aggression components of Military Personnel

(*: p<0.05) (PA: Physical aggression; HOS: Hostility; VA: Verbal aggression; TA: Total aggression; Yes: Alcohol drinkers; No: Non alcohol drinkers)

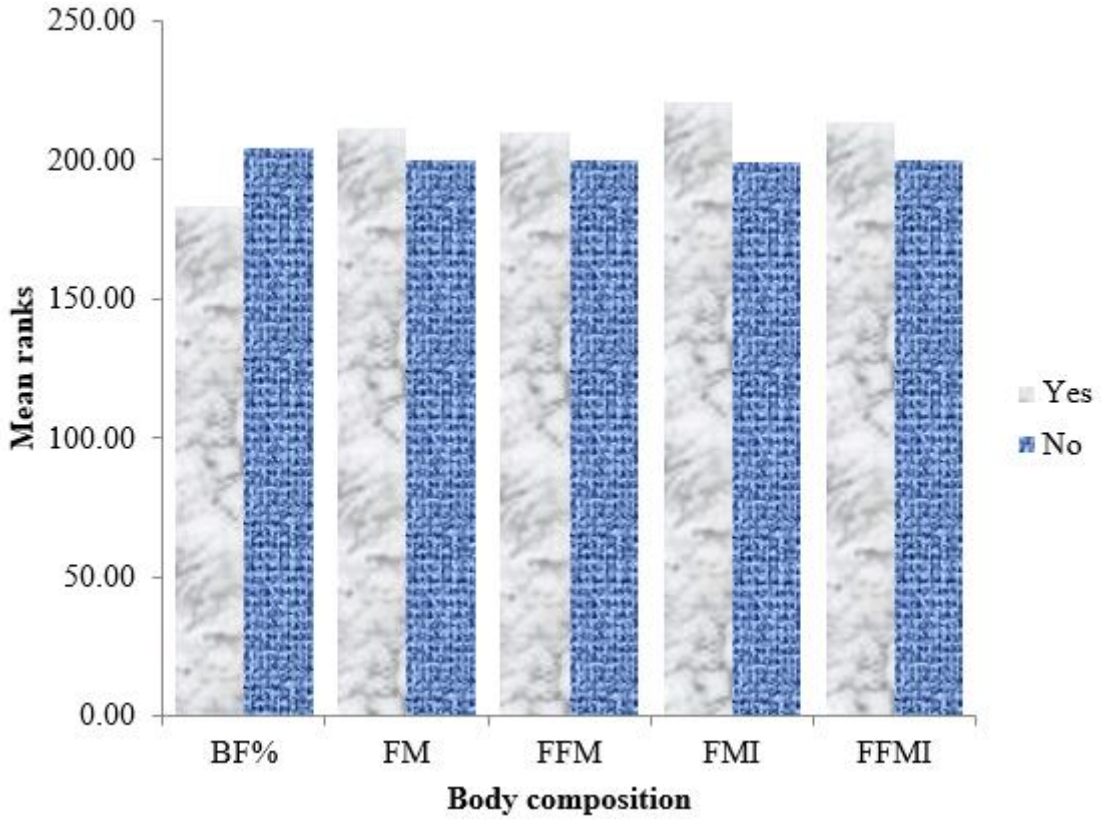


Figure 4.8: Influence of alcohol consumptionon the body composition variables of military personnel (p>0.05).
(BF: Body fat; FM: Fat mass; FFM: Fat free mass; FMI: Fat mass index; FFMI: Fat free mass index; Yes: Alcohol drinkers; No: Non alcohol drinkers)

4.4 Discrimination between Officers and Soldiers using Anthropometric and Body Composition Variables

Table 4.7: Four variables entered into the stepwise discriminant function analysis, i.e., R2D, FFMI, WHR and Height.The Wilks' Lambda was decreasing as more variables were added to the equation and a p-value of <0.0001 indicates that all the steps can discriminate between the officers and soldiers significantly more than by chance. For the equation below the table, it could be inferred that a value of -0.014 or greater obtained using the equation indicates Soldiers, whereas a value less than -0.014 indicates the officers.

Table 4.8: This analysis proved effective in the identification of military cadres, with overall accuracy being 59.5%, in which 62% of Soldiers and 56.6% of officers were correctly classified. The officers had the highest level of misclassification (48.4%) compared with the Soldiers (38%).

Table 4.8: Stepwise discriminant function analyses for the discrimination between officers and soldiers

Steps	Selected variables	Exact F	Wilks' Lambda	p-value	Group centroid	Sectioning point
1	R2D	5.218	0.987	<0.001	0.222^{S}	-0.014
2	R2D, FFMI	6.038	0.971	<0.001	-0.250^{O}	
3	R2D, FFMI, WHR	5.687	0.959	<0.001		
4	R2D, FFMI, WHR, Height	5.543	0.947	<0.001		

R: Right; D: Digit; FFMI: Fat free mass index; WHR: Waist hip ratio; S: Soldier; O: Officer

Cadre = -16.713+R2D (0.118) + FFMI (-0.170) + WHR (10.303) + Height (-0.034) (Soldier ≥-0.014 < Officer)

Table 4.9: Classification summary of military cadre discrimination using R2D, FFMI, WHR and Height

		Predicted Group Membership		
		Soldier	Officer	Overall accuracy
Percentage	Soldier	62.0%	38.0%	59.5%
	Officer	43.4%	56.6%	

4.5. Relationship between 2D:4D Ratio and Anthropometric Variables, Body Composition and Aggression

The relationship between 2D:4D ratio and aggression, anthropometric variables, and body composition of the general study population is presented in table 4.9. Verbal aggression, R2D and L2D were statistically significantly positively correlated with both R2D:4D and L2D:4D ($p<0.05$). The WC, WHR, FFM, biceps and subscapular skinfold were statistically significantly negatively correlated with L2D:4D only ($p<0.05$). Supraspinal skinfold, R4D, L4D, BF% was statistically significantly negatively correlated with both R2D:4D and L2D:4D ($p<0.05$).

Table 4.9 presents the results of the relationship between 2D:4D ratio and aggression, anthropometric variables, and body composition of the Officers and Soldiers. In the soldiers physical aggression, verbal aggression, total aggression and R4D were statistically significantly positively correlated with both R2D:4D and L2D:4D ($p<0.05$) but anger was only significantly positive correlated with R2D:4D ($p<0.05$). The WC, WHR, BF% and supraspinal skin fold in the Soldiers significantly negative correlated with both R2D:4D and L2D:4D ($p<0.05$). Also, in the Soldiers the CC, FFM, biceps and subscapular skin fold statistically significantly negatively correlated with only ($p<0.05$). The L4D demonstrated statistically significantly positive correlation with only L2D:4D ($p<0.05$).

On the hand, in the officers, the components of aggression and body composition did not show significant correlations with the digit ratios ($p>0.05$). The weight demonstrated statistically significantly positive correlation with only R2D:4D ($p<0.05$). Also, supraspinal skinfold, R2D, L2D, R4D and L4D were significantly positive correlated with both R2D:4D and L2D:4D ($p<0.05$).

Table 4.10: Relationship between 2D:4D Ratio and Aggression, Anthropometric Variables, and Body Composition of the Whole Study Population

Parameters	R2D:4D	L2D:4D
Components of Aggression		
Anger Score	0.049	0.033
Physical Aggression Score	0.084	0.095
Hostility Score	0.043	0.033
Verbal Aggression Score	0.108*	0.110*
Total Aggression score	0.070	0.074
Anthropometric Variables		
Weight (kg)	0.074	0.039
Height (m)	0.011	0.023
Body Mass Index (kgm^{-2})	0.076	0.024
Waist Circumference (cm)	-0.094	-0.178**
Hip Circumference (cm)	-0.038	-0.091
Waist Hip Ratio	-0.097	-0.179**
M id Upper Arm Circumference (cm)	-0.020	-0.065
Chest Circumference (cm)	0.020	-0.057
Bicep Skin Fold (mm)	-0.047	-0.122*
Tricep Skin Fold (mm)	-0.035	-0.058
Subscapular Skin Fold (mm)	-0.058	-0.131**
Supraspinal Skin Fold (mm)	-0.194**	-0.197**
Right hand 2 digit (mm)	0.398**	0.345**
Right hand 4 digit (mm)	-0.358**	-0.151**
Left hand 2 digit (mm)	0.288**	0.469**
Left hand 4 digit (mm)	-0.241**	-0.329**
Body Composition Variables		
Body Fat (%)	-0.177**	-0.186**
Fat Mass (kg)	0.013	0.002
Fat Free Mass (kg)	-0.020	-0.136**
Fat Mass Index	0.004	-0.019
Fat Free Mass Index	0.053	0.031

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.11: Relationship between 2D:4D ratio and aggression, anthropometric variables, and body composition of the Officers and Soldiers

	Officers		Soldiers	
Parameters	R2D:4D	L2D:4D	R2D:4D	L2D:4D
Components of Aggression				
Anger Score	-0.070	-0.059	0.145*	0.113
Physical Aggression Score	-0.048	0.040	0.175*	0.147*
Hostility Score	-0.068	0.001	0.131	0.064
Verbal Aggression Score	-0.035	0.004	0.206**	0.198**
Total Aggression score	-0.072	-0.006	0.171*	0.140*
Anthropometric Variables				
Weight (kg)	0.163*	0.101	0.001	-0.016
Height (m)	0.044	0.052	-0.035	-0.001
Body Mass Index (kgm^{-2})	0.127	0.061	0.040	-0.013
Waist Circumference (cm)	-0.037	-0.095	-0.138*	-0.250**
Hip Circumference (cm)	-0.019	-0.033	-0.042	-0.140*
Waist Hip Ratio	-0.034	-0.116	-0.156*	-0.235**
Mid Upper Arm Circumference (cm)	0.037	0.006	-0.063	-0.130
Chest Circumference (cm)	0.108	0.032	-0.058	-0.144*
Bicep Skin Fold (mm)	-0.018	-0.100	-0.048	-0.136*
Tricep Skin Fold (mm)	-0.020	-0.027	-0.024	-0.087
Subscapular Skin Fold (mm)	-0.036	-0.087	-0.069	-0.174*
Supraspinal Skin Fold (mm)	-0.198**	-0.145*	-0.173*	-0.242**
Right hand 2 digit (mm)	0.451**	0.267**	0.347**	0.406**
Right hand 4 digit (mm)	-0.336**	-0.226**	-0.382**	-0.103
Left hand 2 digit (mm)	0.323**	0.427**	0.245**	0.487**
Left hand 4 digit (mm)	-0.191**	-0.391**	-0.293**	-0.278**
Body Composition Variables				
Body Fat (%)	-0.083	-0.119	-0.232**	-0.235**
Fat Mass (kg)	0.019	-0.031	-0.009	0.043
Fat Free Mass (kg)	0.039	-0.052	-0.074	-0.213**
Fat Mass Index (Kgm^{-2})	-0.038	-0.089	0.028	0.037
Fat Free Mass Index (Kgm^{-2})	0.107	0.087	0.012	-0.024

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

CHAPTER FIVE

5.0 DISCUSSION

Jellife (1996) reported that the biceps and triceps skin fold thickness can serve as an indicator of nutritional status in man. Therefore, any decline in these skin fold thicknesses may be translated as a decrease in subcutaneous fat and these could mean reduced energy intake, as fat content is dependent on nutritional intake and energy expenditure of the individual (Borkan & Norris, 1980). In the present study, the Officers had significantly higher mean values for bicep skin fold compared with the Soldiers. The disparity in the value of the skinfold thickness in the officers and soldiers could be attributed to the different socio-economic status of the two cadres of the military personnels under study. The officers generally belong to the high socio-economic ladder in the profession i.e., they typically supervise soldiers and do not routinely perform physical labour and high physical exertion have been shown to reduce skinfold thickness (Bhardwaj & Kopoor, 2007).

Variation in finger length ratio is thought to reflect the influence of prenatal testosterone during development (Manning, 2002a; Manning *et al.,* 2003a). While this correlation is somewhat conjectural, two non-exclusive causes have been posited. The first is that common genes (*Hox a* and *Hox d*) underlie development of both fingers and gonads (Kondo *et al.,* 1997; Peichel *et al.,* 1997). The second is that allelic variation in androgen receptor sensitivity influences digit ratio. More masculine finger ratios are associated with androgen receptor alleles with fewer CAG base-pair microsatellite repeats in the terminal domain (Manning *et al.,* 2003a). Increased number of such repeats produces receptors with lower androgen sensitivity (Chamberlain *et al.,* 1994; Kazemi-Esfarjani *et al.,* 1995).

Digit ratio has consistently been shown to be more dimorphic on the right hand than on the left in humans (Manning *et al.,* 1998; Williams *et al.,* 2000; McFadden and Shubel, 2002), baboons (McFadden and Bracht, 2003) mice (Brown *et al.,* 2002b), and finches (Burley and Foster, 2004). Several authors have suggested that androgenization affects the right hand more than the left (Williams *et al.,* 2000; McFadden and Shubel, 2002; Brown *et al.,* 2002b). When both right and left hand digit ratios have been used to investigate relationships between digit ratio and psychological factors, stronger effects are seen on the right hand, or found on the right hand only (Williams *et al.,* 2000; Brown *et al.,* 2002a; Csatho *et al.,* 2003a, 2003b). Also, several studies have linked lower 2D:4D ratio with greater physical ability and strength, better sporting performance and a propensity toward jobs demanding greater physical ability (Manning, 2002; Honekopp *et al.,* 2006; Longman *et al.,* 2011).

In the present study only R2D and R2D:4D ratio showed significant differences between the officers and soldiers. An unexpected trend in the digit ratios (R2D:4D) with the officers having significantly lower values than the soldiers was observed though soldiers undergo more physical activity which is in contrast to the work of (Manning *et al.,* 2002; Longman *et al.,*2011). Even though the officers belong to a high social ranking they also do perform physical labour when operationally required to do so e.g. the current boko haram insurgency in the country have witnessed top ranking officers at the war fronts. This gallant act by the officers in the Nigerian military is a testimony of their high level of involvement in strenuous and rigorous physical activity and this might be a possible explanation to the trend observed and this is in line to the work of Manning and Taylor, 2001 whom reported that 2D:4D ratio to be negatively correlated to physical performance in males

The soldiers were found to be more physically aggressive compared with the officers in the present study. Similar to our finding is the work of Russell and Arms (1995) and Harris and Knight-Bohnhoe (1996) who both concluded from their study on the American soldiers that lower ranking military personnels were more physically aggressive when compared with the high ranking military personnels. The higher physical aggression might be related to the socio-economic and professional status (Greitmeyer, and Sagioglou, 2016) which might be the reason why soldiers in the military profession are more aggressive than the military soldiers.

In the present study, the officers were observed to be having a lower measurement for the fat mass and a higher value for FFMI compared with the soldiers counterpart. The observed trend was not as expected since soldiers in Nigeria are involved more in strenuous exercises than the military officers. Inverse relationships were found for all measures of body size and composition and all physical activity indices (Lowman *et al.*, 2006). Mathur and Salokun (1985) have attributed relatively low FM to be fundamental to excellence and performance in various sporting activities. However, significant differences were not observed in the other body composition variables between the officers and soldiers. Reasons for this observation are not fully understood, but both similar standard of living and physical activity between the groups may offer potential explanations. To the best of our knowledge, there are no documented literatures to compare with the present study.

With regards to the effect of length of service on the anthropometric variables, weight, WC, HC WHR, MUAC, CC, skin fold thicknesses and digit ratios were found to be significantly different based on the length of service i.e. were generally increasing with the duration of stay of military personnels in service. This trend could be attributed to

the increasing level of welfare and social class of the military men as they further climb the ladder of the profession with advancing length of stay in service. Varney *et al.* (2009) reported that increase in socioeconomic status is positively related to increased markers for obesity, weight, BMI, WC.

The long-term overall implication of this trend is a reduction in their physical stamina and an increase propensity to develop cardiovascular and metabolic diseases. To buttress this point Kaufman *et al.* (2000) and Henderson *et al.* (2000) asserted that most of the injuries and damages which occurred during military trainings happened to those who suffered from unfit body dimensions and their resultant mismatch with tools and equipment.

In the present study, irrespective of the duration of stay of military men in service the aggression components were not affected. The reason for this is not clear but social equity or egalitarianism in the Nigerian military force could be a possible explanation. To the best of the author's knowledge; there are no previous documented reports to compare with the present findings. However, body composition was observed to be significantly influenced by the length of stay of military men in service. A general increasing trend was observed with increasing length of stay as well as age indirectly while in service. Zamboni *et al.* (2003) reported that the body composition of human changes with advancing age. In males FM is maintained into the fifth decade of life but then begin to lose muscle mass due to both hormonal changes and decline in activity levels (Pichard *et al.,* 2000). Such changes continue into old age but are strongly influenced by the quality of the environment (Visser *et al.,* 2003). The significantly increasing trend in BF% is a harbinger of various forms of cardiovascular and metabolic diseases.

Recent studies have suggested that cigarette smoking increases abdominal obesity and visceral adiposity tissue (VAT) (Jee *et al.,* 2002; Bamia *et al.,* 2004; Canoy *et al.,* 2005) and VAT is influenced by the cortisol concentration (Pasquali and Vicennati, 2000). Smokers were shown to have higher fasting plasma cortisol concentrations than did nonsmokers (Cryer *et al.*, 1976). Higher cortisol concentrations could be a consequence of the stimulation of sympathetic nervous system activity that is induced by smoking (Williamson *et al.,* 1991; Yoshida *et al*., 1999). In other situations, a lack of estrogens and an excess of androgens was associated with VAT accumulation in women (Evan *et al.,* 1983), and testosterone administration in women was followed by an increase in VAT mass (Elbers *et al.,* 1997). Female smokers showed no change in absolute estrogen concentrations but had higher androgen concentrations (Khaw *et al.,* 1988) and a lower bioavailability of estrogens (Michnovicz *et al.,* 1986) than did female nonsmokers. Testosterone concentrations may also be affected by smoking, although the data are inconsistent (Vermeulen *et al.,* 1999). In men, VAT increased when testosterone concentrations decreased (Vermeulen *et al.,* 1999), and testosterone administration in middle-aged men reduced VAT by increasing lipolysis (Maseroli *et al*., 2020). Smoking may reduce testosterone concentrations in men (Meikle *et al.,* 1988). In male dogs, smoking induced a large reduction in serum testosterone concentrations (Mittler *et al.,* 1983). Overall, these results suggest that, in addition to excess cortisol, an imbalance between male and female sex hormones in females and a decrease in testosterone in males could play a role in the effect of smoking on VAT.

The present study revealed that non-smokers had significantly high values for the WC, HC and skin fold thickness when compared with the smokers. The observed trend is incongruous with the aforementioned patterns and possible reason could be linked to the lopsidedness of the study population (smokers (34) vs non-smokers (368). Also,

contrary to previously mentioned findings, body composition was not significantly affected by cigarette smoking. Gross imbalance in the number of smokers and non smokers could also be a reason for this result. With regards to the effect of cigarette smoking on aggression no significant effect was detected in the present study.

Alcohol consumption was found to have significant impact on aggression in the present study. The alcohol–aggression relationship is exceedingly complex, as evidenced by myriad moderat-ing variables and various putative mechanisms by which aggression is facilitated in at-risk individuals and/or situations. Alcohol myopia theory has now garnered ample empirical support (Giancola *et al.,* 2010). Laboratory data suggest that alcohol use increases or decreases aggression depending on whether attention is manipulated toward cues that promote (e.g., provocation) or inhibit (e.g., non-aggressive norms) aggression, respectively. For instance, distraction from provocative cues reduces physical aggression among intoxicated men (Giancola and Corman, 2007; Gallagher & Parrott, 2011). Meta-analytic reviews evidence smaller effect sizes of alcohol on aggression when participants are distracted (Bushman & Cooper, 1990). Cross-sectional studies suggest that heavy drinking is associated with aggression primarily among hostile individuals who endorse dispositional tendencies towards aggression-related cognitive biases (Leonard and Blane, 1992) or who are susceptible to alcohol-related shifts in attention toward provocative cues (Gallagher *et al.,* 2010). Accordingly, prior research has demonstrated that individuals at risk for aggression show attentional biases towards aggression- relevant contextual stimuli (Eckhardt & Cohen, 1997; Smith & Waterman, 2004). It therefore follows from alcohol myopia Theory that alcohol use may potentiate aggression by narrowing attention onto salient, provocative cues. However, individuals surely differ in what they perceive to be salient as well as in their dominant response to a given salient cue. Thus, this putative

mechanism is posited to be especially relevant in high-risk individuals. While prior research has examined the moderating effects of information processing biases (Ganiocola, 2004), the mediational attention allocation hypothesis assumed to underlie the alcohol–aggression association has received scant empirical attention (Gallagher & Parrott, 2011).

The previous studies have shown that alcohol ingestion affects the body composition (Addorato *et al.,* 1997; Molina *et al.,* 2003; Jin *et al.,* 2011; Martin-Gonzalez *et al.,* 2011). The possible pathways alcohol consumption alters the body composition include: increasing abdominal fat by increasing cortisol secretion via non-alcohol dehydrogenase pathway or microsomal ethanol oxidizing system and decreasing the body system capability to oxidize lipids. However, in the present study alcohol consumption did not have significant effect on the body composition variables. Possible reasons could be ascribed to genetics, physical activity, type and quantity of alcohol consumed and gross disproportion in the number of alcohol and non-alcohol drinkers.

In the present study, on using all the anthropometric and body composition variables; four variables entered into the stepwise discriminant function analysis, i.e., R2D, FFMI, WHR and height. The overall classification accuracy was 59.5%, with around 62% of soldiers and 56.6% of officers correctly classified. No other study related to anthropometric and body composition parameters of military men exists for us to compare our findings, and we believe that anthropometric and body composition parameters may have the potential to serve as an adjunct for discrimination of military cadres in forensic/screening scenarios along with other routinely used methods. Nevertheless, it is well-known fact that anthropological attributes vary among different populations, thus necessitating specific standards of assessment for each population.

In accord with previous studies (Neave *et al.,* 2003; Vehmas *et al.,* 2006; Danbarno *et al.,* 2007) on the relationship between 2D:4D and height, weight, BMI, HC, MUAC and CC, the present study also investigated the same phenomena in this Nigerian population and did not also find significant relationship between these variables for the total sample. However, some studies documented either a positive relationship between 2D:4D and height, weight and BMI-heavier males tended to have a lower digit ratio (Dongen, 2009; Almasry *et al.,* 2011) or a negative impact of pre-natal testosterone on body mass-heavier males had a higher digit ratio (Fink *et al.,* 2003). Such discrepancies between our results and some of the previous findings may occur because of inter-population variation in nutritional and behavioural factors that influences body composition and size throughout the lifespan. Moreover, pre-natal testosterone concentration is more likely to influence birth size and body size in childhood (due to the shorter period of time elapsing since pre-natal exposure) than body size in adulthood, when many different factors have been influencing growth. This is exactly the pattern that we observed in the studied population. It is also likely that in adults other traits are better markers of adult body composition than body weight or BMI. For example, 2D:4D correlated with waist-to-hip ratio (Manning, 2002) and hand grip strength (a proxy of muscular strength) (Fink *et al.,* 2006; Zhao *et al.,* 2012) among males and with waist-to-chest ratio (Fink *et al.,* 2003) among females. Also, on the relationship between digit ratios and WC, triceps, subscapular and supraspinal skinfold a significant negative correlation were observed in the present work. The works of Tester and Campbell (2007) and Hurt and van Anders (2006) are in agreement with our finding.

A positive correlation was observed in the present study between digit ratio and verbal aggression for the whole study sample while no relationship was seen with physical

aggression, hostility, anger and total aggression. This finding suggests that digit ratio may be a determining factor for verbal aggression in the whole military personnel. In contrast with our finding Austin *et al.* (2002); Bailey and Hurd, (2005b) and Dogan *et al.* (2008) reported positive correlations between digit ratio and physical aggression only. The discrepancies between the studies could be related to social differences in the population samples and genetics. Soldiers in the present study had a high digit ratio and consequently high scores for physical aggression, verbal aggression, anger and total aggression. This finding implies that digit ratio may be a determining factor for physical, verbal and total aggression in the soldiers only. On the hand, these relationships were absent in the officers as such digit ratio is not a determining factor for aggression in the officers. Genetics and social class disparity may offer some potential explanation.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

There were notable differences in some of the anthropometric parameters, body composition and physical aggression between the soldiers and officers. Also, length of stay of military men in service, cigarette smoking and alcohol consumption showed varying effects on the anthropometric parameters, body composition and aggression components. Furthermore, this study also revealed that some anthropometric and body composition variables gave a moderate to good (59.5%) military cadre discrimination accuracy, which emphasizes its utility as an adjunct for screening military men in the Jaji Military Cantonment, Kaduna, Nigeria. Lastly, the relationships between 2D:4D and some anthropometric variables, body composition and aggression have been established.

6.2 Recommendations

i. The first valuable database for the anthropometric variable of Military men in Jaji has been generated and emphasis should be made on its usage in the design, sizing, and tariffing of military clothing, protective, and personal equipment and also as a basic input in the human factors engineering of military equipment systems: aircraft, vehicles, tanks, submarines, and many other types of weapons systems.

ii. 2D:4D digit ratio be considered as a potential screening tool for military personnel.

iii. Future studies should consider comparing different military cantonments with a larger sample size in the country and should also be gender sensitive.

iv. Level of physical activity, type and quantity of alcohol consumed as well as pack years of smoking should be taken into cognizance in future studies so as to classify and quantify the varying effects on the body composition, anthropometric variables and aggression.

6.3 Contributions to knowledge

i. The first database for the anthropometric data of military men in Jaji has been demonstrated.

ii. The study demonstrated a significant ($p < 0.05$) positive correlation between digit ratio (R2D:4D and L2D:4D) and verbal aggression ($r = 0.108$, $r = 0.110$ respectively).

iii. Equation for discriminating between soldiers and officers in Jaji Military Cantonment have been generated.

Cadre = - 16.713 + R2D (0.118) + FFMI (-0.170) + WHR (10.303) + Height (-0.034) (Soldier $\geq$ -0.014 < Officer).

REFERENCES

Abaje I.B., Sawa, B.A.M., Iguisi, E.O., Abdulhamid, A.I. (2015). Assessment of rural communities adaptive capacity to climate change in Kaduna State, Nigeria. *Journal of Environmental and Earth Science*, 5(20): 2224-3216.

Addorato, G., Capristo, E., Greco, A.V., Caputo, F., Stefanini, G.F. and Gasbarrrini, G. (1997). Energy expenditure substrate oxidation and body composition in subjects with chronic alcoholism: new findings from metabolic assessment. *Alcohol and Clinical Experiment Research*, 21(6): 962-967.

Aksut, S.V., Aksut, G., Karamehmetoglu, A. and Oram, E. (1986). The determination of serum estradiol, testosterone and progesterone in acute myocardial infarction. *Japanese Heart Journal*, 27: 825-837.

Almasry, S.M., El-Domiaty, M.A., Algaidi, S.A., Yasser M. Elbastawisy, Y.M., and Safwat, M.D. (2011). Index to ring digit ratio in Saudi Arabia at Almadinah Almonawarah province: a direct and indirectmeasurement study. *Journal of Anatomy*, 218: 202-208.

Anders, V.S.M., Vernon, P.A., Wilbur, C.J., and Vernon, W. (2006). Finger-length ratios show evidence of prenatal hormone-transfer between opposite-sex twins. *Hormones and Behaviour*, 49(3): 315-9.

Austin, E.J., Manning, J.T., McInroy, K. and Mathews, E. (2002). A preliminary investigation of the associations between personality, cognitive ability and digit ratio. *Personality and Individual Differences*, 33: 1115-1124.

Bailey, A.A. and Hurd, P.L. (2005a). Finger length ratio (2D:4D) correlates with physical aggression in men but not in women. *Biological Psychology*, 68: 215-222.

Bailey, A.A. and Hurd, P.L. (2005b). Depression in men is associated with more feminine finger length ratios. *Personality and individual differences*, 39: 829-836.

Baker, F. (1888). Anthropological notes on the human hand. *American Anthropologist*, 1: 51-76.

Bamia, A.C., Trichopoulou, D.L. and Trichopoulos, D. (2004). Tobacco smoking in relation to body fat mass and distribution in a general population sample, *International Journal of Obesity*, 28(8): 1091-1096.

Bardin, C.W. and Catterall, J.F. (1981). Testosterone: a major determinant of extragenital sexual dimorphism. *Science*, 211(4488): 1285-94.

Baron-Cohen, S. (2002). The extreme male brain theory of autism. *Trends Cognitive Science*. 6(6): 248-54.

Benderlioglu, Z. and Nelson, R. (2004). Digit length ratios predict reactive aggression in women, but not in men. *Hormones and Behavior,* 46: 558-564.

Berchtold-Kanz, E., Anhut, H., *Held,* R., Neufang, B. *and* Hertting, G. (1981). Regional distribution *of* arachidonic acid metabolites *in* rat brain following convulsive. 319-329.

Berenbaum, S.A., Bryk, K.K., Nowak, N., Quigley, C.A. and Moffat, S. (2009). Fingers as a marker of prenatal androgen exposure. *Endocrinology*, 150 (11): 5119-5124.

Bhardwaj, S. and Kapoor, S. (2007). Nutritional anthropometry and health status: A study among Dhanka tribals of Rajasthan. *Anthropologist,* 9: 211-214.

Bolstad, G., Benum, B. and Rokne, A. (2001). Anthropometry of Norwegian light industry and office workers. *Applied Ergonomics,* 32: 239-246.

Bonadonna, R.C., Groop, L., Kraemer, N., Ferrannini, E., Del Prato, S. and DeFronzo, R.A. (1990). Obesity and insulin resistance in humans: a dose-response study. 39 (5): 452-459.

Borkan, G.A. and Norris, A.H. (1980). Assessment of biological age using a profile of physical parameters. *Journal of Gerontology,* 35: 177-184.

Brown, W.M., Finn, C.J., Bradley, M.C. and Breedlove, S.M. (2002a). Differences in finger length ratios between self-identifies "butch" and "femme" lesbians. *Archives of Sexual Behavior,* 31: 123-127.

Brown, W.M., Finn, C.J. and Breedlove, S.M. (2002b). Sexual dimorphism in digit-length ratios of laboratory mice. *The Anatomical Record,* 267: 231-234.

Brown, M. (2008). Skeletal muscle and bone: effect of sex steroids and aging. *Advances in Physiology Education.* Brown, W. M., Hines, M., Fane, B. A., and Breedlove, S. M. (2002). Masculinized finger length patterns in human males and females with congenital adrenal hyperplasia. *Hormones and Behavior,* 42: 380-386.

Burley, N.T. and Foster, V.S. (2004). Digit ratio varies with sex, egg order, and strength of mate preference in zebrafinches. Proceedings of the Royal Society of London Series B. *Biological Sciences,* 271: 239-244.

Bushman, B.J. and Cooper, H.M. (1990). Effects of alcohol on human aggression: an integrative research review. *Psychology Bulletin,* 107: 341-354.

Buss, A. H. and Perry, M. P. (1992). The aggression questionnaire. *Journal of Personality and Social Psychology*, 63: 452-459.

Butovskaya, M.L., Vasilyev, V.A., Lazebny, O.E., Burkova, V.N., Kulikov, A.M., Mabulla, A. and Ryskov, A.P. (2012). Aggression, digit ratio, and variation in the androgen receptor, serotonin transporter, and dopamine D4 receptor genes in African Foragers: The Hadza. *Behavior genetics, 42*, 647-662.

Cabric, M., Krakowiak, H., Sokołowska, E. and Krakowiak, A. (2012). The 2D:4D ratio versus features of body composition and body constitution in young women and men. *Medical Biological Science,* 26(4): 23-29.

Campbell, A. and Muncer, S. (2008). Intent to harm or injure? Gender and the expression of anger. *Aggressive Behaviour, 34,* 282-93.

Canoy, D., Wareham, N. and Luben, R. (2005). Cigarette smoking and fatdistribution in 21,828 British men and women: a population-based study. *Obesity Research,* 13(8): 1466 -75.

Chamberlain, N.L., Driver, E.D. and Miesfeld, R.L. (1994). The length and location of cag trinucleotide repeats in theandrogen receptor n-terminal domain affect transactional function. *Nucleic Acids Research,* 15: 3181-3186.

Ciumas, C., Linden, H.A. and Savic, I. (2009). High fetal testosterone and sexually dimorphic cerebral networks in females. *Cerebral Cortex,* 19 (5): 1164-72.

Cook, C.J. and Crewther, B.T. (2012). Changes in salivary testosterone concentrations and subsequent voluntary squat performance following the presentation of short video clips. *Hormones and Behavior, 61*, 17-22.

Crabbe, P., Bogaert, V., De Bacquer, D., Goemaere, S., Zmierczak, H., and Kaufman, J. M. (2007). "Part of the interindividual variation in serum testosterone levels in healthy men reflects differences in androgen sensitivity and feedback set point: contribution of the androgen receptor polyglutamine tract polymorphism". *Journal of Clinical of Endocrinological Metabolism,* 92(9): 3604-3610.

Cryer, P.E., Haymond, M.W., Santiago, J.V. and Shah, S.D. (1976). Norepinephrine and epinephrine release and adrenergic mediation of smoking-associatedhemodynamic and metabolic events. *New EnglandJurnal of Medicine,* 295: 573-577.

Csatho, A., Osvath, A., Bicsak, E., Karadi, K., Manning, J. and Kallai, J. (2003a). Sex role identity related to the ratio ofsecond to fourth digit length in women. *Biological Psychology,* 62 (2): 147-156.

Csatho, A., Osvath, A., Karadi, K., Bicsak, E., Manning, J. and Kallai, J. (2003b). Spatial navigation related to the ratioof second to fourth digit length in women. *Learning and Individual Differences,* 13: 239-249.

Dabbs, J.M. and Chang, E. (1998). Spatial ability, navigation strategy, and geographic knowledge among men and women. *Evolution and Human Behavior,* 19(2): 89-98.

Danborno, B., Adebisi, S.S., Adelaiye, A.B. and Ojo, S.A. (2007). Sexual dimorphism and relationship between chest, hip and waist circumference with 2D, 4D and 2D:4D in Nigerians. *The Internet Journal of Biological Anthropology*, 12(2): 127-130.

Danborno, B., Adebisi, S. S., Adelaiye, A. B. and Ojo, S.A. (2010): Relationship between second and fourth digit lengths,digit ratio and aggression in Nigerians. *Journal of Environmental Neuroscience and Biomedicine,* 2: 229-234.

Das, B. and Kozey, J. (1999). Structural anthropometric measurements for wheelchair mobile adults. *Applied Ergonomics,* 30: 385-90.

Del Vecchio1, F.B., Del Vecchio1, A.H.M., Gonçalves, A., Franchini, E. and Padovani, C.R. (2011). The canonical correlation between the biological markers of performance and physical fitness in high level judo athletes. *Physical Education and Sport*, 9: 121-129.

Dickman, S. (1997). HOX gene links limb, genital defects. *Science,* 275(5306): 1568-1569.

Dogan, A., Barut, C., Konuk, N. and Bilge, Y. (2008). Relation of 2D:4D to aggression and anger. *Neurology, Psychiatry and Brain Research*, 14: 151-158.

Dongen, S.V. (2009). Second to fourth digit ratio in relationto age, BMI and life history in a population of youngadults: a set of unexpected results. *Journal of Negative Results - Ecology and Evolutionary. Biology*, 6: 1-7.

Dorr, H. G., and Sippell, W. G. (1993). Prenatal dexamethasone treatment in pregnancies at risk for congenital adrenal hyperplasia due to 21-hydroxylase deficiency: Effect on midgestational amniotic fluid steroid levels. *Journal of Clinical Endocrinological Metabolism.* 76 (1): 117–120.

Driscoll, T. and Ackermann, B. (2012). Applied musculoskeletal assessment: results from a standardised physical assessment in a national population of professional orchestral musicians. *Rheumatology S*, 2: 2161-1149.

Durnin, J.V. and Womersley, J. (1974). Body fat assessed from total body density and its estimation fromskinfold thickness: measurements on 481 men and women aged from 16 to 72 years. *Britain Journal of Nutrition,* 32(1): 77-97.

Ecker, A. (1875). Some remarks about a varying character in the hands of humans. *Archives of Anthropology,* 8: 68-74.

Eckhardt, C.I. and Cohen, D.J. (1997). Attention to anger-relevant and irrelevant stimuli following naturalistic insult. *Personality of Individual Differences,* 23: 619-629.

Elbers, J.M., Asscheman, H., Seidell, J.C., Megens, J.A. and Gooren, L.J. (1997). Longterm testosterone administration increases visceral fat in female to maletranssexuals. *Journal of Clinical Endocrinology and Metabolism,* 82: 2044-7.

English, K.M., Mandour, O., Steeds, R.P., Diver, M.J., Jones, T.H. and Channer, K.S. (2000). Men with coronary artery disease have lower levels of androgens than men with normal coronary angiograms. *European Heart Journal,* 21: 890-894.

en.wikipedia.org/wiki/kaduna-state/ geography

Evan, D.J., Hoffmann, R.G., Kalkhoff, R.K., Kissebah, A.H. (1983). Relationship of androgenic activity to body fat topography, fat cell morphology, and metabolic abberations in premenopausal women. *Journal of Clinical Endocrinology and Metabolism,* 57(2): 304-310.

Fink, B., Neave, N. and Manning J. T. (2003): Second to fourth digit ratio, body mass index, waist-to-hip ratio, and waist-to-chest ratio: their relationships in heterosexual men and women. *Annals of Human Biology,* 30: 728-738.

Fink, B., Neave, N., and Manning, J. T. (2006). The 2nd-4th digit ratio (2D:4D) and neck circumference: Implications for risk factors in coronary heart disease. *International Journal of Obesity (London),* 30: 711-714.

Fletcher, D. and McNaughton, L. (1987). Three methods of assessing percent body fat in elite cyclists. *Journal of Sports Medicine,* 27: 211-216.

Fleck, S.J. (1983). Body composition of elite American athletes. *American Journal of Sports Medicine,* 11: 393–403.

Friedl, K.E. (1992). Body composition and military performance: Origins of the army standards. In: body composition and physical performance: applications for the military services. B.M. Marriott and J. Grumstrup-Scott, eds. Washington, DC: National Academy Press, pp: 31–55.

Friedl, K.E., Moore, R.J., Martinez-Lopez., L.E, Vogel, J.A., Askew, E.W., Marchitelli, L.J., Hoyt, R., and Gordon, C.C. (1994). Lower limits of body fat in healthy active men. *Journal of Applied Physiology,* 77: 933–940.

Friedl, K.E., Moore, R.J., Hoyt, R.W., Marchitelli, L.J., Martiniez-Lopez, L.E., and Askew, E.W. (2000). Endocrine markers of semistarvation in healthy lean men in a multistressor environment. *Journal of Applied Physiology,* 88: 1820–1830.

Friedl, K.E, Westphal, K.A, Marchitelli, L.J, Patton, J.F, Chumlea, W.C, and Guo, S. (2001). Evaluation of changes in body composition in young women after a physical training program. *American Journal of Clinical Nutrition,* 73: 268–275.

Friedl, K.E. (2004). Can you be large and not obese? The distinction between body weight, body fat, and abdominal fat in occupational standards. *Diabetes Technology and Therapeutics,* 6: 732–749.

Friedl, K.E. (2009). Waist circumference threshold values for type 2 diabetes risk. *Journal of Diabetes Science and Technology* 3: 761–769.

Gallagher, K.E., Hudepohl, A.D. and Parrott, D.J. (2010). The power of being present: the role of mindfulness on the relation between men's alcohol use and sexual aggression toward intimate partners. *Aggressive Behaviour,* 36: 405-413.

Gallagher, K.E. and Parrott, D.J. (2011). Does distraction reduce the alcohol–aggression relation? A cognitive and behavioral test of the attention-allocation model. *Journal of Consultation in Clinical Psychology,* 79: 319-329.

Gallup, G.G., Frederick, M.J., and Pipitone, R.N. (2008). Morphology and behavior: Phrenology revisited. *Review of General Psychology,* 12: 297-304.

Garn, S.M., Burdi, A.R., Babler, W.J. and Stinson, S. (1975). Early prenatal attainment of adult metacarpal. *Behavioral Neuroscience,* 124: 278-287.

Garrow, J.S. and Webster, J. (1985). Quetelet's index (W/H2) as a measure of fatness. *International Journal of Obesity,* 9: 147-153.

George, R. (1930). Human finger types. *Anatomical Records,* 46 (2): 199-204.

Geschwind, N. and Galaburda, A.M. (1985). Cerebral lateralization: Biological mechanisms, associations, and pathology: I. A hypothesis and a program for research. *Archives of Neurology,* 42: 428-459.

Giancola, P.R. (2004). Executive functioning and alcohol-related aggression. *Journal of Abnormal Psychology,* 113: 541-555.

Giancola, P.R. and Corman, M.D. (2007). Alcohol and aggression: a test of the attention-allocation model. *Psychology Science,* 18: 649-655.

Giancola, P.R., Josephs, R.A., Parrott, D.J. and Duke, A.A. (2010). Alcohol myopia revisited: clarifying aggression and other acts of disinhibition through a distorted lens. *Perspectives in Psychological Science,* 5: 265-278.

Greitmeyer, T. and Sagioglou, C. (2016). Subjective socioeconomic status causes aggression : a test of social deprivation. *Journal of Personal Social Psychology,* 111(2): 178-194.

Gur, R.C., Gunning-Dixon, F., Bilker, W.B. and Gur, R.E. (2002) Sex differences in temporo-limbic and frontal brain volumes of healthy adults. *Cerebral Cortex,* 12, 998-1003.

Harman, E.A and Frykman, P.N (1992). The relationship of body size and composition to the performance of physically demanding military tasks. In: Body composition and physical performance: Applications for the military services. B.M. Marriott and J. Grumstrup-Scott, eds. Washington, DC: National Academy Press, pp: 105–118.

Hamilton, C. (2009). Cognition and sex differences. *Tijdschrift voor Psychiatrie,* 51(12): 965-965.

Harris, M.B., and Knight-Bohnhoff, K. (1996). Gender and aggression II: Personal aggressiveness. *Sex roles*, 35(1-2): 27-42.

Henderson, N., Knapik, J. and Shaffer, S. (2000). Injuries and injury risk factors among men and women in US army combat medic advanced individual training. *Military Medical Journal*, 165: 647-52.

Hendrikse, J., McSweeney, K., Hoff, E. B., Atkinson, P., Miller, G., Connor, G., and Heber, H. (2002). Effectively including human factors in the design of new facilities. *United States Department of Transportation Publications and Papers*, pp: 1

Himes, J.H., Dietz, W.H. (1994). Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. The Expert Committee on Clinical Guidelines for Overweight in Adolescent Preventive Services. *American Journal of Clinical Nutrition,* 59(2): 307-316.

Hines, M. (2006). Prenatal testosterone and gender-related behaviour. *European Journal of Endocrinology,* 155 (1): 115-21.

Honekopp, J., Manning, J.T. and Muller. C. (2006). Digit ratio (2D:4D) and physical fitness in males and females: Evidence for effects ofprenatal androgens on sexually selected traits. *Hormone Behaviour,* 49: 545-549.

Honekopp, J., Bartholdt, L., Beier, L. and Liebert, A. (2007). Second to fourth digit length ratio (2D: 4D) and adult sex hormone levels: new data and a meta-analytic review. *Psychoneuro Endocrinology,* 32(4): 313-321.

Honekopp, J. and Schuster, M. (2010). A meta-analysis on 2D:4D and athletic prowess: Substantial relationships but neither hand out predicts the other. *Personality and Individual Differences,* 48: 4-10.

Honekopp, J. and Watson, S. (2010). Meta-analysis of digit ratio 2D:4D shows greater sex difference in the right hand. *American Journal Human Biology, 22*: 619-630.

Honekopp, J. and Watson S. (2011). Meta-analysis of the relationship between digit-ratio 2D:4D, and aggression. *Personality and Individual Differences,* 51: 381-386.

Huang, T.K., Harris, K.J., Lee, R.E., Nazir, R., Born, W. and Kaur, H. (2010). Assessing overweight, obesity, diet, and physical activity in college students. *Journal of American College Health,* 52(2): 83-86.

Hurd, P.L., Vaillancourt, K.L. and Dinsdale, N.L. (2011). Aggression, digit ratio and variation in androgen receptor and monoamine oxidase a genes in men. *Behavior Genetics,* 41(4): 543-556.

Hurt, P.L. and Van-Anders, S.M. (2006). Lattitude, digit ratio and Allens and Bermanns rules: a comment on Loehlin, Mcfadden, Medland and Martin. *Archives of Sexual Behaviour,* 36: 139-141.

Ibegbu, A.O., Danjuma, Z.C., Hamman, W.O., Umana, U.E., Ikyembe, D.T. and Musa, S.A. (2012). Anthropometric study of the index (2nd) and ring (4th) digits in Ebira ethnic group of Nigeria. *Asian Journal of Medical Sciences,* 4(2): 79-84.

ISAK (International Society for Advancement of Kinanthropometry) (2001). International Standards for Anthropometry Assesssment. Potchefstroom, South Africa.

Ismail, M.N. and Chi, C.B. (1987). Energy balance study in obese students. In *Proceedings of Nutritional Society of Malnutrition,* 3: 43-50.

Ismail, M.N. and Zawiah, H. (1988). Energy requirements of Malaysian students. *Proceedings of Nutritional Society of Malnutrition,* 3: 63-72.

Ismail, M. N. and Zawiah, H. (1989). Kajiankeperlu and ankeseimbangantenaga di kalanganpelajardanpekerjauniversiti (Studies on energy requirements and energy balance among student and university staff). *Penyelidikan Semasa Sains Hayat,* 107-123.

Ismail, M.N., Isa, M., Janudin, A. (1988). Energy requirements of Malaysian students. *Proceedings of Nutritional Society of Malnutrition,* 3: 63-72.

Jee, S.H., Lee, S.Y., Nam, C.M., Kim, S.Y. and Kim, M.T. (2002). Effect of smoking on the paradox of high waist-to-hip ratio and low body mass index. Obesity Research 10(9): 891-5.

Jelliffe, D.B. (1996). The assessment of nutrition status of the community. *World Health Organization Monograph Series Geneva,* 53: 50-84.

Jin, L., Huang, Y., Bi, Y., Zhao, L., Xu, M., Xu, Y. and Chen, Y. (2011). Association between alcohol consumption and metabolic syndrome in 19, 215 middle aged and elderly Chinese. *Diabetes Research in Clinical Practice,* 92(3): 386-392.

Johnson, N. (1997). The history of the US army standards. *Military Medical Journal,* 162: 564-570.

Jurimae T., Hurbob, T. and Jurimae, J. (2009). Relationship of handgrip strength with anthropometric and body composition variables in prepubertal children. *Human Biology,* 60: 225-238.

Karwowski, W. (2006). The discipline of ergonomics and human factors. *Handbook of human factors and ergonomics, 3.*

Kate, L., Ruth, C. and David, S. (2015). Age, gender, and puberty influence the development of facial emotion recognition. *Frontier in Psychology,* 6: 761.

Kaufman, K. R., Brodine, S. and Shaffer, R. (2000). Military training-related injuries: surveillance, research, and prevention. *American Journal of Preventive Medicine, 18*(3): 54-63.

Kazemi-Esfarjani, P., Trifiro, M.A. and Pinski, L. (1995). Evidence for a repressive function of the long polyglutaminetract in the human androgen receptor: possible pathogenic relevance for the (cag) n-exppanded neuropathies. *Human Molecular Genetics,* 4: 523-527.

Khaw, K.T., Tazuke, S. and Barrett-Connor, E. (1988). Cigarette smoking and levelsof adrenal androgens in postmenopausal women. *New England Journal of Medicine,* 318: 1705-1709.

Kilduff, L., Cook, C. J., Bennett, M., Crewther, B., Bracken, R. M. and Manning, J. (2013). Right-left digit ratio (2D:4D) predicts free testosterone levels associated with a physical challenge. *Journal of Sports Sciences,* 31: 677-683.

Kimura, D. (1996). Sex, sexual orientation and sex hormones influence human cognitive function. *Current Opinion in Neurobiology,* 6: 259-263.

Kimura, D. (1999). Sex and cognition. Cambridge: MIT Press.

Kimura, S., Ishibashi, T., Hatanaka, M., Sakakibara, Y., Hashimoto, J. and Sakaguchi, K. (2000) Molecular cloning and characterization of a plant homologue of the origin recognition complex 1 (ORC1). *Plant Science,* 158(1-2): 33-39

Komuya, A., Inoue, A. and Sasaguri, Y. (1992). Rapidly destructive arthropathy of the hip. Study on bone resorption factors in joint with a theory of pathogenesis. *Clinical Orthop,* 28: 273.

Kondo, T., Zakany, J., Innis, W.J. and Duboule, D. (1997). Of fingers, toes, and penises. *Nature,* 390: 29.

Kratochvil, L. and Flegr, J. (2009). Differences in the 2nd to 4th digit length ratio in humans reflect shifts along the common allometric line. *Biology Letters*, 5: 643-646.

Kvist, H., Chowdhury, B., Grangard, U., Tylen, U. and Sjostrom, L. (1988). Total and visceral adipose-tissue volumes derived from measurements with computed tomography in adult men and women: Predictive equations. *American Journal of Clinical Nutrition,* 48: 1351–1361.

Leonard, K.E. and Blane, H.T. (1992). Alcohol and marital aggression in a national sample of young men. *Journal of Interpersonally Violence,* 7, 19-30

Lippa, R.A. (2006). Are 2D: 4D finger-length ratios related to sexual orientation? Yes for men, no for women. *Journal of Personal Socio Psychology*, 85: 179.

Little, M.A. (2012). Human population biology in the second half of the twentieth century. *Current Anthropology*, *53*(S5).

Longman, D., Stock, J.T. and Wells, J.C. (2011). Digit ratio (2D:4D) and rowing ergometer performance in males and females. *American Journal of Physical Anthropology,* 4: 97-104.

Loon, M.J.W. (2009). *Gender difference in human empathy. Theories on the Timbergen four "why's".* Unpublished Master, Utrecht University, Utrecht.

Lowman, G.T., Ring, k., Schmitz, K., Treuth, S.M., Loftin, M., YANG, S., Sothern, M. and Going, S. (2006). Association of body size and composition with physical

activity in adolescent girls. *Medicine and Science in Sport and Execise,* 38(6): 11

Lukaski, H.C. (1987). Methods for the assessment of human body composition: traditional and new. *American Journal of Clinical Nutrition,* 46: 537-56.

Lutchmaya, S., Baron-Cohen, S, Raggatt P, Knickmeyer, R. and Manning, J.T. (2004). 2nd to 4th digit ratios, fetal testosterone and estradiol. *Early human development,* 77(1): 23-28.

LWudy, S.A., Dorr, H.G., Solleder, C., Djalali, M. and Homoki, J. (1999). Profiling steroid hormones in amniotic fluid of mid pregnancy by routine stable isotope dilution/gas chromatography mass spectrometry: Reference values and concentrations in fetuses at risk for 21-hydroxylase deficiency. *Journal of Clinical Endocrinological Metabolism,* 84(8): 2724-2728.

Malas, M.A., Dogan, S., Evcil, E.H. and Desdicioglu, K. (2006). Fetal development of the hand, digits and digit ratio (2D:4D). *Early human development,* 82: 469-475.

Manning, J.T., Scutt, D. Wilson, J. and Lewis-Jones, D.I. (1998). The ratio of 2nd to 4th digit length: a predictor of sperm numbers and concentrations of testosterone, luteinizing hormone and oestrogen. *Human Reproduction,* 13(1): 3000-3004.

Manning, J.T. and Bundred, P. (2000). The ratio of 2nd to 4th digit length: a new predictor of disease predisposition. *Medical Hypotheses,* 54, 855-7.

Manning, J. T. and Taylor. (2001).Second to fourth digit ratio and male ability sport: implications for sexual selection in humans *Evolutionary Human Behaviour* 61-69.

Manning, J.T. (2002). Digit ratio: a pointer to fertility, behavior, and health. *London: Rutgers University Press,* 24-30.

Manning, J.T. (2002a). Digit Ratio: A Pointer to Fertility, Behaviour, and Health, Rutgers U Press, New Brunswick, NJ. 24-30

Manning, J.T. (2002b). The ratio of 2nd to 4th digit length and performance in skiing. *Journal of Sports and Medical Physical Fitness,* (42): 446-450.

Manning, J.T., Henzi, P., Venkatramana, P., Martin, S. and Singh, D. (2003). Second to fourth digit ratio: ethnic differences and family size in English, Indian and South African populations. *Annals of Human Biology*, 30: 579-88.

Manning, J.T., Bundred, P.E., Newton, D.J. and Flanigan, B.F. (2003a). The second to fourth digit ratio and variation in the androgen receptor gene. Evolution and Human Behavior 24: 399-405.

Manning, J.T., Vang, E.S., Walton, J., Bundred, P.E., Van Heyningen, C. and Lewis-Jones, D.L. (2004). Second to fourth digit ratio (2D:4D) and testosterone in men. *Asian Journal of Andrology*, 6: 211-6.

Manning, J.T., Churchill, A. J.G. and Peters, M. (2007). The effects of sex, ethnicity, and sexual orientation on self-measured digit ratio (2D:4D) .*Archives of Sexual Behavior*, 36: 223-233.

Manning, J.T., Kilduff, P., Trivers, R. and Kilduff, T. (2013). Digit ratio (2D:4D) in Klinefelter's syndrome. *Andrology*1 (1): 94-99.

Marco, G., Garden, T., Santo, G., Danila, D.M. and Maurizio, L.G. (2005). Testosterone and aggressiveness. *ed Sci Monit,* 11(4): 136-145.

Marriott, B.M. and Grumstrup-Scott, J. (1990). Critique of the Military's Approach to Body Composition Assessment and Evaluation.

Martin-Gonzalez, C., Gonzalez-Reimers, E., Santolary-Fernaendez, F., Fernendez-Rodriguiez, C., Garcia-Valde, C. and Gonzalez-Diaz, A. (2011). Prognostic value of changes in lean and fat mass in alcoholics. *Clinical Nutrition,* 30(6): 822-830.

Maseroli, E., Comeglio, P., Corno, C., Cellai, I., Filippi, S., Mello, T., Galli, A., Rapizzi, E., Presenti, L., Truglia, M.C., Lotti, F., Facchiano, E., Beltrame, B., Lucchese, M., Saad, F., Rastrelli, G., Maggi, M., Vignozzi, L. (2020). Testosterone treatment is associated with reduced adipose tissue dysfunctionand non alcoholic fatty liver disease in obese hypogonadal men. *Journal of Endocrinological Investigation* 44(4):819-842.

Mathur, D.N. and Salokun, S.O. (1985). Body composition of successful Nigerian female athletes. *Journal of Sports Medicine,* 25: 21-27.

Mayhew, T.M., Gillam, L., McDonald, R. and Ebling, F.J.P., (2007). Human 2D (index) and 4D (ring) digit lengths: their variation and relationships during the menstrual cycle. *Journal of Anatomy,* 211(5): 630-638.

McClure, E.B. (2000). A meta-analytic review of sex differences in facial expression processing and their development in infants, children, and adolescents. *Psychological Bulletin,* 126: 424-453.

McEwen, B. (1981). Neural gonadal steroid action. *Science,* 211: 1303-1311.

McFadden, D. and Bracht, M.S. (2003). The relative lengths and weights of metacarpals and metatarsals in baboons (papiohamadryas). *Hormones and Behavior,* 43: 347-355.

McFadden, D. and Shubel, E. (2002). Relative lengths of fingers and toes in human males and females. *Hormones and Behavior,* 42: 492-500.

McIntyre, M. H., Cohn, B. A. and Ellison, P. T. (2006). Sex dimorphism in digital formulae of children. *American Journal of Physical Anthropology,* 129: 143-150.

McNulty, P. (2001). Prevalence and contributing factors disorder behaviors in active duty service women in the army, navy, air force, and marines. *Military Medical Journal,* 166: 53-58

Meikle, A.W., Liu, X.H., Taylor, G.N. and Stringham, J.D. (1988). Nicotine and cotinineeffects on 3 alpha hydroxysteroid dehydrogenase in canine prostate. *Life Sciences,* 43: 1845-1850.

Michnovicz, J.J., Hershcopf, R.J., Naganuma, H., Bradlow, H.L. and Fishman, J. (1986). Increased 2-hydroxylation of estradiol as a possible mechanism for the anti-estrogenic effect of cigarette smoking. *New England Journal of Medicine,* 315: 1305-1309.

Mittler, J.C., Pogach, L. and Ertel, N.H. (1983). Effects of chronic smoking on testosteronemetabolism in dogs. *Journal of Steroid and Biochemistry,* 18: 759-63.

Millet, K., and Dewitte, S. (2007). Digit ratio (2D:4D) moderates the impact of an aggressive music video on aggression. *Personality and Individual Differences,* 43: 289-294.

Millet, K. (2010). An inter-actionist perspective on the relation between 2D:4D and behaviour: An overview of (moderated) relationships between 2D:4D and economic decision making. *Personality and Individual Differences,* 51: 397-401.

Mohamed, A.S., Sapuan, S.M., Megat, M.M.H., Ahmad, A., Hamouda, M.S. and Hang, B.T., Tuah, B.B. (2010). Modeling technology transfer for petroleum industry in Libya: An overview. *Scientific Research and Essay*, 5(2): 130-147.

Molina, P.E., Hock, J.B., Neison, S., Guidot, D.M., Lang, C.H., Wands, J.R., and Crawford, J.M. (2003). Mechanism of alcohol induced tissue injury. *Alcohol and Clinical Experiment Research,* 27(3): 563-575.

Moreno, E., Yan, M. and Basler, K. (2002). Evolution of TNF signaling mechanisms: JNK-dependent apoptosis triggered by Eiger, the Drosophila homolog of the TNF superfamily. *Current Biology,* 12(14): 1263-1268.

National Bureau on Statistics. (2012): www.maternal, newborn and child health Programme 2. Com> Kaduna State

Naing, L., Winn, T. and Nordin, R. (2006). Practical Issues in Calculating the Sample Size for Prevalence Studies. *Archives of Orofacial Sciences.* 1.

Neave, N., Laing, S. and Fink, B.M. (2003). Second to fourth digit ratio, testosterone and perceived male dominance. *Proceedings of the Royal Society of London. Series B,* 270: 2167-2172.

Nicolay, C. and Walker, A. (2005). 'Grip Strength and endurance: Influences of anthropometric variation, hand dominance, and gender'. *International Journal of Industrial Ergonomics,* (35): 605-618.

Okten, A., Kalyoncu, M. and Yaris, N. (2002). The ratio of second- and fourth-digit lengths and congenital adrenal hyperplasia due to 21-hydroxylase deficiency. *Early Human Development,* 70: 47-54.

Onimawo, I.A. and Cole, A.H. (2000). A longitudinal study of changes in body composition of young adult Nigerians. *Nigerian Journal of Science,* 36: 47-57.

Onimawo, I.A., Echendu, C.A. and Udodi, M.N. (2004). Body composition and nutrient intake of hypertensive elders and middle aged men and women in Nigeria. *Journal of Nutrition. Elderly,* 24: 55-67.

Pang, S., Levine, L.S., Cederqvist, L.L., Fuentes, M., Riccardi, V.M. and Holcombe, J.H. (1980). Amniotic fluid concentrations of delta 5 and delta 4 steroids in fetuses with congenital adrenal hyperplasia due to 21 hydroxylase deficiency and in anencephalic fetuses. *Journal of Clinical Endocrinology and Metabolism,* 51: 223-229.

Pasquali, R. and Vicennati, V. (2000). Activity of the hypothalamic-pituitary adrenal axis in different obesity phenotypes. *International Journal of Obesity Related Metabolic Disorder*, 24: S47-49.

Paul, S.N., Kato, B.S., Hunkin, J.L., Vivekanandan, S. and Spector, T.D. (2006). The big finger: the second to fourth digit ratio is a predictor of sporting ability in women. *British Journal of Sports Medicine.,* 40(12): 981-983.

Peichel, C.L., Prabhakaran, B. and Vogt, T.F. (1997). The mouse ulna less mutation deregulates posterior hoxd gene expression and alters appendicular patterning. *Development,* 124: 3481-3492.

Perciavalle, V., Corrado, D.D., Petralia, M.C., Gurrisi, L., Massimino, S. and Coco, M. (2013). The second-to-fourth digit ratio correlates with aggressive behaviour in professional soccer players. *Molecular Medicine Reports,* 7: 1733-1738.

Phillips, G.B., Pinkernell, B.H. and Jing, T.Y. (1994). The association of hypotesteronemia with coronary artery disease in men. *Arteriosclerosis and Thrombosis,* 14: 701-706.

Pichard, C., Kyle, U.G. and Bracco, D. (2000). Reference values of fat-free and fat masses by bioelectrical impedance analysis in 3393 healthy subjects. *Nutrition,* 16: 245-254.

Pierre, M. and Shi, Y. (2000). Performance of a 2D image-based anthropometric measurement and clothing sizing System. *Applied Ergonomics*, 31: 445-51.

Pourtaghi, G., Valipour, F., Sadeghialavi, H. and Lahmi, M.A. (2014). Anthropometric characteristics of Iranian military personnel and their changes over recent years. *International Journal of Occupational and Environmental Medicine*, **5**: 115-124.

Power, C., Lake, J.K. and Cole, T.J. (1997). Measurement and long term health risks of child and adolescent fatness. *International Journal of Obesity Related Metabolic Disorder,* 21: 507-526.

Putz, D.A., Gaulin, S.J.C. and Sporter, R.J. (2004). Sex hormones and finger length. What does 2D:4D indicate? *Evolution and Human Behavior*, 25: 182-199.

Rahimi, R., Qaderi, M., Faraji, H. and Boroujerdi, S. (2013). Effects of very short rest periods on hormonal responses to resistance exercise in men. *Strength and conditioning Journal,* 24(7): 1851-1859.

Robinson, Joyce C., Robinette, Kathleen M. and Sehner, G.F. (1988). User's guide to accessing the anthropometric data base at the center for anthropometric research data, AAMRL-TR-88-012, Armstrong Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base.

Robinson, S.J. and Manning, J.T. (2000). The ratio of 2nd to 4th digit length and male homosexuality. *Evolution and Human Behavior*, 21: 333-345.

Rochelle, N., Shawn, C., and Carlos, J. (2002). US Military weight standards. *American Journal of Medicine,* 113: 486-90.

Rosano, G.M., Leonardo, F. and Pagnotta, P. (1999). Acute anti-ischaemic effect of testosterone in men with coronary artery disease. *Circulation,* 99: 1666-1670.

Rosano, G.M. (2000). Androgens and coronary heart disease. A sex-specific effect of sex hormones? *European Heart Journal,* 21: 868-871.

Russell, G.W. and Arms, R.L. (1995). False consensus effect, physical aggression, anger, and a willingness to escalate a disturbance. *Aggressive Behavior*, 21(5): 381-386.

Sarria, A., Garcia-Llop, L.A., Moreno, L.A., Fleta, J., Morellon, M. P., Bueno, M. (1998). Skinfold thickness measurements are better predictors of body fat percentage than body mass index in male Spanish children and adolescents. *European Journal of Clinical Nutrition,* 52(8): 573-576

Salvendy, G. (2012). *Handbook of human factors and ergonomics*. John Wiley & Sons.

Santtila, M., Hakkinen, K., Karavirta, L., and Kyrolainen, H. (2008). Changes in cardiovascular performance during an 8-week military basic training period combined with added endurance or strength training. *Military Medicine,* 173: 1173–1179.

Schaap, L.A., Pluijm, S.M.F., Smit, J.H., van Schoor, N.M., Visser, M., Gooren, L.J.G. and Lips, P. (2005). The association of sex hormone levels with poor mobility, low muscle strength and incidence of falls among older men and women. *Clinical Endocrinology,* 63: 152-160.

Sewardson, M., Vylithingum, S., Jailal, I. and Desai, R.K. (1990). Abnormalities in sex hormones are a risk factor for premature manifestation of coronary artery disease in South African Indian men. *Atherosclerosis,* 83: 111-117.

Shih, Y.C. and Liang, S.F.M. (2014). Bridging research and good practices towards patients welfare*: Proceedings of the 4th International Conference on Healthcare Ergonomics and Patient Safety (HEPS), Taipei, Taiwan,* CRC Press.

Sluming, V.A. and Manning, J.T. (2000). Second to fourth digit ratio in elite musicians: evidence for musical ability as an honest signal of male fitness. *Evolution and Human Behavior,* 21: 1-9.

Smith, P. and Waterman, M. (2004). Role of experience in processing bias for aggressive words in forensic and non-forensic populations. *Aggressive Behaviour,* 30: 105-122.

Swartz, C.M. and Young, M.A. (1987). Low serum testosterone and myocardial infarction in geriatric male patients. *Journal American Gerontological Society,* 35: 39-44.

Tester, N. and Campbell, L. (2007) Sporting achievement: what is the contribution of digit ratio?

US Department of Defense, Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics. (1981). *Study of the Military Services Physical fitness,* Washington, DC.

Varney, M., Malon, A., Oleko, A., Salanave, B., Roudier, C., Szego, E., Deschamps, V., Hercberg, S., Castetbon, k. (2009). Association of socioeconomic status with

overall overweight and central obesity in men and women ; the French nutrition and health survey,2006.*Biomedical Central Public Health*, 9:215s

Vehmas, T., Solovieva, S. and Leino-Arjas, P. (2006). Radiographic 2D:4D index in females: no relation to anthropometric, behavioural, nutritional, health-related, occupational or fertility variables. *Journal of Negative Results in Biological Medicine*, 5: 12.

Vermeulen, A., Goemaere, S., and Kaufman, J.M. (1999). Testosterone, body composition and aging. *Journal of Endocrinology Investment*, 22: 110-6.

Visnapuu, M. and Jurimae, T. (2007). Handgrip strength and hand dimensions in young handball and basketball players. *Journal of Strength Conditioning Research*, 21(3): 923-929.

Visser, M., Pahor, M., Tylavsky, F., Kritchevsky, S.B., Cauley, J.A., Newman, A.B., Blunt, B.A. and Harris, T.B. (2003). One- and two-year change in body composition as measured by DXA in a population-based cohort of older men and women. *Journal of Applied Physiology*, 94(6): 2368-2374.

Voyer, D. and Bryden, M. P. (1990). Gender, level of spatial ability, and lateralization of mental rotation. *Brain and Cognition*, 13: 18-29.

Voyer, D., Voyer, S. and Bryden, M.P. (1995). Magnitude of sex differences in spatial abilities: A meta-analysis and consideration of critical variables. *Psychological Bulletin*, 117(2): 250-270.

Walder, D.J., Andersson, T.L., McMillan, C., Breedlove, A.L. and Walker, E.F. (2006). Sex differences in digit ratio (2D:4D) are disrupted in adolescents with schizotypal personality disorder: Altered prenatal gonadal hormone levels as a risk factor. *Schizophrenia Research*, 86: 118-124.

Weather and Climate. (2023) - The Global Historical Weather and Climate Data, https//:tcktcktck.org/ Nigeria>kaduna.

White, R. M., and Churchill, E. (1971). *The body size of soldiers: US army anthropometry-1966* (No. C/PLSEL-94).

Williams, T.J., Pepitone, M.E., Christensen, S.E., Cooke, B.M., Huberman, A.D., Breedlove, N.J. and Breedlove, S.M. (2000). Finger length ratios and sexual orientation. *Nature*, 404: 455-456.

Williamson, D.F., Madans, J., Anda, R.F., Kleinman, J.C., Giovino, G.A. and Byers, T. (1991). Smoking cessation and severity of weight gain in a national cohort. New England Journal of Medicine, 324: 739-456.

Wilmore, J.H. (1983). Body composition in sport and exercise: directions for future research. Medicine & Science in Sports & Exercise, 15(1): 21-31.

Wilson, G.D. (1983). Finger-length as an index of assertiveness in women. Personality and Individual Differences, 4: 111-112.

Wilson, G.D. (2010). Fingers to feminism: The rise of 2D:4D. *Quarterly Review*, 4(2): 25-32.

Wilson, R.P., Robinson, E.H. and Poe, W.E. (1981). Apparent and true availability of amino acids from common feed ingredients for channel catfish. *The Journal of Nutrition,* 111: 923-929.

Wu, X.L., Yang, D.Y., Chai, W.H., Jin, M.I., Zhou, X.C. and Peng, L. (2013). The ratio of second to fourth digit length (2D:4D) and coronary artery disease in a Han Chinese population. *International Journal of Medical Sciences*, 10: 1584-1588

Ye, H., Xiangjun, H., Jingya, B., Jing, W., Jinquan, H., Yutang, W. and Huanjiu, X., (2012). A statistical analysis on skinfold thickness and measurement of body composition for Chinese adults. *Academic Journals*, 7: 2827-2834.

Yoshida, T., Sakane, N. and Umekawa, T. (1999). Nicotine induces uncoupling protein 1 in white adipose tissue of obese mice. *International Journal of Obesity Related Metabolic Disorder,* 23: 570-575.

Zamboni, M., Armellini, F., Milani, M.P., DeMarchi, M., Todesco, T. and Robbi, R. (1992). Body fat distribution in pre- and post-menopausal women and anthropometric variables and their inter-relationships. *International Journal of Obesity*, 16: 495.

Zamboni, M., Zoico, E., Scartezzini, T., Mazzali, G., Tosoni, P., Zivelonghi, A. and Bosello, O. (2003). Body composition changes in stable-weight elderly subjects: the effect of sex. *Aging Clinical Experimental Research*, 15(4): 321-327.

Zhao, D., Li, B., Yu, K. and Zheng, L. (2012). Digit ratio (2D: 4D) and handgrip strength in subjects of Han ethnicity: impact of sex and age. *American Journal of Physical Anthropology,* 149(2): 266-271.

Zheng, Z. and Martin, J.C. (2011). Developmental basis of sexually dimorphic digit ratios. *Proceedings of National Academic of Sciences* Early edition, 108: 16289-16294.

APPENDICES

LETTER OF INTRODUCTION

I am Ahmad Umar SHEHU, an MSc student in the Department of Human Anatomy of the institution mentioned earlier. I am carrying out a research on the ***'****Digit Ratio (2d:4d), Sociodemographic Characteristics, Anthropometric and Adiposity Markers of Military Personnels in Jaji, Kaduna State, Nigeria'*. Participation is voluntary and it involves the collection of certain information about your Bio-dataand measurements of some anthropometric parameters.

The information collected from you will be used strictly to achieve the objectives of this study and for scientific publication. I assure you that this study has been reviewed and approved by my supervisors and the University Committee on Research Ethics.

Thank you for your understanding.

Yours sincerely,

Ahmad Umar SHEHU

APPENDIX I

Committee on Use of Human Subjects for Research

Directorate of Academic Planning & Monitoring
Ahmadu Bello University, Zaria
Director: Professor M. L. Sule B Pharm, MSc, PhD, (ABU), MPSN Tel: 08036184581
Chairman: Prof I. H. Nock, B.Sc,M.Sc (ABU), PhD (NewDelhi) 08065425450 | Secretary: U. D. Abdullahi, 08034619772

Appl No.: ABUCUHSR/2017/Human Anatomy/001 4th August, 2017

Approval No: ABUCUHSR/2017/003

Dr. Wilson O. Hamman
Department of Human Anatomy,
Faculty of Medicine,
Ahmadu Bello University,
Zaria.

Sir,

PROVISIONAL APPROVAL OF RESEARCH TITLED "ANTHROPOMETRIC CHARACTERISTICS OF MILITARY MEN JAJI"

This is to convey the provisional approval of the ABUCUHSR to you for the aforestated study domiciled in Department of Human Anatomy of the Ahmadu Bello University. The approval is predicated on the assumption that you shall maintain and cater for the study subjects as indicated in your application.

Monitoring of the Research by spot checks, invitations, interactions with the subjects any other means the Committee deems fit shall be undertaken at the convenience of the Committee.

This approval can and shall be revoked should a significant breach in the terms and condition of the approval occur. It is hence your responsibility to ensure that the agreed terms are maintained to the end of the Study.

The said approval shall be posted on the ABUCUHSR Page on the University's website.

Note upon completion of the research, ethical clearance certificate will be issued.

U.D. Abdullahi
For: ABUCUHSR Chairman

Cc Director, DAPM
Director, IC &ICT
Dean, Faculty of Medicine
HOD, Human Anatomy
Prof. Aisha I. Hamman

RESTRICTED

HEALTH REFERENCE ETHICS COMMITTEE

RE: ANTHROPOMETRIC CHARACTERISTIC, BODY COMPOSITION AND AGGRESSI AMONGST MENTAL MEN IN JAJI MILITARY CANTONMENT NIGERIA

Name of Principal Investigator	SHEHU AHMAD UMAR
Address of the Principal Investigator	JAJI CANTONMENT MEDICAL CENTRE MILITA CANTONMENT
Date of receipt of valid application	2nd June 2017
Date of meeting when final determination On ethical approval was made	12th June 2017

Dear Shehu Ahmad Umar,

The Institution Ethics Committee (Health Reference Ethics Committee (HREC) has received and discussed your application to conduct the above mentioned research in Jaji Military cantonment with you as the principal investigator. The submitted protocol, the Consent forms, and other participant information materials has been reviewed and given approval By the HREC. Please n hat the approval date span between 12th June 2017 and 12th June 2018. No participant ecruitment can be made outside these dates. The research work has been approved to be onducted in the present form. No changes are permitted in the research without prior approv y the 44 NARHK HREC, except in circumstances outlined in National Code for Health Research thics: http://www.nhrec.net. If there is delay in starting the research, please inform the 4 NARHK HREC so that the starting date can be adjusted accordingly. 44 NARHK HREC reserv he right to conduct compliance assessment visit to your research site without prior notificatior

12/6/17

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APPENDIX II

CONSENT FORM

Dear Mr/Mrs/Miss,

You are kindly being asked to participate in a research study conducted by Shehu Ahmad Umar, an MSc candidate in the Department of Human Anatomy of the above-named institution, carrying out a research on 'DIGIT RATIO (2D:4D), SOCIODEMOGRAPHIC CHARACTERISTICS, ANTHROPOMETRIC AND ADIPOSITY MARKERS OF MILITARY PERSONNELS IN JAJI, KADUNA STATE, NIGERIA'. Participation is voluntary. It involves collection of certain information about your height, weight, age, digit ratio and BMI: which will take you about 15 minutes.

The information collected from you will be used strictly to achieve the objectives of this study and scientific publication. I assure you that this study has been reviewed and approved by my supervisors and the University Committee on Research Ethics.

Thanks for your understanding.

Yours sincerely,

Shehu Ahmad Umar

APPENDIX III

CONSENT TO PARTICIPATE IN RESEARCH

DIGIT RATIO (2D:4D), SOCIODEMOGRAPHIC CHARACTERISTICS, ANTHROPOMETRIC AND ADIPOSITY MARKERS OF MILITARY PERSONNELS IN JAJI, KADUNA STATE, NIGERIA.

You are asked to participate in a research study conducted by Dr. B Danborno, Dr. W. O Hamman, and Ahmad Umar Shehu, Faculty of medicine, Ahmadu Bello University Zaria.

If you have any questions or concerns about the research, please feel free to contact: Shehu Ahmad Umar, Faculty of Medicine, Tel: 08032582053, Dr. B. Danborno, Faculty of medicine, Tel: 08139429300

PURPOSE OF THE STUDY
The present study is aimed at COMPARING ANTHROPOMETRIC CHARACTERISTICS AND BODY COMPOSITION OF SOLDIERS, MILITARY OFFICERS AND NON-MILITARY PERSONNEL IN JAJI MILITARY CANTONMENT.

POTENTIAL RISKS AND DISCOMFORT
This study does not pose any form of physical, emotional or psychological risks

POTENTIAL BENEFITS TO PARTICIPANTS
The end result of this study, when published will help in knowing the "SECOND TO FOURTH DIGIT RATIO, ANTHROPOMETRIC VARIABLES, BODY COMPOSITION AND AGGRESSION AMONGST MILITARY PERSONNELS IN JAJI KADUNA STATE, NIGERIA"and the conclusions that will be drawn will aid in improving military performance.

PAYMENT FOR PARTICIPATION
Participation will not attract any financial benefit

CONFIDENTIALITY
Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study

PARTICIPATION AND WITHDRAWAL
You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

RIGHTS OF RESEARCH PARTICIPANTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through Ahmadu Bello University Research Ethics Board. If you have questions regarding your rights as a research participant, contact:

Prof. B. Danborno
Department of Anatomy,
Faculty of Medicine,
Ahmadu Bello University.
Tel: 08139429300
E-mail: sbdanborno@yahoo.com

Prof. W. O Hamman
Department of Anatomy,
Faculty of Medicine,
Ahmadu Bello University.
Tel: 08062303007
E-mail: hammanow@yahoo.com

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE

I have read the information provided for the study "COMPARATIVE STUDIES OF ANTHROPOMETRIC CHARACTERISTICS AND BODY COMPOSITION OFSOLDIERS, MILITARY OFFICERS AND NON-MILITARY PERSONNEL IN JAJI MILITARY CANTONMENT." as described herein. I have been given a copy of this form.

_____
Name of Participant

_____ _____
Signature of Participant Date

SIGNATURE OF WITNESS

_____
Name of Witness

_____ _____
Signature of Witness Date

SECOND TO FOURTH DIGIT RATIO, ANTHROPOMETRIC VARIABLES, BODY COMPOSITION AND AGGRESSION AMONGST MILITARY PERSONNELS IN JAJI KADUNA STATE, NIGERIA

Name: Shehu Ahmad Umar.

Position: MSc Student

Contact Address: Department of Anatomy, Faculty of Medicine, Ahmadu Bello University, Zaria

1. I confirm that I have read and understood the information sheet for the above study and have had the opportunity to ask questions.
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.
3. I agree to take part in the above study.
4. I agree to the use of anonymised quotes in the publications.

Name of Participant	Date	Signature
Name of Researcher	Date	Signature

Questionnaire for the Second to Fourth Digit Ratio, Anthropometric Variables, Body Composition and Aggression amongst Military Personnel in Jaji , Kaduna State, Nigeria.

Please tick or circle the appropriate letter where necessary below:

DEMOGRAPHY OF PARTICIPANT

1. Date of birth _____ (DD/MM/YYYY)
2. Age_____ (years)
3. Number of siblings:
   a. Brothers: _____ (from your mother only)
   b. Sisters: _____ (from your mother only)
4. What's your birth order?
   a. Firstborn [ ] b. Second born [ ] c. Third born [ ] d. Last born [ ]

5. ETHNIC BACKGROUND

Mother's Ethnic Group: _____

Grand Mother's Ethnic Group: _____

Father's Ethnic Group: _____

Grand Father's Ethnic Group:_____

ANTHROPOMETRIC ASSESSMENT

6. Weight: _____ (kg)
7. Height: _____ (m)
8. BMI: _____ (kg/m^2)
9. Waist-Hip ratio_____
10. Waist circumference: _____ (cm)
11. Hip circumference:_____ (cm)
12. Waist-Hip ratio:_____ (cm)
13. Mid upper arm circumference: _____ (cm)
14. Chest circumference:_____ (cm)
15. Head circumference:_____ (cm)
16. Head length: _____ (cm)
17. Head width:_____ (cm)
18. Body mass _____ (kg)

19. Lean body mass _____ (kg)

20. Fat percentage _____ (%)

21. HAND ANTHROPOMETRY

Length of digits (mm)

Hand	**Fingers**				
	I	**II**	**III**	**IV**	**V**
Right					
Left					

22. PARENTS' EDUCATIONAL BACKGROUND

1. Mother's level of education
   A. None [ ] B. Primary school [ ] C. Secondary school [ ] D. Tertiary [ ]

2. Father's level of education
   A. None [ ] B. Primary school [ ] C. Secondary school [ ] D. Tertiary [ ]

Buss–Perry Aggression Questionnaire

	Extremely uncharac-teristic	Somewhat uncharac-teristic	Neither uncharac-teristic nor charac- teristic	Somewhat charac-teristic	Extremely charac-teristic
1. Some of my friends think I am a hothead.	○	○	○	○	○
2. If I have to resort to violence to protect my rights, I will.	○	○	○	○	○
3. When people are especially nice to me, I wonder what they want.	○	○	○	○	○
4. I tell my friends openly when I disagree with them.	○	○	○	○	○
5. I have become so mad that I have broken things.	○	○	○	○	○
6. I can't help getting into arguments when people disagree with me.	○	○	○	○	○
7. I wonder why sometimes I feel so bitter about things.	○	○	○	○	○
8. Once in a while, I can't control the urge to strike another person.	○	○	○	○	○
9. I am an even-tempered person.	○	○	○	○	○
10. I am suspicious of overly friendly strangers.	○	○	○	○	○
11. I have threatened people I know.	○	○	○	○	○
12. I flare up quickly but get over it quickly.	○	○	○	○	○
13. Given enough provocation, I may hit another person.	○	○	○	○	○
14. When people annoy me, I may tell them what I think of them.	○	○	○	○	○
15. I am sometimes eaten up with jealousy.	○	○	○	○	○
16. I can think of no good reason for ever hitting a person.	○	○	○	○	○
17. At times I feel I have gotten a raw deal out of life.	○	○	○	○	○
18. I have trouble controlling my temper.	○	○	○	○	○
19. When frustrated, I let my irritation show.	○	○	○	○	○
20. I sometimes feel that people are laughing at me behind my back.	○	○	○	○	○
21. I often find myself disagreeing with people.	○	○	○	○	○
22. If somebody hits me, I hit back.	○	○	○	○	○
23. I sometimes feel like a powder keg ready to explode.	○	○	○	○	○
24. Other people always seem to get the breaks.	○	○	○	○	○
25. There are people who pushed me so far that we came to blows.	○	○	○	○	○
26. I know that "friends" talk about me behind my back.	○	○	○	○	○
27. My friends say that I'm somewhat argumentative.	○	○	○	○	○
28. Sometimes I fly off the handle for no good reason.	○	○	○	○	○
29. I get into fights a little more than the average person.	○	○	○	○	○