# SECOND TO FOURTH DIGIT RATIO IN RELATION TO DEMOGRAPHY, SYSTEMIZING AND EMPATHIZING AMONGST BAJJU AND ASHOLIO ETHNIC GROUPS OF KADUNA STATE

**BY**

**Abel Yashim SOLOMON**

**DEPARTMENT OF HUMAN ANATOMY**
**FACULTY OF MEDICINE**
**AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA**

**August, 2015**

# SECOND TO FOURTH DIGIT RATIO IN RELATION TO DEMOGRAPHY, SYSTEMIZING AND EMPATHIZING IN BAJJU AND ASHOLIO ETHNIC GROUPS OF KADUNA STATE

**BY**


**Abel Yashim SOLOMON**
**(BSc ABU, 2012)**
**MSc/MED/23841/2012-2013**


**A DISSERTATION SUBMITTED TO SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA**

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN HUMAN ANATOMY**


**DEPARTMENT OF HUMAN ANATOMY**
**FACULTY OF MEDICINE**
**AHMADU BELLO UNIVERSITY,**
**ZARIA, NIGERIA**


**August, 2015**

## DECLARATION

I, ABEL YASHIM SOLOMON declare that the work in the thesis titled ‘‘**Second to Fourth Digit Ratio in Relation to Demography, Systemizing and Empathizing Amongst Bajju and Asholio population of Kaduna State.”** was carried out by me in the Department of Human Anatomy, Faculty of Medicine, Ahmadu Bello University, Zaria. The information used for my literature review was fully acknowledged in the text and references. This thesis has not been presented in any scientific gathering, neither has it been presented for another degree or diploma at any University.

| ______________________ | ______________________ | ______________________ |
|---|---|---|
| **ABEL YASHIM SOLOMON** | **SIGNATURE** | **DATE** |

**APPROVAL PAGE**

The project thesis titled **Second to fourth digit ratio in relation to demography, systemizing and empathizing amongst Bajju and Asholio population of Kaduna state by ABEL YASHIM SOLOMON** meets the regulations governing the award of degree of Master of Science in Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literacy presentation.

**Dr .B. Danborno (BSc, MSc, PhD)** __________________ __________________
**Chairman** Supervisory Committee, Signature Date
Department of Human Anatomy,
Faculty of Medicine,
Ahmadu Bello University.

**Dr. J. N ALAWA (BSc, MSc, PhD)** __________________ __________________
**Membe**r Supervisory Committee, Signature Date
Department of Human Anatomy,
Faculty of Medicine,
Ahmadu Bello University.

**Prof. S. S. Adebisi (BSc, MSc, PhD)** __________________ ______________
**Head of Department,** Signature Date
Department of Human Anatomy,
Faculty of Medicine,
Ahmadu Bello University.

**Professor Kabiru Bala** __________________ __________________
**Dean School of Postgraduate Studies,** Signature Date
Ahmadu Bello University.

## ACKNOWLEDGEMENT

All thanks to God for his grace and strength given me to carry out this research. I must also appreciate my incumbent mentor Dr. B. Danborno for his infinite patience, support, and inspiring words while he played his supervisory role in the course of this study, which makes this work a masterpiece. My appreciations also goes to Dr. J. N. Alawa for her constructive contributions and suggestion, words will not be enough to express my gratitude. Her patience to supervise me in this work is highly commended.

Many thanks to my Head of Department, Prof. S.S Adebisi, mylecturers such as Dr, Austin Ibegbu for his encouragement, Dr. U. E. Umana, Dr. W. O. Haman and Mr. S. A Musa for the pain they took to pass knowledge to me. They all tolerated my naivety, and inadequacy in so many ways to bring out the best in me. Mr. James Timbuak who helped me with some information to make this work great. I dare not forget Mr. Abel Agbon for his encouragement and advise.

I am highly indebted to the P.G Fellowship for their constant prayers for the success of this work. Much thanks to my colleagues one of whom is Monday Nwankwo, who has helped and encourage me from the start to the finish of this work with some equipments and even guide for the analysis of my data, may God bless you. Others include Stella Amuzor and Andrew for their support and encouragement, these individuals played vital role to encourage get along with this work. Their support to me covers all angle.

Thanks must also go to all male and female students who volunteered to take part in this study.

I must also thank my research assistants Miss Sheba and Mr. Bitrus for taking their time and the pain of helping me collect the data used in this study, I am indeed grateful. My heartfelt thanks to Mr. Matthew Habila of the department of geography for helping me out with the map used to

carryout this study, thank you so much. I must also remember my parents for their financial support, my able brother John Y. Solomon for being there for me when I needed him most, he has been so resourceful to me, always calling to know how the work is going, I really appreciate you all. Kudos to all those who at some point have made contributions, comments, appraise or made constructive criticisms to make the work what it is today.

# DEDICATION

I dedicate this work to my Parents Mr. and Mrs. Solomon Dauda Shekari and my siblings John, Nehemiah, Blessing and Gloria for their continual support during this work.

**TABLE OF CONTENTS**

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF APPENDICES

**ABSTRACT**

The ratio of 2nd to 4th digit length (2D:4D), the systemizing quotient (SQ) and the empathizing quotient (EQ) are commonly put forth as correlates of prenatal testosterone. However, the evidence that 2D:4D is related to SQ or EQ is mixed. Indirect finger measurements were used and no significant associations with 2D:4D and SQ or EQ was found, whereas significant correlations between 2D:4D and a composite measure of SQ and EQ using direct finger measurements was reported. This study aimed at reporting associations of traits largely determined *in-utero* (2D:4D), SQ, EQ and other anthropometric indices in participants from two ethnic groups, namely Bajju and Asholio of Kaduna state. SQ and EQ were assessed in 600 participants, 300 from each ethnic group consisting of both males and females, using a questionnaire of 120 questions. Body anthropometrics such as height, weight, hip, waist, chest circumference were measured using stadiometer and measuring tape. Digit lengths of the second and fourth fingers were directly measured from the proximal crease to the tip of the finger using vernier caliper. Digit ratio was found to be significantly lower in males than females in both ethnic groups (right hand; males: $0.964 \pm 0.050$, females: $0.987 \pm 0.054$, $t = 2.579$, $p = 0.010$, : left hand; males: $n = 0.984 \pm 0.040$, females: $n = 1.011 \pm 0.039$, $t = 4.549$, $p = .0001$).There was significant negative correlation between SQ and 2D:4D and this being stronger for right hand (right $r = -0.18$, left; $r = -0.08$, $p < 0.01$ and 0.05) and independent of weight, age, height, ethnicity, body mass index, waist-hip ratio, waist-chest ratio and education. There was no significant correlation between EQ and left and right 2D:4D (right $r = 0.13$, left; $r = 0.11$, $p > 0.01$ and 0.05) , right hand 2D:4D being the major predictor of SQ (*B=0.154*, *p=0.00*). Significant positive correlations was found between female's left and right hand 2D:4D, waist and hip circumference, and WCR (right $r = 0.12$, 0.26, 0.19 left; $r = 0.10$, 0.26, 0.25 $p < 0.01$ and 0.05). (v) BMI has no relation with right ratio in the female, is negatively related to left hand 2D:4D but insignificant (right $r = 0.13$, left; $r = -0.013$, $p > 0.01$ and 0.05). In

conclusion, it is found that right hand 2D:4D was negatively correlated with SQ in males and females. The relationship was strong to the effects of sex, age, height and education. This suggests that 2D:4D and SQ are influenced by Prenatal Testosterone at similar developmental times. There was no association between 2D:4D and EQ. Birth order and family size shows effect on SQ and EQ

# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 BACKGROUND OF THE STUDY

Digit ratio is the ratio of the lengths of different digits or fingers typically measured from the midpoint of proximal crease where the finger joins the hand to the tip of the finger (Mayhew *et al.,* 2007). An individual's fingers and toes begin to develop in the 6th week of pregnancy. Digit ratios are determined while the embryo forms and will then remain the same without change during individual development (Manning*et al.,* 2004). The fetus grows quickly from the 9th week of pregnancy, and this is the sensitive period for fetal development. The major feature of the fetal period is cell differentiation, which is sensitive to external environmental changes. So during this period, if the fetus encounters changes in the intra-uterine environment, such as intra-uterine under-nutrition or hormone level changes, not only will the fetal 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). Estrogen 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 that females (Manning*et al.,*1998) and it is a cross-cultural trait (Manning*et al.,* 2003; Manning *et al.,* 2004).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). (Gwunireama *et al.,* 2010) confirmed that digit ratio is sexually dimorphic and represents the original data for the people of the Niger Delta. 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 has 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).

Baron-Cohen (2003) proposed a theory which encompasses two different styles of thinking or 'cognitive styles' namely systemizing and empathizing. Systemizing is the drive to analyse and explore a system, to extract underlying rules that govern the behavior of a system and the drive to construct systems. Whereas empathizing is the drive to identify the thoughts and emotions of others and respond appropriately (Baron- Cohen, 2002, 2003; Baron-Cohen *et al.,* 2003).Cognitive styles in the current context should not be confused with the same term that cognitive psychologists traditionally conceptualized as the way someone perceives and remember information along a dimension (Kozhevnikov, 2007). While the two definition might share similar or overlapping characteristics, Baron-Cohen's conceptualization of cognitive style is born out of the volume of work with autistic children and endeavors to explain functional and cognitive differences between individuals with and without autistic traits. Males on average score higher on tests of systemizing and females usually score higher on tests of empathy (Baron-Cohen, 2002, 2003). These sex differences may arise as a result of the influence of Prenatal testosterone PT acting on the fetus such that it has an organizing effect on the brain and thus facilitates the ability in systemizing but reduces the ability to emphasize. Males develop a lower 2D:4D than females by the end of the first trimester of gestation (Malas *et al.,* 2006; Galis *et al.,* 2010). Because of the early fetal development of sexualdimorphismin2D: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).Over the past few years, this hypothesis has generated much interdisciplinary research interest (Gallup *et al.,* 2008; Voracek *et al.,* 2009). 2D:4D was shown to be a correlate of a multitude of sex-dependent, hormonally influenced variables such as behavioral, cognitive, personality, and somatic traits, adult onset disorders, and measures related to fertility and sexuality (Manning, 2002).

Many studies showed that low 2D:4D ratios correlated with athletic ability (Manning*et al.,* 2001; Manning *et al.,* 2007) and male aggression (Bailey and Hurd2005; McIntyre *et al.,* 2007).In a study conducted among the Nigerian population, showed males have a significantly negative relationship between right and left 2D:4D ratio with birth weight, while females show positively significant relationship in both right and left hands. This means that association exists between 2D:4D ratio and birth weight which could be predicted most especially from the left hands (Danborno *et al.,* 2010). On the other hand, results regarding other variables were less homogenous. For example, some studies investigating relations between finger digit ratios and sexual orientation reported that homosexual men have higher 2D:4D ratio than heterosexual men (McFadden *et al.,* 2002; Manning *et al.,* 2007), some homosexual men have lower 2D:4D ratio than heterosexual men (Rahman *et al.,* 2003; Rahman, 2005), and others showed that there was no significant difference between 2D:4D ratio in homo- and heterosexual men (Williams *et al.,*2000; Voracek *et al.,* 2007). The latest meta-analysis regarding 2D:4D and sexual orientation (Grimbos *et al.,* 2010) showed that there was no difference between heterosexual and gay men (but heterosexual women had more feminine 2D:4D ratio than did lesbians). Additionally, ethnicity explained some between-studies variation in men. Cross-racial differences in sexual dimorphism of 2D:4D is poorly investigated. Surprisingly, 2D:4D varies across nations and these cross-national differences are noticeably larger than the sex differences found within nations (Manning *et al.,* 2007; Manning *et al.,* 2000, 2003, 2004). As Voracek and Dressler (2006) discussed, these differences are poorly understood and, therefore, cross-cultural studies concerning 2D:4D are still interesting. Until 2006, samples from more than 25 different countries or ethnic groups were collected and investigated, but the participants were mainly White (Voracek*et al.,* 2006).

Human digits are numbered consecutively from 1 (thumb) to 5 (little finger). Because thumb length is difficult to measure, digit ratio generally just includes the six ratios of digit lengths, being 2D:3D, 2D:4D, 2D:5D, 3D:4D, 3D:5D and 4D:5D (Manning 2002). In 2000, a related paper published in Nature introduced studies on digit ratio, and pointed out that "finger length ratio may reveal some surprising information of development"(Williams *et al.,* 2000).

Accordingly, numerous studies have found associations between digit ratio and sexually dimorphic variables including – but not limited to – aggression, gender self-concept, stimulation seeking traits, nociception, and sporting ability (Fink *et al.,* 2006; Hampson *et al.,* 2008; Manning, 2002; Schmukle *et al.,* 2007; Schwerdtfeger *et al.,* 2008; Tester *et al.,* 2007).Recently researchers have been trying to investigate the relationship between 2D:4D and traits like coronary heart disease (Fink *et al*, 2006), gym-based physical fitness (Hoenekopp *et al.,* 2006), development of psychopathology (Fink *et al.,* 2007), cooperative behaviour (Millet *et al.,* 2006), attention deficit hyperactivity disorder (Stevenson *et al.,* 2007).

Progress has been rapid in describing the traits of digit ratio, especially the second to fourth digits (2D:4D) and its correlation studies in humans. It has been shown in early studies that 2D:4D differ between the genders. Males have lower 2D:4D ratio than females. It is generally assumed that this difference is established during early prenatal development under the influence of sex hormones. This view has illustrated by the recent experimental mouse work of (Zheng *and Martin* 2011:

Manning 2011). They revealed that the sex differences in 2D:4D were the results of prenatal testosterone (PT) and prenatal estrogen (PE) signaling in a narrow developmental time window in utero. Furthermore, an evidence suggests that in the human male, fetus starts to produce testosterone in week 8 and testosterone peaks at about week 11 or 12 to 14 (Scott *et al.*, 2009). The 2D:4D ratio is probably fixed during this tight time (Mallas *et al.*, 2006). Because of this, there has been increasing use of the 2D:4D ratio as an index of prenatal hormone exposure, and extensive studies in humans have found correlations between digits ratios and a variety of physiological and psychological conditions, including fertility, athletic ability, sex-biased diseases, social behaviors, and sexual orientation (Manning*et al.*, 2003: Zheng *and Martin* 2011).

Over the last decade, studies of 2D:4D ratio of many different populations have suggested a link between developmental stability and organism's general health and reproductive fitness (Roney *et al.*, 2004). Manning *et al.*,reported that 2D:4D was related to fertility in men (Manning *et al* 1999: Manning*et al.*, 2004). Low 2D:4D values in the right hand were associated with high sperm counts and high concentrations of testosterone. This finding is in agreement with earlier study by Wood (Wood *et al.*, 2003) on ICSI of sperm. However, (Firman *et al.*, 2003; Bang *et al.*, 2005) reported no association between 2D:4D and sperm parameters in men from the general population. In contrast, (Auger*et al.*, 2010) reported a week but significant positive association between low 2D:4D and fertility in a general population sample.

Manning and colleagues have shown that 2D:4D ratios vary greatly between different ethnic groups (Manning *et al.*, 2004) This variation is far larger than the differences between sexes; in Manning's words, "There’s more difference between a Pole and a Finn than a man and a woman."(Terrance *et al.*, 2000).

## 1.2 STUDY LOCATION

The study was conducted in Ahmadu Bello University, Zaria, Kaduna State University, Nuhu Bamalli polytechnic and College of Education Gidan -waya Kaduna state.

### 1.2.1 History

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.

### 1.2.2 Main Cities and Towns

Kaduna (capital city), Zaria, Kagoro, Kafanchan, Kachia and Zonkwa.Kaduna State is one of the seven states that make up the North West geopolitical zone of Nigeria. It has interstate boundaries with Niger State to the west, Zamfara, Katsina and Kano states to the north, Bauchi and Plateau states to the east and FCT Abuja and Nasarawa State to the south.

### 1.2.3 Weather/Climate

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 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 (79in), 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.


Fig. 2: Map of Nigeria showing a Kaduna State

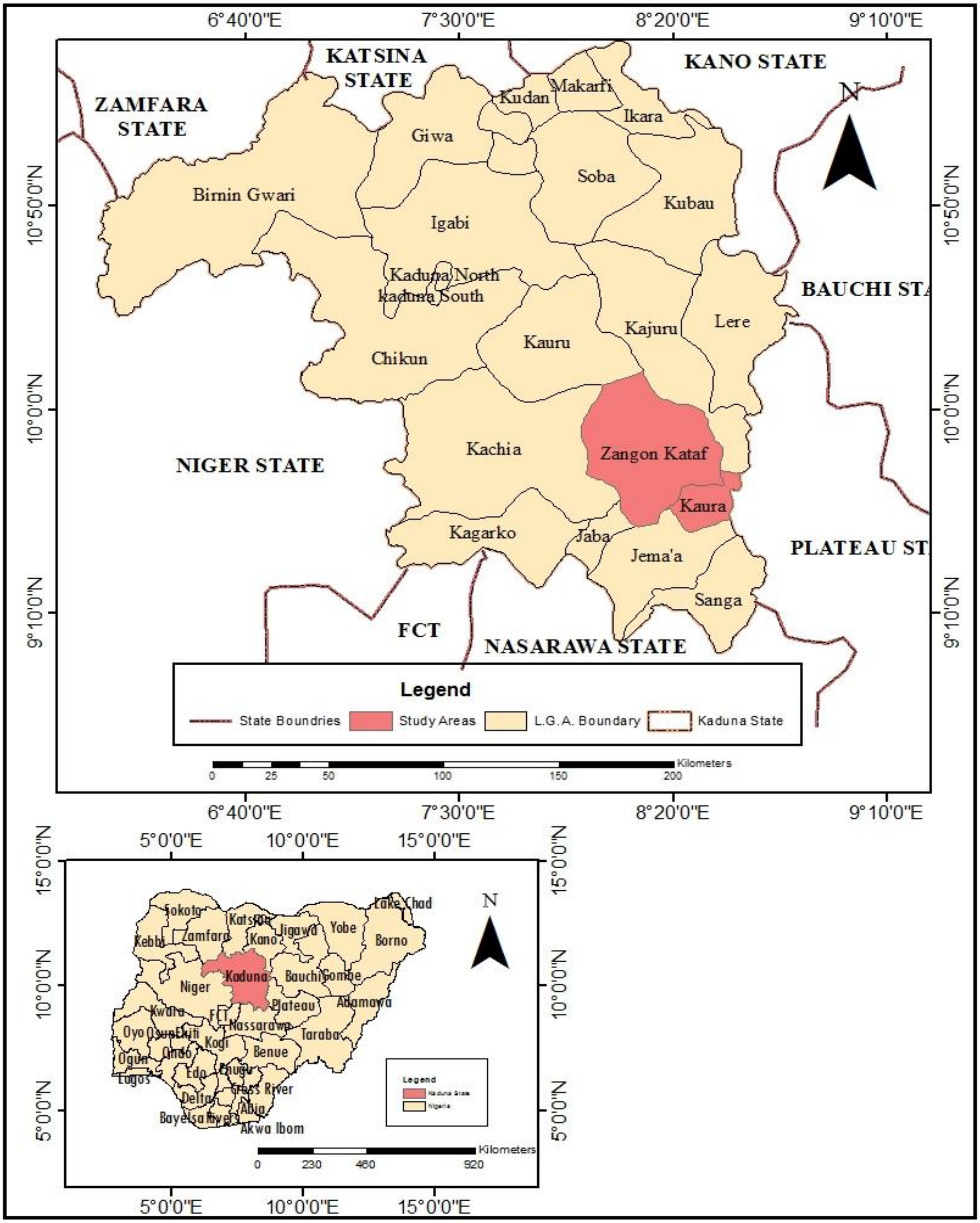


**Figure 3: Map of Kaduna state showing the Asholio and Bajju LGA as Kaura and Zangon-Kata**

### 1.2.4 Land Mass, Location and Population

Kaduna State lies at latitude 10°20′ north and longitude 7°45′ east and covers an area of 45,711.2 square kilometres. It has a population of 6,113,503 (2006 census figures) and a population density of 130 people per square kilometre. It accounts for 4.3% of Nigeria's total population.

### 1.2.5 Original Inhabitants and Settlers

The early settlers of Kaduna State were the Atyap (who occupy its southern part) and the Gbagyi peoples. Archaeological finds show that Kaduna State was home to the ancient Nok civilisation which dates back to 500AD. The main ethnic groups in Kaduna State are the Gbagyi, Hausa, Kamuku, Kadara and Kurama. Fifty-seven languages are spoken in the state; of these, Gbari and Hausa are the major ones. Christianity and Islam are the main religions in Kaduna State, although a fair amount of traditional religion is practised.

### 1.2.6 Administrative Structure

There are 23 Local Government Areas (LGAs) in the state. Each has a chairman as its administrative head. Local Government Areas in Kaduna states are Birni-Gwari, Chikun, Giwa, Igabi, Kajuru, Ikara, Jaba, Kachia, Jema'a, Kaduna North, Kaduna South, Kagarko, Kaura, Kauru, Kubau, Kudan, Lere, Makarfi, Sabon-Gari, Sanga, Soba, Zango-Kataf, Zaria.

### 1.2.7 Ethnic Composition, Culture and the Arts

Apart from the six major ethnic groups found in the State, there are over twenty other ethnic minority groups, each with its language and arts or religion different from the other. Works of art and pottery (e.g. the "Nok Terracotta") found in the southern parts suggest that it is a major cultural centre. Among the major ethnic groups are Kamuku, Gwari, and Kadara in the west, Hausa and Kurama to the north and Northeast. "Nerzit" is now used to describe the Jaba, Kaje, Koro, Kamanton, Kataf, Morwa and Chawai instead of the derogatory term "southern Zaria people". Also, the term "Hausawa" is used to describe the people of Igabi, ikara, Giwa and Makarti LGAs, which include a large proportion of rural dwellers who are strictly "Maguzawas."

In the north, the Hausa and some immigrants from the southern states practice Islam and majority of the people in the southern LGAs profess Christianity. The major Muslim festivals are the "Salah" celebrations while Christmas, New Year and Easter are observed by the Christians. Two traditional festivals of significance are the "TukHam" and "Afan" in Jaba and Jama'a LGAs respectively. Prominent among the traditional arts, are leather works, pottery and indigopit dyeing with Zaria as the major centre.

### 1.2.8 Population Structure and Distribution

Although majority of Kaduna State population live and depend on the rural areas, about a third of the State's populations are located in the two major urban centres of Kaduna and Zaria. However, except in the northwestern quadrant, the rural population concentration is moderate, reaching a high of over 500 persons per sq. km. in Kaduna/Zaria and the neighbouring villages; 350 in Jaba, Igabi and Giwa and 200 in Ikara LGAs. Despite the provisional nature of the census results, observations of movements of young able bodied male labourers in large numbers, from rural villages to towns during the dry season and back to rural agriculture fields during the wet season, suggest a sizeable seasonal labour force migration in the state.

However, the seasonal labour migration has no effect on agricultural labour demands in the rural traditional setting. Indeed, some of these seasonal migrants come to town to learn specific trade or acquire special training and eventually go back to establish in the rural areas as skilled workers (e.g. masons, technicians, tractor drivers, carpenters, motor mechanics, etc). Another major feature of the State's population structure is the near 1:1 male/female ratio, not just for the state as a whole, but even among all the LGAs.

The effects of this may be helpful to the future social and economic development of the rural sector especially in the agro allied rural industries. The large number of secondary school leavers, polytechnic and university graduates provides a growing skilled labour force for the growing industries in the State.

### 1.2.9 Urban and Rural Development and Patterns of Human Settlement:

The pattern of human settlement throughout the State is tied to the historical, political and socioeconomic forces the area has been subjected to, from the precolonial to post colonial period. Prior to the advent of the British occupation, the basic unit of human settlement was the extended family compound. As compounds grew, the needs for security and defense led to a higher hierarchy of settlements called "Garuruka" (towns). These towns were protected by walls with a titled/administrative head appointed by higher political authority, the "Sarki". This pattern of settlement dominated the Hausawa cultural groups to the north (i.e. Giwa, Igabi, Zaria, Sabon Gari, Kudan, Makarfi and parts of lkara LGAs). Higher settlement hierarchy than the rural extended family compounds in other parts of the state was delayed, until the development of social amenities and infrastructure such as motor and rail road, Christian Missionary establishments and recently, produce buyers, markets and administrative reorganizations gave impetus (settlements such as Birnin Gwari, Kuda'a, Kachia, Zango Kataf, Kwoi, Sambam, Kagoma and Saminaka are good examples).

## 1.3 STATEMENT OF RESEARCH PROBLEMS

The ratio of the length of the second to fourth digit (2D:4D ratio) presumably reflects prenatal exposure to sex hormones. The 2D:4D ratio is sexually dimorphic, and males consistently have a slightly lower value (Manning *et al.*, 1998). It is associated with many behavioral and biological variables, including fertility and sexual behavior but few studies have focused on its association with psychosocial traits like systemizing and empathy particularly among the Bajju and Asholio tribes.. Therefore, there is paucity of reference values for direct association between Second to fourth digit ratio, systemizing and empathizing in Bajju and Asholio population of Kaduna state. Hence the need to carry out this research to fill this gap.

## 1.4 JUSTIFICATION

There are indications that 2D:4D ratios correlate with aggression, dominance, sporting ability, fertility problems, number of children, health status, sexual orientation and other variables related to reproductive success. Therefore the need to correlate 2D:4D ratio, BMI, empathizing and systemizing among these ethnic groups is desirable. Results of this study may provide reference for the use of 2D:4D ratio in psychoanalysis of individuals. It may also confirm systemizing and empathy quotient as behavioural marker for prenatal testosterone.

## 1.5 SIGNIFICANCE OF STUDY

Digit ratio has been reported by many workers to show sexual dimorphism with women having higher ratio than men (Phelps 1952, Manning *et al.*, 1998, Manning *et al.*, 2002). This study will provide information about the digit ratio of Asholio and Bajju young adults and its association with systemizing, empathy and BMI. Can also provide functional index of nutritional status and social rehabilitation. The result of the present study will also show the influence of anthropometric indexes, ethnicity, geographical location, digit ratio on systemizing and empathy.

## 1.6 AIMS AND OBJECTIVES

### 1.6.1 AIM OF THE STUDY

The aim of this study is to evaluate the association of 2D:4D, empathizing, systemizing and anthropometric indexes among the Bajju and Asholio tribes in Kaduna state.

### 1.6.2 OBJECTIVES OF STUDY

The objectives of the present study is to investigate:

i. Sexual dimorphism in 2D:4D ratio amongst the Bajju and Asholio people.
ii. Ethnic difference in 2D:4D ratio between the Bajju and Ashilio groups.
iii. The relationship between 2D:4D ratio and BMI.
iv. The relationship between systemizing, empathizing and 2D:4D ratio.
v. Ethnic difference in systemizing and empathizing between the Bajju and Ashilio groups.
vi. The influence of education on empathizing and systemizing.

## 1.7 STUDY HYPOTHESIS

There will be sexual dimorphism in 2D:4D ratio, relationship between 2D:4D ratio with systemizing and empathizing behaviours amongst Bajju and Asholio people of Kaduna State, Northen Nigeria.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 HISTORY OF DIGIT RATIO RESEARCH

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 and 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, G. (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 (Kratochvíl *et al.,* 2009) which may be the basis for the sex difference in digit ratios and/or any putative hormonal influence on the ratios.

Zhengui and Martin, (2011) reports the 2D:4D ratio in mice is controlled by the balance of androgen to estrogen signaling 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 fetus 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 analyzing 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 (Hönekopp *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 (Hönekopp *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 ASSESSMENT 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 DIGIT RATIO DISTRIBUTION

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 and Hurd 2005) 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.

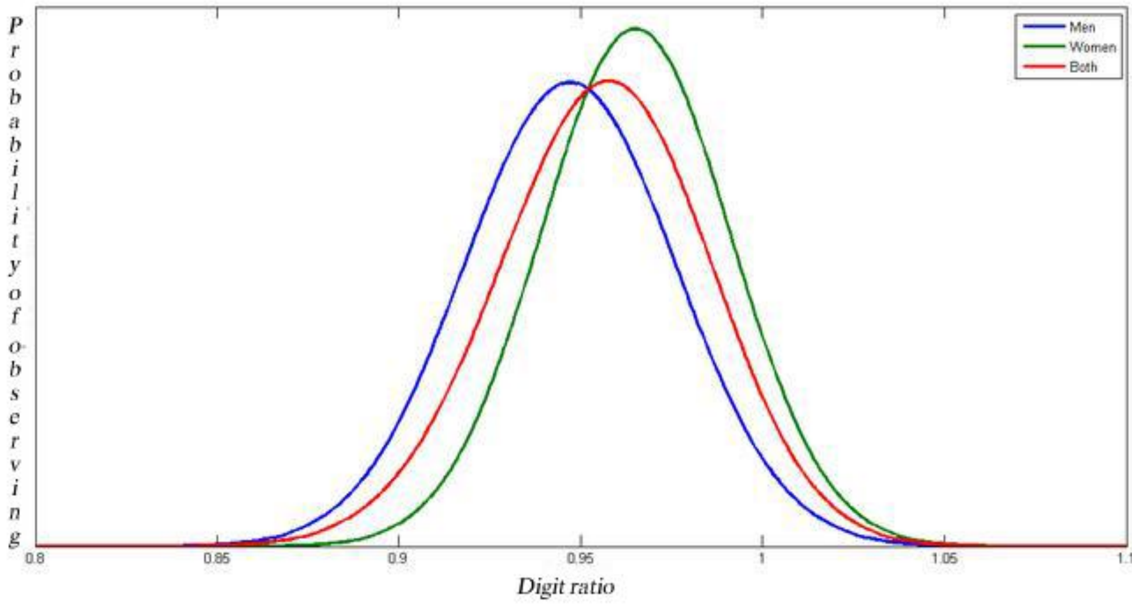


Fig. 1. Distributions of Men (blue), women (green), and the whole population (red). From a study of 136 males and 137 females (Bailey and Hurd *et al.*, 2005)

## 2.4 EVIDENCE OF ANDROGEN EFFECT ON DIGIT RATIO

Women with congenital adrenal hyperplasia (CAH), which results in elevated androgen levels before birth, have lower, more masculinized 2D:4D on average (Brown *et al.,* 2002, Okten *et a.,l* 2002 and Ciumas *et al.,* 2009). Other possible physiological effects include an enlarged clitoris and shallow vagina (Richard *et al.,* 2006). Males with CAH have more masculine (smaller) digit ratios than control males (Brown *et al.,* 2002, 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 androstenedione are several fold higher than in control males (Pang *et al.,* 1980,Dorr *et al.,* 1993 and 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. There are reports of a failure to replicate this finding (Hampson *et al.*, 2012). 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; Galis *et al.,* 2010) 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). In pheasants, the ratio of the 2nd to 4th digit of the foot has been shown to be influenced by manipulations of testosterone in the egg (Romano *et al.,* 2006).

Studies in mice indicate that prenatal androgen acts primarily by promoting growth of the fourth digit (Zheng *et al.,* 2011). There is evidence that this reflects fetal exposure to the hormones testosterone and estrogen (McIntyre, 2006). Several studies present evidence that digit ratios are heritable (Paul *et al.,* 2006; Gobrogge *et al.,* 2008). The level of estrogen in the amniotic fluid is not correlated with higher 2D:4D, and when examined researchers found no difference in estrogen 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. 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 *et al.,* 2010).

## 2.5 GEOGRAPHIC AND ETHNIC VARIATION IN DIGIT RATIO

Manning and colleagues have shown that 2D:4D ratios vary greatly between different ethnic groups (Manning *et al.,* 2000, 2004). This variation is far larger than the differences between sexes; in

Manning's words, "There's more difference between a Pole and a Finn, than a man and a woman (Terrance *et al.*, 2000).

## 2.6 CORRELATION BETWEEN DIGIT RATIO AND TRAITS

Some authors suggest that digit ratio correlates with health, behaviour, and even sexuality in later life. Below is a non-exhaustive list of some traits that have been either demonstrated or suggested to correlate with either high or low digit ratio.

Table 1.1: Summary of digit ratio correlations with different parameters

| Digit Association | Low digit ratio | High digit ratio |
|---|---|---|
| **Physiology and disease** | | i. Lowered sperm counts (Manning *et al.*, 1998)<br>ii. Increased risk for heart disease in males (Manning *et al.*, 2001)<br>iii. Increased risk of obesity and metabolic syndrome in males (Fink *et al.*, 2006)<br>iv. Reduced risk for prostate cancer (Walsh *et al.*, 2010)<br>v. Reduced birth size in males (Ronalds *et al.*, 2002; Klimek *et al.*, 2014) |
| **Psychological disorders** | i. Increased rate of ADHD in males (McFadden *et al.*, 2005,Stevenson *et al.*, 2007, and Martel *et al.*, 2008, 2009)<br>**ii.** Reduced risk in females for anorexia nervosa (Klump *et al.,* 2006) and in males for eating disorders (Smith *et al.*, 2009) | i. Reduced rate of autism and Asperger syndrome (Manning *et al.*, 2001)<br>ii. Increased risk for depression in males (Bailey *et al.*, 2005)<br>iii. Increased rate of schizophrenia (Arató *et al.*, 2004)<br>iv. Increased rate of psychopathy in females (Blanchard *et al.*, 2010)<br>v. Reduced risk of alcohol dependency (Kornhuber *et al.*, 2011)<br>vi. Reduced risk of video game addiction (Kornhuber *et al.*, 2013)<br>vii. Increased Anxiety in males (Evardone *et al.*, 2009) |
| **Physical and competitive behavior** | | i. Reduced performance in sports (Manning *et al.*, 2001)<br>ii. Reduced financial trading ability (Coates *et al.*, 2009)<br>Right handedness Skills (Fink *et* |

| | | |
|---|---|---|
| | | *al.*, 2004)inconclusive (Titus-Ernstoff, 2003) |
| **Cognition and personality** | i. Assertiveness in females (Wilson, 1983)<br>ii. Aggression in males (Bailey *et al.*, 2004; Benderlioglu *et al.*, 2005)<br>iii. Masculinity of Handwriting (Beech *et al.*, 2005)<br>iv. Perceived 'dominance' and masculinity of man's face (Neave *et al.*, 2003; Burriss *et al.*,2007)<br>In an orchestral context, rank and musical ability in males (Sluming *et al.*, 2000) | iii. |
| **Management** | i. Leadership (Derval, 2010)<br>ii. Innovation (Derval, 2010)<br>v. | |
| **Sensory Perception** | | i. Smell perception (Derval, 2010)<br>ii. Color perception (Derval, 2010)<br>iii. Tactile perception (Derval, 2011) |
| **Sexual orientation** | Lesbians have a lower digit ratio, on average, than heterosexual women (Csathó *et al.*, 2003, Williams *et al.*, 2000, Tortorice , 2002, McFadden et al., 2002, Hall *et al.*, 2003, Rahman *et al.*, 2003, Putz *et al.*, 2004, Rahman, 2005,Kraemer *et al.*, 2006,Wallien *et al.*, 2008,Grimbos *et al.*, 2010,Hirashi *et al.*, 2012) | i. Sexual preference for more masculine men among women (Csathó *et al.*, 2003) and gay men (McIntyre, 2003) with high digit ratio; a preference for a masculine facial type means a more "feminized" mindset.<br>ii. Lesbians are more likely to be femme and less likely to be butch with a high digit ratio (Tortorice,2002;Brown,2002). Identical female twins discordant for sexual orientation still show the difference (lesbian less than straight, on average) in digit ratio (Hall *et al.*, 2003; Hirashi |

| | | |
|---|---|---|
| | | *et al.,* 2012).<br>iii Homosexuality for men (McFadden *et al.,* 2002; Churchchill *et al.,* 2007) but this is disputed (Grimbos *et al.*, 2010; Robinson *et al.,* 2000) and subject to geographic variations (Schneider *et al.*, 2006) |

## 2.7 CORRELATION BETWEEN DIGIT RATIO AND MUSCULAR ENDURANCE

Relationship between digit ratio (2D:4D) and dynamic muscular endurance was 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.,* 2009). 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 (Paul *et al.,* 2006; Honekopp *et al.*, 2006).

Moreover, 2D:4D ratio is a biological marker for assessing the 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, 2005), 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 have interested in the relationship between different hand dimensions with sport abilities and physical fitness components. Visanpo *et al* (2007) found that there is a significant relationship between the hand grip and the ratio of digits in male basketball and volleyball players of 10-17 years old (Visanpo *et al.,* 2007). Experimental research results show that digit ratio (2D:4D) can predict some sport behaviors. 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 the soccer, speed running and ski is reported in many researches (Manning, 2002a, b; Manning and Taylor, 2001; 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 (Whiting and Zernicke,1998). 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 fibers 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, 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, 2009), 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 experiment. Mehdizadeh *et al* (2011) studied the relationship between digit ratio (2D:4D) and some physical fitness factors such as aerobic fitness, flexibility, strength and muscular endurance in immature and non-athlete girls.

They showed a significant relationship between left and right hand 2D:4D and physical fitness in immature girls. Rashidlamir *et al.,* (2009) also reported the similar relationship between hand grip and digit length in preadolescent trained male swimmers. 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, 2009). Although muscular endurance is very important in health and physical fitness, but there is 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; Jurimae, 2009; Schaap *et al.,* 2005). 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 the 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 (Rahemi *et al.,* 2013). Rahemi 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).

Another study has shown that women generally have more muscular endurance than males at sub-maximal levels; however this advantage seems to disappear or lessen when working at levels closer to their voluntary maximum(Hicks *et al.,* 2001). Moreover, the acquisitive nature of muscular endurance, gender differences and subsequently the difference in sex hormones level and muscle fiber type distribution are the factors affecting the relationship between the digit ratio (2D:4D) and muscular endurance. Muscular endurance is an acquisitive variable, but the digit ratio forms in the prenatal phase and doesn't change after birth and during the life time (Lutchmaya, *et al.,* 2003; Honekopp *et al.,* 2006).

## 2.8 CORRELATION BETWEEN DIGIT RATIO AND JEALOUSY

Jealousy is thought to be an evolved psychological response with distinct differences between men and women (Buss, 2000). Feelings of jealousy are evoked partly through a process of social comparison in which jealous individuals compare their own characteristics with those of the rival—when the rival is believed to surpass them on these characteristics, the rival is likely to be perceived as a threat to the relationship and therefore evoke feelings of jealousy (Buunk *et al.,* 2007; DeSteno and Salovey, 1996). Because men and women value different characteristics in a mate, they may pay attention to different characteristics in a rival. Cross-cultural studies on mate preferences have shown that women (more than men) prefer mates with high social status and dominance, which is presumably an evolved preference for men who can provide them and their children with resources. In contrast, men (more than women) prefer mates who are high in physical attractiveness, which may serve as an important cue to a woman's health and fertility (Buss, 1994).

Paralleling sex differences in mate preferences, males respond more jealously to a rival with status- and dominance-related characteristics, whereas females respond more jealously to a rival who is physically attractive (Buss *et al.*, 2000; Dijkstra and Buunk, 2002). Strong evidence for the link between higher embryonic exposure to androgens and lower 2D:4D comes from a recent study of dizygotic twins showing that 2D:4D is more masculinized among females with a male twin than among females with a female twin (van Anders, and Wilbur, 2006). There is also experimental evidence that injecting testosterone into eggs leads to changes in digit ratio in the ring-necked pheasant (Romano *et al.*, 2005). Within each sex, 2D:4D has been found to be associated with a variety of physical and psychological characteristics. For example, men with lower 2D:4D are more aggressive, more athletic, less feminine (on the Bem Sex Role Inventory), and more musically talented (Bailey and Hurd, 2005; Manning and Taylor, 2001; Rammsayer and Troche, 2007; Sluming and Manning, 2000). Women with lower 2D:4D have higher waist-to-hip ratio, are more masculine (on the Bem Sex Role Inventory), and are more athletic (Csathó *et al.*, 2003; Manning *et al.*, 2000; Pokrywka, and Bitel, 2005). Among both men and women, 2D:4D is correlated positively with verbal intelligence and agreeableness, and negatively with numerical intelligence and physical fitness (Hönekopp, and Manning, 2006; Luxen and Buunk, 2005).

Because women desire status- and dominance-related (typically “masculine”) features in a mate, these features observed in a rival are likely to evoke a particularly high level of jealousy among less masculine men. Likewise, because men desire physically attractive (typically “feminine”) features in a mate, these features observed in a rival are likely to evoke a particularly high level of jealousy among less feminine women. One speculation is that although low 2D:4D is associated with physical fitness ( Hönekopff and Müller, 2006), it is also associated with features such as musical ability, numerical intelligence, and cooperative behavior (e.g., Luxen and Buunk, 2005; Millet and DeWitte, 2006; Sluming and Manning, 2000)— characteristics that may be more directly associated with social rather than physical dominance. Indeed, it has been noted that the adaptive consequences of male masculinity may manifest through socially mediated behaviors, rather than simply through physical characteristics (Gangestad and Thornhill, 2007). Men’s jealousy was aroused most strongly by socially dominant rivals (and the least strongly by physically dominant rivals).

Nevertheless, future research must examine more directly how 2D:4D is related to various types of dominance, more dominant and masculine (Neave, and Manning, 2003), there is no unequivocal evidence that lower 2D:4D is associated with more socially dominant behaviors. His findings also indicate that jealousy is not an invariant response, but is flexibly engaged in a predictable manner, depending on one’s sex and characteristics relevant to one’s mate value. Future research should investigate which psychological variables—such as sex role identity—

may mediate the effects of 2D:4D on jealousy and on other psychological phenomena within the realm of romantic and interpersonal relationships.

## 2.9 CORRELATION BETWEEN DIGIT RATIO AND MALE ABILITY IN SPORTS

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 and Catterall, 1981; McEwen, 1981). Androgens are critical for sexual differentiation of the nervous system and the development of abilities such as spatial judgement (Geschwind and Galaburda, 1985; Kimura, 1996, 1999), and in males the formation of an efficient cardiovascular system (Manning and Bundred, 2000).

In his report Manning *et al.,* (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 affect of Country was removed. He suggest 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 and 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, and Oram, 1986; Swartz and Young, 1987, Sewardson, and Desai, 1990; Phillips, and Jing, 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 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 *et al.*, (2001) therefore suggest that 2D:4D ratio is a negative correlate of male competitiveness, fertility and attractiveness.

## 2.10 CORRELATION BETWEEN DIGIT RATIO AND FACIAL ATTRACTIVENESS

There is growing evidence that human second-to-fourth digit ratio (or 2D:4D) is related to facial features involved in attractiveness, mediated by *in utero* hormonal effects. Androgens such as testosterone are also involved in the development and maintenance of secondary sexual characters, and thereby in mate choice. Because maintaining a high level of testosterone is costly for males, those that display enhanced sexual characters without suffering too much from immunosuppression are considered high-quality males (Folstad *et al.*, 1992). Therefore, women should ultimately increase their reproductive success by choosing mates displaying testosterone-dependent sexual traits (Folstad *et al.*, 1992).

In humans, men with higher levels of circulating testosterone have voices with lower fundamental frequency (Evans *et al.*, 2008) and more masculine faces (Penton-Voak *et al.*, 2004) two traits that are preferred by women when they become sexually mature. To date, investigations of these putative relationships are scarce and remain principally focused on face and body masculinity of men. Moreover, results from studies are conflicting. For example, Neave *et al.*, (2003) found a negative correlation between 2D:4D ratios of the left and right hand and the female perception of male facial dominance and masculinity, but Koehler *et al.*, (2004) failed to repeat these results and found no relationship between 2D:4D and body and face masculinity.

Furthermore, some authors found a link between 2D:4D and attractiveness (Manning, Roney and Collins 2000, 2004, 2007) whereas others did not Neave *et al.*, (2003). To date, studies testing relationships between 2D:4D ratios and sexually selected traits have only focused on men's bodies and faces, although there is evidence that women use multiple testosterone-dependent cues to select mates, such as voice and body odour (Havlicek *et al.*, 2008) . As for faces , voice frequency and thus attractiveness are related to the level of salivary testosterone . Similarly, androgen level is likely to influence body odour since steroid compounds of axillary odour such as androstadienone are present more in males and are products of testosterone transformation by underarm bacteria (Rennie *et al.*, 1989; Havlicek *et al.*, 2008). Right hand 2D:4D also predicts perceived facial symmetry. The link between 2D:4D and facial attractiveness is consistent with previous studies investigating either self-evaluated attractiveness or men's attractiveness rated by women (Bogaert *et al.,* 2009 and Roney 2004) . This illustrates a female preference for men with a low 2D:4D ratio possibly driven by the fact that these have more symmetrical faces. Such a preference might have evolved because it increases females' reproductive success by gaining benefits from partners who are physically more robust and who have more fertile ejaculates (Manning et al.,1998 and Auger *et al.,* 2010). Ferdenzi*et al.,* (2011) suggests that right 2D:4D is a good predictor of facial attractiveness in men, but not of their voice or body odour attractiveness.

## 2.11 CORRELATION BETWEEN DIGIT RATIO AND TRAFFIC VIOLATIONS

Several demographic and psychosocial factors have been discussed to impact road traffic security and traffic violations (e.g., speeding, violations resulting in fatal accidents, driving while intoxicated, violations resulting in personal injury, driving with a suspended license, passing where prohibited, illegal parking, (Arthur and Day, 2008; Lagarde *et al.,* 2004; Machin and Sankey,2008). Among these variables, age, sex, and driving experience have most consistently been associated with traffic violations. For example, it has been shown that younger and inexperienced drivers are more frequently involved in road accidents (e.g., Williamson, 2003) and males have a higher risk for traffic violations than females (e.g., Simon and Corbett, 1996). Psychological and biological variables have also been discussed to increase risk for traffic violations and, moreover, these variables might partially explain why younger drivers and males are more prevalent among traffic violators. For example, in a recent study, Hatfield and

Fernandes (2009) found that younger drivers exhibit lower risk-aversion and a higher propensity for taking accident risks as compared to older drivers.

In addition, the tendency to seek novel, varied, and complex sensations and experiences, and the willingness to take risks for the sake of such experiences (i.e., sensation seeking; Zuckerman, 1994) are associated with risky driving and traffic violations (Dahlen *et al.*, 2005; Furnham and Saipe, 1993; Jonah, 1997; Jonah *et al.*, 2001; Zuckerman, 1994). It is interesting to note here that males and younger individuals have higher scores on sensation seeking than females and older individuals (Zuckerman, 1994). Besides psychological variables, biological approaches can aid our understanding of inter individual differences in traffic violations. Several studies have focused on biological factors of risk taking and sensation seeking behavior in general (for an overview, Zuckerman, 1994). For example, dopaminergic neurotransmission has been found to be associated with risk-taking behavior in both animals and humans (e.g., Adriani *et al.*, 2009; Ebstein *et al.*, 1996), and gonadal hormones (e.g., testosterone) have been related to risktaking behavior and sensation seeking as well (Aluja and García, 2005; Daitzman and Zuckerman, 1980; Zuckerman, 1994).

More recently, there has been a growing interest in the role of prenatal gonadal hormone exposure on various sexually dimorphic behavioral domains, including childhood play behavior, sexual orientation, and aggressive behavior (e.g., Collaer and Hines, 1995). Specifically, in utero gonadal hormones (androgens and estrogens) have been found to alter neural substrates in such a way as to make them, and hence behavior, more susceptible to the later activational effects of circulating hormones (Goy and McEwen, 1980; Meaney, 1988; Tobet and Baum, 1987). For example, there is considerable evidence that higher testosterone exposure in utero results in more masculinized behavior in later life, and higher estrogen exposure leads to more feminized behavior. The direct assessment of prenatal hormone exposure, however, is challenging and problematic because of obvious ethical reasons. Therefore, research throughout the last decade has identified a more indirect approach to the assessment of prenatal gonadal hormone exposure (i.e., digit ratio). There is now increasing evidence for the hypothesis that prenatal androgens might also increase risk preferences in later life. For example, Coates *et al.,* (2009) recently found that male high frequency financial traders' long-term profitability was inversely related to digit ratio, indicating more financial risk-taking in individuals with a more masculinized digit ratio.

This finding is quite compatible with other hormonal research documenting that testosterone facilitates risk-taking behavior in gambling tasks (Apicella *et al.,* 2008; van Honk *et al.,* 2004). Other studies examined associations between digit ratio and personality variables that are related to risk-taking behavior. For example, the personality trait sensation seeking has been inversely related to digit ratio (Fink *et al.,* 2006; Hampson *et al.,* 2008). Sensation seekers underestimate or accept physical, social, legal, and financial risks as the price for the reward provided by the sensation or experience itself. It should be noted that sensation seeking – similar to digit ratio – has been related to testosterone exposure (Daitzman and Zuckerman, 1980; Resnick *et al.,* 1993). Augmenting–reducing is another personality variable that has been related with the choice of risky lifestyles. It refers to the tendency to cortically augment or reduce sensory stimuli such that reducers are less responsive to sensory stimulation and, thus, more likely to engage in risk-taking behaviors (e.g., Schwerdtfeger, 2007). Similar to sensation seekers, reducers have been found to show a lower digit ratio as compared to augmenters (Schwerdtfeger and Heer, 2008). Andreas et al., (2010) shows thata more masculinized digit ratio predicted more legally registered traffic infringements, suggesting organizational effects of prenatal androgens on traffic offense behavior.

## 2.12 DIGIT RATIO AND PLAY BEHAVIOUR IN CHILDREN

Children's play behavior shows one of the largest sex differences in human behavior (Hines, 2004), with effect sizes of about d = 2 and larger being reported (e.g., Auyeung *et al.,* 2009; Golombok  and Rust, 1993; Knickmeyer *et al.,* 2005). Sex differences in play behavior include a preference for playing with same-sex peers, toy preferences (girl typical: dolls, jewellery, etc.; boy typical: cars, weapons, etc.), and activity preferences (girl typical: playing a female character, playing family, etc.; boy typical: playfighting, ball games, etc.).

Sex differences in play behavior have also been demonstrated in many other species including baboons, chimpanzees, hamsters, marmosets, ponies, rats, rhesus monkeys, sea lions, sheep, and squirrel monkeys, with males showing more rough-and-tumble play than females (Becker, 2002). In animals and humans, differences in testosterone (T) have been shown to play a key role in sexually differentiated play behavior (Auyeung *et al.*, 2009; Goy, Bercovitch, and McBrair, 1988; Pellis, 2002). It has been reported that relationship between the length ratio of the second to the fourth finger (2D:4D), it is presumably a negative correlate of prenatal T levels in humans (Manning, 2002), and sex-typed play behavior in pre-schoolers. Across a wide range of species, males show particularly high T levels during specific periods in early development, typically during gestation or early after birth (Breedlove and Hampson, 2002; Neave, 2008).

Early T exposure produces permanent changes in neural organization (Neave, 2008) and plays an important role in the sexual differentiation of a wide range of behaviors, including sex-typed play behavior. Effects of early T on juvenile play behavior have been experimentally demonstrated in rats (Pellis, 2002) and rhesus macaques (Goy et al., 1988), with higher T levels leading to more rough-and-tumble play. Spikes in male T levels during early development also occur in humans. In male fetuses, T secretion from testes starts at about the 9th week of gestation, and T levels peak between 10 and 20 weeks (Knickmeyer and Baron-Cohen, 2006). In the second trimester, male T production declines and remains at low levels until after birth (Word, George, Wilson, and Carr, 1989). From around three months after birth, there is a second peak in human male T levels (Andersson *et al.,* 1998).

There is now clear evidence that exposure to high T levels during early development has permanent effects on various sex-typed behaviors in humans (Collaer and Hines, 1995; Cohen-Bendahan and Berenbaum, 2005). Most evidence regarding a potential effect of early T on sex-typed play behavior in humans stems from individuals affected with congenital adrenal hyperplasia (CAH). CAH causes excessive androgen production from the adrenal glands during gestation. Although postnatal treatment brings androgen levels back to normal (Speiser and White, 2003), CAH affected girls show masculinised and defeminised play behavior in comparison to normal controls (reviews in Hines, 2003; Knickmeyer *et al.,* 2005). A similar effect was not observed in boys, but CAH affected boys appear to have normal prenatal T levels (Pang *et al.,* 1980). Although studies on girls with CAH support the idea that prenatal T affects sex-typed play behavior in humans, too, these studies have limited internal validity because CAH affected girls differ from normal controls in that they have masculinised genitalia and a severe medical condition (Cohen-Bendahan *et al.,* 2005; Hines, 2003; Knickmeyer *et al.,* 2005). Furthermore, studies on CAH affected individuals cannot elucidate whether normal variation of prenatal T within each sex has any effects on sex-typed play behavior.

This question was addressed in a longitudinal study by Auyeung *et al.,* (2009), which related amniotic T (measured around the 16th week of gestation) to sex-typed play behavior at age nine years as indicated by mothers answering the Pre-School Activities Inventory (PSAI, Golombok and Rust, 1993). Higher testosterone levels were clearly related to more masculine play behavior in girls ($n = 100$, $b = .27$) and boys ($n = 112$, $b = .21$). In a similar study, Knickmeyer et al., did not find a significant correlation between amniotic T and sex-typed play behavior in either girls or boys, which may be a result of this study's moderate sample size (girls: $n = 22$; boys: $n = 31$). Several lines of evidence indicate that 2D:4D is negatively related to early T exposure. 2D:4D shows a universal sex difference with men showing, on average, smaller ratios than women (Manning, Churchill, and Peters, 2007). This sex difference is already apparent at the end of the first trimester (Malas, and Desdicioglu, 2006). The sex difference in 2D:4D as well as individual values, show considerable stability across childhood and adolescence (McIntyre, and Ellison, 2006; McIntyre, and Towne, 2005; Trivers and Jacobson, 2006).

Moreover, the development of digits and the uro-genital tract are controlled by the same homeobox genes (Kondo and Duboule, 1997), and postnatal 2D:4D was found to be significantly related to the prenatal T/estrogen ratio as determined by amniocentesis (Lutchmaya, and Manning, 2004). In addition, T sensitivity depends on the number of CAG repeats in the androgen receptor gene, and the number of these repeats is related to 2D:4D (Manning and Flanagan, 2002). Also, individuals exposed to atypical T levels before birth show alterations in sex-typical 2D:4D, thus CAH children displayed lower 2D:4D than normal controls in two out of three studies (Brown and Breedlove, 2002; Ökten and Yaris, 2002; Buck and Acerini, 2003). Furthermore, girls with male as compared to those with female co-twins are believed to have higher prenatal T levels and they also have lower 2D:4D (van Anders and Wilbur, 2006; Voracek and Dressler, 2007; but see Medland and Martin, 2008, for a negative result). Also, mothers' smoking during pregnancy is positively related to fetal T levels and it correlates negatively with sons' 2D:4D (Manning, and Brabin, 2007).

Moreover, high prenatal T levels delay the onset of menarche, and 2D:4D is negatively related to self-reported menarcheal age in women (Matchock, 2008). Finally, high prenatal T levels have been implicated as causes of polycystic ovarian syndrome in females (Cattrall and Weston, 2005) and of autism (Baron-Cohen and Belmonte, 2005); 2D:4D has been found to be lower in autistic people (Manning and Sanders, 2001) and in females with polycystic ovarian syndrome (Cattrall *et al.,* 2005) than in normal controls. In sum 2D:4D appears to be negatively affected by prenatal T in humans. At the same time, 2D:4D appears unrelated to circulating steroid levels (Hönekopp, and Liebert, 2007) and can thus be regarded as useful for studying long lasting effects of prenatal T in humans. For this reason, 2D:4D has become increasingly popular for studying effects of early androgenisation on human adult behavior and physiology (Voracek and Loibl, 2009). Here, we investigate for the first time a potential negative relationship between children's sex-typed play behavior and 2D:4D. Unlike Auyeung *et al.,* (2009), who looked at nine-year olds, we look at pre-schoolers. Negative relationships between 2D:4D and masculinity of play behavior would lend additional support to the idea that prenatal T masculinises children's play behavior; in connection with the findings of Auyeung and colleagues, they would further support the validity of 2D:4D as an easy to use measure of organizational effects of early testosterone. The ideas that normal variations in early Testosterone affect sex-typed play behavior in humans and that they thus further support the validity and usefulness of 2D:4D for studying the effects of early androgenisation in humans.

## 2.13 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 (Hines, 2005) and brain size (Hines, 2005) 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 cognition (Baron-Cohen, 2003; Hamilton, 2009; Kimura, 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. In human cognitive psychology, visual spatial tasks possibly demonstrates one of the biggest sex differences with male advantage particularly for the mental rotation task and spatial perception skills (Hyde, 2005; Voyer, and Bryden, 1995). On the other hand, a meta-analytic study confirm that facial emotion processing demonstrate female advantage (McClure, 2000). Inaddition, this observation is possibly related to brain structural differences between male and female (Gur and Gunning-Dixon, 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 Jr and Chang, 1998). Similarly, men’s enhanced performance of the mental rotation task has been attributed to their role in tool making (Kimura, 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 (Hyde, 2005) 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, 2003) and 2D:4D finger digit length. In addition, sexual dimorphism for functional asymmetry is commonly observed (Hines, 2005; Kimura, 2000).

## 2.14 BODY MASS INDEX, WEIGHT, HEIGHT AND DIGIT RATIO

Several studies have noted the recent secular changes in BMI in the United States (Troiano *et al.*, 1995; Adair and Gordon-Larsen, 2001; Ogden *et al.*, 2002), as well as around the world (Fredriks *et al.*, 2000; Bundred *et al.*, 2001; Armstrong *et al.*, 2003; Lissau *et al.*, 2004). Studies in the United States have noted that there has been an increase in mean levels of BMI, with distributions skewed to the right (Flegal and Troiano, 2000), suggesting the extent of overweight has been increasing faster than the prevalence (Jolliffe, 2004). Although the mean BMI has increased for the population, the BMI in children who are heavier has increased more than children who are less heavy.

Several factors predisposing to increases in BMI, including increases in total calories and in consumption of fast foods, decreases in physical activity, and, a factor not totally independent of the first two, an increase in hours spent watching television have been proposed. There have been several studies that noted an increase in total consumption of calories over the past 30 years (Jahns *et al.*, 2001), with the greatest increases in consumption of salty snacks and soft drinks and decrease in consumption of milk (Nielsen *et al.*, 2002). When fast food is consumed (which occurred on 30% of the days), more total energy was consumed, with a greater caloric density (Bowman *et al.*, 2004); this study further noted that fast food consumption contributed 57 kcal daily to all US youth (Bowman *et al.*, 2004). Another report noted that when overweight and normal weight adolescents were observed in a fast food setting, overweight participants consumed more calories than their leaner counterparts, and that they consumed more calories on fast food days compared with non-fast food days (Ebbeling *et al.*, 2004). The impact of dietary changes has had an impact on Western as well as non-Western populations. Popkin (2002) has noted a ‘nutrition transition’ over many societies, with a pattern of diet high in saturated fat, sugar and refined foods, and low in fibre.

## 2.15 DIGIT RATIO AND RISK TAKING

There is now increasing evidence for the hypothesis that prenatal androgens might also increase risk preferences in later life. For example, Coates et al., (2009) recently found that male high frequency financial traders’ long-term profitability was inversely related to digit ratio, indicating more financial risk-taking in individuals with a more masculinized digit ratio. This finding is quite compatible with other hormonal research documenting that testosterone facilitates risk-taking behavior in gambling tasks (Apicella et al., 2008; van Honk et al., 2004). Other studies examined associations between digit ratio and personality variables that are related to risk-taking behavior. For example, the personality trait sensation seeking has been inversely related to digit ratio (Fink *et al.,* 2006; Hampson *et al.,* 2008).

Sensation seekers underestimate or accept physical, social, legal, and financial risks as the price for the reward provided by the sensation or experience itself. It should be noted that sensation seeking – similar to digit ratio – has been related to testosterone exposure (Daitzman and Zuckerman, 1980; Resnick *et al.,* 1993). Augmenting–reducing is another personality variable that has been related with the choice of risky lifestyles. It refers to the tendency to cortically augment or reduce sensory stimuli such that reducers are less responsive to sensory stimulation and, thus, more likely to engage in risk-taking behaviors (Schwerdtfeger, 2007). Similar to sensation seekers, reducers have been found to show a lower digit ratio as compared to augmenters (Schwerdtfeger and Heer, 2008).

## 2.16 MALE-TO-FEMALE TRANSEXUAL PEOPLE

A study in Germany has found a correlation between digit ratio and male-to-female transexualism. Trans-women were found to have a higher digit ratio than cis-gender males, but one that was comparable to control females (Schneider *et al.,* 2006).

## 2.17 DIGIT RATIO AND DEVELOPMENT

There is some evidence that 2D:4D ratio may also be indicative for human development and growth. Ronalds *et al.,* (2002) showed that men who had an above average placental weight and a shorter neonatal crown-heel length had higher 2D:4D ratios in adult life. Moreover, studies about 2D:4D correlations with face shape suggest that testosterone exposure early in life may set some constraints for subsequent development. Prenatal sex steroid ratios (in terms of 2D:4D) and actual chromosomal sex dimorphism were found to operate differently on human faces, but affect male and female face shape by similar patterns (Fink *et al.,* 2004). He also found that men with low (indicating high testosterone) and women with high (indicating high estrogen) 2D:4D ratios express greater levels of facial symmetry (Fink *et al.,* 2005). However, exposure to very high levels of testosterone and/or estrogen in the womb may have negative effects as well.

## 2.18 EMPATHIZING-SYSTEMIZING THEORY

The empathizing–systemizing (E-S) theory suggests that people may be classified on the basis of their scores along two dimensions: empathizing (E) and systemizing (S). It measures a person's strength of interest in empathy (the ability to identify and understand the thoughts and feelings of others and to respond to these with appropriate emotions); and a person's strength of interest in systems (in terms of the drive to analyse or construct them). A system is anything that follows rules. Key classes of systems including mechanical systems, natural systems, abstract systems, and collectible systems. Rules in turn are defined as repeating, lawful patterns.

According to the originator of the theory, Simon Baron-Cohen, the E-S theory has been tested using the Empathy Quotient (EQ) and Systemizing Quotient (SQ), developed by him and colleagues, and generates five different 'brain types' depending on the presence or absence of discrepancies between their scores on E or S. E-S profiles show reliable sex differences in the general population (more females showing the profile E>S and more males showing the profile S>E) (Baron-Cohen *et al.,*2005) The E-S theory is a better predictor of who chooses STEM (Science, Technology, Engineering and Mathematics) subjects than is gender (Bellington *et al.*, 2007) The E-S theory has been extended into the 'Extreme Male Brain' (EMB) theory of autism and Asperger syndrome, which are associated in the E-S theory with below-average empathy and average or above-average systemizing (Baron-Cohen *et al.,* 2009). According to Baron-Cohen, females on average score higher on measures of empathy and males on average score higher on measures of systemizing. This has been found using the child and adolescent versions of the Empathy Quotient (EQ) and the Systemizing Quotient (SQ), which are completed by parents about their child/adolescent (Auyueng *et al.,* 2009) and on the self-report version of the EQ and SQ in adults (Baron-Cohen *et al.,* 2009).

Similar sex differences on average have been found using performance tests of empathy such as facial emotion recognition tasks (Golan *et al.,* 2006) and on performance tests of systemizing such as measures of mechanical reasoning or 'intuitive physics' (Lawson *et al.,* 2004). In order to explain sexual dimorphism in the occurrence of autism where every one female who has autism is matched by four males with this condition, Baron-Cohen (2003) proposed a theory which encompasses two different styles of thinking or '*cognitive styles'* namely *systemizing* and *empathizing*. Systemizing is defined as "the drive to analyze, explore and construct a system. The systemizer intuitively figures out how things work, or extracts the underlying rules that govern the behavior of a system" (Baron-Cohen, 2003) while empathizing is "the drive to identify another person's emotions and thoughts, and to respond to them with an appropriate emotion" (Baron-Cohen, 2003). Systemizers typically display aptitude in figuring out how things work, or rules governing the behavior of a system. In contrast, empathizers are generally able to detect others' emotional nuances and react accordingly.

Cognitive stylesin the current context should not be confused with the same term that cognitive psychologists traditionally conceptualized as the way someone perceives and remember information along a dimension (Kozhevnikov, 2007). While the two definition might share similar or overlapping characteristics, Baron-Cohen's (Baron-Cohen, 2003) conceptualization of cognitive style is born out of the volume of work with autistic children and endeavors to explain functional and cognitive differences between individuals with and without autistic traits. In addition, systemizing and empathizing are treated as relatively independent cognitive styles. The two cognitive styles are elicited by two independent 60-item questionnaires. As such, an individual can score equally high or low for both cognitive styles. The prevalence for autism, a condition marked by repetitive behavior/obsessive interests and, deficiency in social development and communication (APA, 1994; ICD-10, 1994), is skewed towards males (Skuse, 2000).

An extension of systemizing cognitive style, the “extreme male brain”, is exemplified by autistic savants, who are cognitively and socially inept individuals but nonetheless display superhuman feats in a specific domain. The domains of interest which are typical of savants including mathematics, art, music and linguistics may be considered as abilities that require systemizing thinking. Specifically, autistic savants were observed to possess hypersensitivity to details and extraordinary ability to extract concrete rules and relationship that can be applied consistently within a single domain (Baron-Cohen and Chakrabarti, 2009; Hermelin, 2001). These observations correspond to Baron-Cohen’s (Baron-Cohen, 2003) definition of systemizing. Similar to sex bias in autism, autistic savant males outnumber females (Treffert, 2009). Baron-Cohen (2003) extend his theory of cognitive styles to include males and females in the general population where men are predominantly systemizers and women empathizers. According to Baron-Cohen (2003), the notion that cognitive style is sexually dimorphic is corroborated by behavioral and cognitive evidence observed among neonates through to adults. Additionally, the theory attributes biological precursors for sexually dimorphic brains based on the observations that sex typical behaviors come about at a young age (Baron-Cohen, 2003) and are observed across many diverse cultures (Baron-Cohen, 2003). For example, at birth, girls looked longer at faces while boys looked longer at suspended mechanical mobiles (Connellan and Ahluwalia, 2000). similarly, sex based proclivity for certain objects has also been observed in vervet monkeys where young males showed preference for a car and a ball; young females showed preference for a doll and a pot; while no difference in preference was observed for a picture book and a stuffed dog, items that have not previously been showed to result in a differential preference between human boys and girls (Alexander and Hines, 2002).

In the same vein, occupations that are essentially systemizing such as the crafting of musical instruments, physics and mathematics are predominantly occupied by men, while women tend to favor empathizing occupations like nursing, therapy and teaching (Baron-Cohen, 2003; Kanazawa and Vandermassen, 2005). Apart from autism, other clinical studies that revealed sexual dimorphism include the observation that men who suffer from schizophrenia demonstrated lower premorbid and current functioning compared to women (Häfner, 2002; Salem and Kring, 1998; Shtasel and Gur, 1992). Similarly, social functioning were previously attributed to superior premorbid functioning and social skills among women in a group of schizophrenic and schizoaffective patients (Mueser and Wixted, 1990).

In the cognitive domain, men and women display varying aptitudes such as the mental rotation task, the embedded figure test, verbal fluency and emotion recognition (Baron-Cohen, 2003). Men generally perform better on spatial tasks while women perform better on tasks involving facial emotions (Baron-Cohen, 2003; Hamilton, 2009; Kimura, 2000). In at least one study, men who obtained higher scores on systemizing than women, also performed better on the mental rotation task and a targeting task compared to women (Cook and Saucier, 2010). Baron-Cohen (2003) places emphasis on biological differences in the brain between the sexes. While this notion is supported by the evidence aforementioned, the concept of systemizing-empathizing cognitive styles is essentially a measure of the outcome of a combination of biological and sociocultural factors because it examines an individual's level of systemizing and empathizing at the point when s/he response to the questionnaire. The resultant cognitive style is therefore viewed as a combination of biological and social influences over the course of the person's life rather than biological antecedents per se. Baron-Cohen concedes that while biology plays a part in shaping cognitive styles, culture and socialization are indisputable factors that also contribute to sexually dimorphic brains (Baron-Cohen, 2003). In fact, social factors are identified as essential in contributing to sexual dimorphic behaviors in differential predilection for science and mathematics between men and women (Halpern *et al.,* 2007) and inferring other people's thoughts (Thomas and Maio, 2008). This notion is similar to a study which examined the concept of psychological gender (Bourne and Maxwell, 2010).

This study found that the psychological male showed greater lateralization for the recognition of facial emotions. Specifically, psychologically feminine males showed greater right hemispheric bias for the anger, sadness and surprise emotions. This is analogous to the notion that males with empathizing cognitive style show the same hemispheric bias for these facial emotions. To date, research on cognitive styles (Baron-Cohen, 2003) is skewed towards the clinical population, predominantly autistic children. Much less is known about cognitive styles among the healthy population. While few studies found male and female superiority for systemizing and empathizing respectively in the healthy population (E.g. Baron-Cohen,*et.al.,* and Wheelwright, 2003; Connellan, *et al.,* 2000; Wakabayashi, *et.al*., 2006), extant studies are generally skewed towards the clinical population. Similarly, research on cognitive styles (Baron-Cohen, 2003) emphasizes between-sex differences.

Researchers concede that there are certainly overlaps between the sexes (Baron-Cohen, *et al.*, 2003; Kimura, 2000). In other words, it is possible for some men to show cognitive profile similar to women and vice versa. Information regarding the variability of cognitive styles within the sexes remains scant. This notion is further investigated by Hyde (2005) who proposed the *Gender Similarity Hypothesis* in reaction to the overemphasis of between-sex differences in the literature. In particular, while there is little argument against physiological differences and associated motor performances between the sexes, sexual dimorphism in the cognitive domain is more contentious (Hyde, 2005). Of particular interest is the 118 studies mentioned in Hyde's (2005) review which examined facial expression processing found effect sizes ranging from -0.13 to -0.92. A subsequent study noted that genes are also contributing to individual differences in cognitive styles including empathy (Knafo and Rhee, 2008). Apart from inconsistency among findings for sexual dimorphism, observable differences within the same sex are also reported previously. Such within-sex behavioral differences are noted when other variables such as race (Ostrow and Knight, 1997), sexual orientation (Kimura, 2000) and sociocultural gender roles i.e. modern vs. traditional feminine gender roles (Lindstrøm, 1999) are considered.

Extant studies report either spatial cognition or social cognition while seldom concurrently examined both spatial and social cognition (Baron-Cohen, 2003; Hines, 2005; Kimura, 2000). Additionally, these studies generally examined the performance of the subjects in terms of accuracy while it remains unclear if an individual's cognitive style influences the processing time. Examining the speed of processing is important considering that slower speed of processing could be a tradeoff for increased accuracy. Generally, studies which examined cognitive performance between the cognitive styles either did not make comparisons between spatial and social cognitive performance (e.g. Knickmeyer and Hackett, 2006), use spatial and social tasks that are very different (e.g. Cook and Saucier, 2010), and/or did not consider the speed of processing in the cognitive tasks (e.g. Connellan, *et al.*, 2000; Cook and Saucier, 2010). Taken together, the task format for the current study is similar for both spatial and social tasks with regards to stimuli display length and respond time. Baron-Cohen (2003) also draws parallels between cognitive styles and functional asymmetry. The two hemispheres of the brain display structural and functional asymmetry. Functional asymmetry refers to the notion that the left hemisphere is predominantly "described as analytic or concerned with sequential processing, whereas the right is considered to be concerned with the integration of information over space and time, a holistic or gestalt processor" (Bryden, 1982). An example of structural asymmetry is the wider right frontal region compared to the left and a wider left occipital region compared to the right (Geschwind and Levitsky, 1968; Weinberger and Wyatt, 1982).

Functionally, lesion studies have revealed that patients with lesion on either of the two hemispheres reported spatial neglect for the contralateral visual fields (Ringman and Adams, 2004; Vuilleumier and Rafal, 2000). The notion of functional asymmetry has been criticized by scholars in response to the public's misinterpretation of brain specialization and spurious claims relating to brain type training (Goswami, 2006). For instance, advising teachers to adopt left and right brain balanced instruction has no sound scientific basis (Goswami, 2006). However, functional asymmetry that is observed in narrowly defined, limited types of cognitive processes remains valid for further exploration. This is evident in the modularity approach in understanding cognition including but not limited to language production. For instance, the Wada test, involving the administration of sodium amytal into the blood stream to essentially put to sleep either of the hemispheres revealed greater involvement of the left hemisphere in language processing (Milner, 1975; Rasmussen and Milner, 1977). Similarly, Baron-Cohen (2003) has argued that baby girls showed greater amount of electrical activity in the left hemisphere compared to the right hemisphere when exposed to sounds of speech. Among adults, greater lateralization for language occurs in men more so than women (Baron-Cohen, 2003).

Considering evidence as such, Baron-Cohen (2003) inferred that greater systemizing ability is related to greater right hemisphere function. For example, professions which rely heavily on spatial cognition like architects and visual artists tend to be right hemisphere dominant based on the observation that more of them are left handed compared to other professions. Admittedly, recent evidence suggests that a top-bottom (dorsal-ventral) differentiation might be a better representation of cognitive processes compared to left-right differentiation (Borst, Thompson, and Kosslyn, 2011). Particularly, it is notable that this representation is governed by the distinction between cognitive processing that is either “expectation-driven” (top/dorsal) or “classification-driven” (bottom/ventral) (Borst, *et al.*, 2011). In other words, expectation-driven processing essentially involves pre-existing knowledge while classification-driven processing refers to the identification of stimuli at a superficial, perceptual level. However, a discussion on intelligence and neural network mentioned that even classification of stimuli on a perceptual level could involve higher level influence (Hawkins and Blakeslee, 2004). It is postulated that the resultant brain structure leads to differential cognitive abilities such as enhanced spatial ability in targeting tasks and greater specialization to the right hemisphere in recognizing emotions.

## 2.19 FETAL TESTOSTERONE

While experience and socialization contribute to the observed sex differences in empathy and systemizing, Baron-Cohen and colleagues suggest that biology also plays a role and a candidate biological factor influencing E and S is fetal testosterone (FT). FT levels are positively correlated with scores on the Systemizing Quotient (Auyueng *et al.*, 2006) and are negatively correlated with scores on the Empathy Quotient (Chapman *et al.*, 2006 and Kinkmeyer *et al.*, 2006). A new field of research has emerged to investigate the role of testosterone levels in autism (Kreiser 2011). Correlational research demonstrated that elevated rates of testosterone were associated with higher rates of autistic traits, lower rates of eye contact, and higher rates of other medical conditions (Ingudumnokul *et al.*, 2007) Furthermore, experimental studies showed that altering testosterone levels influences the maze performance in rats, having implications for human studies (Baron- Cohen *et al.*, 2005). The fetal testosterone theories posit that the level of testosterone in the womb influences the development of sexually dimorphic brain structures, resulting in sex differences and autistic traits in individuals (Baron- Cohen *et al.*, 2005).

## 2.20 EVOLUTIONARY EXPLANATION FOR SEX DIFFERENCES

There are several evolutionary psychology explanations for this gender difference, according to Baron-Cohen. For example, better empathizing may improve care of children. Better empathy may also improve women's social network which may help in various way with the caring of children. On the other hand, systemizing may help males become good hunters and increase their social status by improving spatial navigation and the making and use of tools. Baron-Cohen argues that sex differences are not only due to socialization (Baron-Cohen *et al.*, 2012)

## 2.14 EXTREME MALE BRAIN THEORY OF AUTISM

Baron-Cohen's work in systemizing-empathisizing led him to investigate whether higher levels of fetal testosterone explain the increased prevalence of autism spectrum disorders among males (Baron-Cohen, 2012) in his theory is known as the "extreme male brain" theory of autism. "The male brain is programmed to systemize and the female brain to empathize ... Asperger's syndrome represents the extreme male brain"(Benenson 2003). Baron-Cohen and colleagues extended the E-S theory into the extreme male brain theory of autism, which hypothesizes that autism shows an extreme of the typical male profile (Baron-Cohen et al., 2005). This theory divides people into five groups:

Type E, whose empathy is at a significantly higher level than their systemizing (E>S).

Type S, whose systemizing at a significantly higher level than their empathy (S>E).

Type B (for balanced), whose empathy is at the same level as their systemizing (E=S).

Extreme Type E, whose empathy is above average but whose systemizing is below average (E>>S).

Extreme Type S, whose systemizing is above average but whose empathy is below average (S>>E).

Baron-Cohen says that tests of the E-S model show that twice as many females than males are Type E and twice as many males than females are Type S. 65% of people with autism spectrum conditions are Extreme Type S (Simon 2009) The concept of the Extreme Type E brain has been proposed; however, little research has been conducted on this brain profile (Kreisner 2011). Apart from the research using EQ and SQ, several other similar tests also have found female and male differences and that people with autism or Asperger syndrome on average score similarly to but more extremely than the average male (Baron-Cohen 2011). The brain differences model provides a broad overview of sex differences that are represented in individuals with autism, including brain structures and hormone levels (Kreisner 2011).Some, but not all studies, have found that brain regions that are different in average size between males and females also differ similarly between people who have autism and those who do not have autism

Baron-Cohen's research on relatives of people with Asperger syndrome and autism found that their fathers and grandfathers are twice as likely to be engineers as the general population (Baron-Cohen *et al.,* 1997). Natural science students have more relatives with autism than humanities students. Another similar finding by Baron-Cohen in California has been referred to as the Silicon Valley phenomenon, where a large portion of the population works in technical fields,  autism prevalence rates are ten times higher than the average of the US population. These data suggest that genetics and the environment play a role in autism prevalence, and children with technically minded parents are therefore more likely to be diagnosed with autism (Baron-Cohen *et al.,* 1997). Baron-Cohen's studies have been questioned. The overrepresentation of engineers could depend on a sampling bias,(Christopher 1998) and an analysis of autism diagnoses in California did not find that autism clustered preferentially around areas rich in IT industry. Instead, it found that clusters tended to occur in areas where parents were older and educated to a higher level than were parents in surrounding areas (Vanmeter *et al.,* 2010). Another possibility has been proposed that spins the perspective of the extreme male brain. Social theorists have been investigating the concept that females have protective factors against autism by having a more developed language repertoire and more empathy skills. Female children speak earlier and use language more than their male counterparts, and the lack of this skill translates into many symptoms of autism, offering another explanation for the discrepancy in prevalence.

## 2.15 IMPRINTED BRAIN THEORY

The imprinted brain theory is a somewhat similar although not identical theory. It argues that autism and psychosis are contrasting disorders on a number of variables. This is argued to be due to imbalanced genomic imprinting. According to the imprinted brain theory there could be a mismatch and more severe problems when extreme genomic imprinting occurs in the opposite sex, which would explain why female autism (and male psychosis) is often particularly severe, which is a problem for the "extreme male brain" theory which predicts the opposite (Nash *et al.*, 2007).

# CHAPTER THREE

## 3.0 MATERIALS AND METHODS

### 3.1 RESEARCH PARTICIPANTS

The subjects that participated in the study were students of Bajju and Asholio ethnic group of Kaduna State (n=600).

### 3.3 METHODOLOGY

Data for this study was obtained from over 600participants from the Asholio and Bajju ethnic groups. An informed verbal consent was sought from the student who were above eighteen years old and willing to participate in the survey. In order to encourage more candid and reliable responses, participants were made to complete a self-administered questionnaire. Systematic sampling method was used to select 600 students of both Bajju and Asholio ethnic groups.

Relevant data was collected such as anthropometric measurements of individuals wearing light clothing and without shoes, as described here: a. height was measured to the nearest 0.1 cm using the portable stadiometer; weight was measured in an upright position, to the nearest 0.1 kg, using a calibrated balance beam scale; b. BMI was be calculated as body weight (kg) divided by the square of the body height ($m^2$); and c.waist circumference measurements was taken at the end of normal expiration, to the nearest 0.1 cm, by measuring from the narrowest point between the lower borders of the rib cage and the iliac crest. In order to reduce observation errors, anthropometric measurements was read twice independently and the mean of the two measurements were taken as the actual value.

Individual with a BMI of less than 20 will be considered underweight; those with BMI in the range of 20-24.9 will be considered normal, 25-29.9 over-weight, while those with BMI greater than 30 will be considered obese (WHO, 2010).

All participants consented to the study. The figures for 2D and 4D was obtained by measuring the length between the basal crease where the fingers join the palm and the tip of the fingers with the vernier caliper. The ratio will then be computed by dividing 2D by 4D. In order to establish the repeatability of measurements taken, each finger of both hands was measured twice. All individuals answer series of questions, in the form of questionnaire which include gender, age, BMI (weight/height2), Tribe, empathizing and systemizing, administered in English language with ethical approval from the university ethical approval committee.

### 3.4 Sampling Size Determination

The sample size for this study was obtained using the formula:

[$n = z^2pq/d^2$] (Naing *et al.*, 2006)

Where:

n= the desired sample size

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

p= the proportion in the target population having the particular trait (when no estimate 50% is used; i.e. 0.5)

q= 1.0-p

d= degree of accuracy desired, usually set at 0.06

Therefore, n= $(1.96)^2(0.5)(0.5)/(0.06)^2 = 284$

For the purpose of this study a minimum of 284 subjects which was rounded to 300 from both ethnic groups was used.

### 3.5 Systemizing Quotient (SQ) and Empathizing Quotient (EQ)

Systemizing quotient (SQ) and empathizing quotient (EQ) questionnaire (Baron-Cohen, 2003) was used to determine the degree of systemizing and empathizing of participants. Questionnaire consists of 40 items each, taken from the full version of this test by Baron-Cohen. 20 of the filler items were removed from each of the test. For the SQ questionnaire, the following items were scored two points for 'strongly agree' responses and one point for 'slightly agree' responses: 1, 4, 5, 7, 13, 15, 19, 20, 25, 29, 30, 33, 34, 37, 41, 44, 48, 49, 53, 55. The following items will be scored two points for 'strongly disagree' responses and one point for 'slightly disagree' responses: 6, 11, 12, 18, 23, 24, 26, 28, 31, 32, 35, 38, 40, 42, 43, 45, 51, 56, 57, 60.For the EQ questionnaire, the following items were scored two points for 'strongly agree' responses and one point for 'slightly agree' responses: 1, 6, 19, 22, 25, 26, 35, 36, 37, 38, 41, 42, 43, 44, 52, 54, 55, 57, 58, 59, 60. The following items were scored two points for 'strongly disagree' responses and one point for 'slightly disagree' responses: 4, 8, 10, 11, 12, 14, 15, 18, 21, 27, 28, 29, 32, 34, 39, 46, 48, 49, 50. Based on the total score for the EQ questionnaire, those scoring ranging from 0-32 are categorized as low in empathizing, typical of individuals with high-functioning autism. Scores ranging from 33-52 are described as average, 53-63 are above average, and 64-80 are very high (Baron-Cohen, 2003). Based on the total score for the SQ questionnaire, those scoring between 0-19 are categorized as low in systemizing and 20-39 are average. Scores ranging from 40-50 are categorized as above average, typical of individuals with high-functioning autism. Scores between 51-80 are categorized as very high in systemizing, where every 1 normal male in the range is matched with 3 males with high-functioning autism and females rarely score in this range (Baron-Cohen, 2003).

The following variables were captured in the questionnaires:

i. Age (yr)

ii. Place of birth

iii. Ethnic group

iv. Marital status

v. Weight (kg)

vi. Head circumference (cm)

vi. Height (cm)

## 3.6 Data collection technique

Samples for this study were collected from students of Ahmadu Bello University, Zaria, Kaduna State university and polytechnic and College of Education Gidan -waya Kaduna state. Who were between the ages of 18 and above.

### 3.7 Anthropometry

**i. Height (cm)**: standing height was measured taking the maximum distance from the floor to the highest point on the head, when the subject was facing forward. Shoes was put off, feet together, and arms by the sides. Heels, buttocks and upper back should also be in contact with the wall when the measurement is made. This measurement will be carried out using a stadiometer**.**

**ii. Weight (kg)**: an overall measure of body size that does not distinguish between fat and muscle. Weight was measured to the nearest 0.1kg when the subject is standing and putting on light indoor clothes using the inner scan.

**iii. Body Mass Index (BMI):** calculations were done as follows:

$$BMI=\left(\frac{Weight\ in\ Kg}{Square\ of\ height\ in\ metres}\right)\frac{Kg}{m^2}$$

**iv. Mid Upper Arm Circumference (cm)**: The bicep was flexed, while the tape is wrapped around the flexed bicep, half way between the shoulder and the elbow.

**v. Chest circumference (cm)**: This measurement was taken at the level of the middle of the sternum (breast-bone), with the tape passing under the arms. After the tape is in position, the arms should be relaxed by the side, and the measurement taken at the end of a normal expiration.

**vi. Waist circumference (cm)**: the tape was used to circle the waist (like a belt would circle the waist) at the natural waistline, which is midpoint between the lowest rib and the iliac crest. The subject was asked to stand erect while measurements were taken.

**vii. Hip circumference (cm)**: the tape was wrapped over the largest part of the buttocks.

**viii. Head Circumference (cm)**: This circumference measure was taken with a tape wrapped around the skull from the glabella to the prominence behind the head.

## 3.8 ETHICAL APPROVAL

Ethical approval was obtained from the Faculty of Medicine's committee on ethics (see Appendix I) and permission to conduct the study was obtained from the authorities of participating schools. Only subjects who gave informed consent to participate with the research were included in this study.

## 3.9 INCLUSION AND EXCLUSION CRITERIA

### 3.9.1 Inclusion Criteria

The following were used as inclusion criteria:

i. Subjects must be of Asholio and Bajju ethnic group only.

ii. Only subjects without injuries to the fingers will be used.

iii. Subjects must be mentally and physically fit.

iv. Respondent must be between age 18 years old and above.

### 3.9.2 Exclusion Criteria

The following were used as exclusion criteria

I Subjects with injuries to the fingers will be excluded.

ii Subjects of other ethnic groups.

Iii Subjects who are not within the designated age range.

## 3.10 STATISTICAL ANALYSES

Data was expressed as mean $\pm$ standard deviation (SD) and percentages. Student's t-test was used to test the difference in the mean and percentages of sex and tribe and all variables between Asholio and Bajju ethnic groups. Pearson's correlation coefficients was used to test the relationship between each of the measured anthropometric parameters. Correlation coefficients between SQ and right and left 2D:4D. Linear regression was used to generate predictive equation for the variables. $P < 0.05$ was deemed significant and SPSS version 18 (IBM Corp., New York, 2009) was used for the statistical analyses.

## CHAPTER FOUR

## 4.0 RESULTS

### 4.1 ANALYSIS OF STUDY POPULATION

A total population of (n = 600) participated in this study, three hundred (50%) of the subjects were from Bajju ethnic group while the remaining three hundred (50%) from Asholio ethnic group. In each ethnic group, a hundred and fifty were males and other females..The study was conducted in Kaduna state (Zangon Kataf LGA), and (Kaura LGA). The age range of the study subjects is 18 years and above, while their mean age is 25.00±5.19years with a standard deviation of years.

### 4.2 DESCRIPTIVES STATISTICS

There were 600 participants (300 males and 300 females) with a mean (±SD) age of 25.00 ± 5.19 years, right digit ratio of 0.98 ± 0.05, Left digit ratio of 1.00 ± 0.04, SQ scores of 31.44 ± 11.34 and EQ scores of 49.86 ± 11.80 (Table 4.1). Males were slightly older than females (males: 26.29 ± 6.25 years, females: 23.71 ± 3.41 years). From the obtained values for body height of all the 600 participants, a significant sexual dimorphism in both ethnic group was observed with Males on- average- being taller than females(males: 1.67 ± 0.07 m, females:1.63 ± 0.07 m, t = 3.711, p = 0.000) (Table 4.2).With regard to education, a total of 9.7 % participants are post-graduate students, 90.3 % are undergraduates (Fig.4.1). 46.9 % and 79.3 % are undergraduate and postgraduate respectively for Bajju ethnic group while 53.1 % and 20.7 % are undergraduate and postgraduate respectively for Asholio ethnic group (Fig. 4.2).The mean right hand 2D:4D was 0.975 ± 0.053, and mean left hand 2D:4D was 0.997 ± 0.042. There was a significant sex difference with males having lower values than females in both ethnic groups, this difference being stronger for the left hand (right hand; males: 0.964 ± 0.050, females: 0.987

± 0.054, t = 2.579, p = 0.010, : left hand; males: n = 0.984 ± 0.040, females: n = 1.011 ± 0.039, t = 4.549, p = 0.0001). For systemizing quotient SQ and empathy EQ, Males had significantly higher SQ scores than females (males: n = 300, SQ = 35.92 ±9.99; females: n = 300, SQ = 26.92 ± 10.82, t = 10.55, p = 0.002, d = 8.97) and lower EQ scores than females (males: n = 300, EQ = 42.41 ± 10.45; females: n = 300, EQ = 57.32 ± 7.06, t = -19.96, p = 0.0001, d = -14.90). This is evident in both ethnic groups (Table 4.2). Table 4.3 shows the Bajju males dominate in most of the variables except for few in which the Asholio have high scores (Bajju males: n = 300, SQ = 37.37 ±10.16; Asholio males: n = 300, SQ = 37.53 ± 10.53, t = 10.80, p = 0.00, d = 8.97). The Bajju males have higher chest and waist circumference than the Asholio. Table 4.4 shows the comparison of Bajju and Asholio females in which the Bajju females have higher values in the variables except for head circumference in which Bajju females have 47.69 ± 8.34 and Asholio females had 49.71 ± 2.52. In Table 4.5 the females of Asholio ethnic group have higher digit ratios for both hands as well as the empathizing quotient. The males have higher BMI and chest circumference.

**Table 4.1:Means and standard deviations of SQ, EQ and body anthropometrics (n=600)**

| | | | | Males | | | Females | | Min-Max | t | p |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variables** | **Mean** | **SD** | **Min-Max** | **Mean** | **SD** | **Min-Max** | **Mean** | **SD** | | | |
| Age (yrs) | 25 | 5.20 | 15.00-56.00 | 26.29 | 6.25 | 15-43 | 23.71 | 3.42 | 19.0-56.0 | 6.26 | 0.00 |
| Weight (kg) | 61.96 | 5.83 | 45.00-89.00 | 62.57 | 5.68 | 50-89 | 61.36 | 5.91 | 45.0-80.0 | 0.44 | 0.01 |
| Height (cm) | 165 | 0.07 | 143-190 | 167 | 0.07 | 100-200 | 163 | 0.07 | 100-200 | 0.25 | 0.00 |
| Body mass index (kg/m²) | 22.88 | 2.82 | 15.50-32.80 | 22.51 | 2.80 | 15.9-32.8 | 23.25 | 2.79 | 15.5-31.2 | 0.55 | 0.00 |
| Waist circumference (cm) | 76.85 | 8.25 | 29.00-102.0 | 77.78 | 7.56 | 29-102 | 75.92 | 8.81 | 54.0-95.0 | 0.11 | 0.00 |
| Hip circumference (cm) | 93.55 | 8.63 | 34.00-117.0 | 89.73 | 7.46 | 34-117 | 97.36 | 8.02 | 60.0-112 | 0.98 | 0.00 |
| Waist-hip ratio | 0.83 | 0.10 | 0.40-1.20 | 0.87 | 0.09 | 0.4-1.2 | 0.78 | 0.08 | 0.60-1.10 | 0.29 | 0.00 |
| Mid Upper Arm Circumference | 29.37 | 3.33 | 20.00-43.00 | 28.95 | 2.76 | 20-43 | 29.79 | 3.77 | 20.0-42.0 | 0.00 | 0.00 |
| Chest circumference (cm) | 85.41 | 7.93 | 65.00-106.0 | 91.09 | 5.91 | 65-106 | 79.73 | 5.13 | 70.0-102 | 0.00 | 0.00 |
| Head length (cm) | 27.8 | 3.59 | 19.00-39.00 | 27.51 | 3.07 | 31-65 | 28.09 | 4.02 | 19.0-36.0 | 0.00 | 0.04 |
| Head width (cm) | 22.4 | 4.20 | 12.00-34.00 | 22.66 | 4.40 | 20-39 | 22.14 | 3.98 | 15.0-34.0 | 0.07 | 0.13 |
| Right 2D:4D | 0.98 | 0.05 | 0.80-1.09 | 0.96 | 0.05 | 12-33 | 0.99 | 0.06 | 0.79-1.08 | 0.05 | 0.00 |
| Left 2D:4D | 1.00 | 0.04 | 0.86-1.22 | 0.98 | 0.04 | 0.79-1.08 | 1.01 | 0.04 | 0.86-1.12 | 0.72 | 0.00 |
| Waist chest circumference | 0.91 | 0.12 | 0.35-1.24 | 0.86 | 0.09 | 0.85-1.21 | 0.95 | 0.12 | 0.57-1.17 | 0.00 | 0.00 |
| Waist-height circumference | 0.47 | 0.05 | 0.17-0.62 | 0.47 | 0.05 | 0.35-1.24 | 0.47 | 0.06 | 0.33-0.58 | 0.00 | 0.74 |
| Systemizing quotient (SQ) | 31.44 | 11.34 | 14.00-56.00 | 35.85 | 9.98 | 14-50 | 27.02 | 10.90 | 14.0-56.0 | 0.00 | 0.00 |
| Empathy quotient (EQ) | 49.86 | 11.80 | 23.00-70.00 | 42.37 | 10.42 | 28-70 | 57.35 | 7.59 | 23.0-60.0 | 0.00 | 0.00 |

**Table 4.2: Comparison of digit ratio and anthropometric parameters of subjects from Bajju and Asholio ethnic groups**

| **Parameters** | **(Bajju, n = 300) Mean ± SD** | **(Asholio, n = 300) Mean ± SD** | ***t*** | ***p*** |
|---|---|---|---|---|
| Right digit ratio | 0.99 ± 0.03 | 0.95 ± 0. 06 | 8.835 | 0.00 |
| Left digit ratio | 0.99 ± 0.04 | 1.00 ± 0.04 | -2.581 | 0.10 |
| Systemizing quotient | 36.37± 10.16 | 26.53 ±10.27 | 11.801 | 0.00 |
| Empathy quotient | 51.86 ± 9.84 | 47.88 ± 13.17 | 4.181 | 0.00 |
| Weight (kg) | 62.68 ± 6.52 | 61.25 ± 4.94 | 3.019 | 0.00 |
| Height (cm) | 165 ± 0.08 | 167 ± 0.06 | 3.466 | 0.04 |
| Body Mass Index (kg/m$^2$) | 23.18 ± 3.00 | 22.57 ± 2.59 | 2.664 | 0.09 |
| Waist Circumference (cm) | 79.18 ± 7.97 | 74.53 ± 7.86 | 7.199 | 0.00 |
| Hip Circumference (cm) | 92.95 ± 9.99 | 94.14 ± 6.98 | -1.682 | 0.09 |
| Mid Upper Arm Circumference (cm) | 30.44 ± 3.56 | 28.31 ± 2.67 | 8.257 | 0.00 |
| Waist-Hip Ratio | 0.85 ± 0.10 | 0.79 ± 0.07 | 8.826 | 0.00 |
| Chest Circumference (cm) | 85.70 ± 8.38 | 85.13 ± 7.46 | 0.884 | 0.37 |
| Head Circumference (cm) | 47.69 ± 8.34 | 49.71 ± 2.52 | -3.738 | 0.00 |
| Head length | 28.46 ± 4.30 | 27.14 ± 2.52 | 4.603 | 0.00 |
| Head width | 22.31 ± 4.30 | 22.49 ± 4.10 | -0.507 | 0.00 |
| Waist-Chest Ratio | 0.79 ± 0.11 | 0.93 ± 0.11 | 5.398 | 0.00 |
| Educational status | 0.15 ± 0.36 | 0.04 ± 0.19 | 4.806 | 0.00 |
| Waist-Height Ratio | 0.48 ± 0.05 | 0.45 ± 0.04 | 7.121 | 0.00 |

**Table 4.3: Comparison of digit ratio and anthropometric parameters of males from Bajju and Asholio ethnic groups**

| Parameters | (Bajju) Mean ± SD | (Asholio) Mean ± SD | *t* | *P* |
|---|---|---|---|---|
| Right 2D:4D | 0.99 ± 0.03 | 0.99 ± 0. 06 | 3.835 | 0.03 |
| Left 2D:4D | 0.99 ± 0.04 | 1.00 ± 0.04 | -2.581 | 0.10 |
| Systemizing quotient | 37.37± 10.16 | 37.53 ±10.27 | 10.801 | 0.00 |
| Empathy quotient | 48.86 ± 9.84 | 50.88 ± 13.17 | 4.181 | 0.00 |
| Weight (kg) | 61.68 ± 6.52 | 60.25 ± 4.94 | 3.019 | 0.00 |
| Height (cm) | 164 ± 0.08 | 163 ± 0.06 | -0.466 | 0.64 |
| Body Mass Index (kg/m$^2$) | 22.18 ± 3.00 | 21.57 ± 2.59 | 2.664 | 0.09 |
| Waist Circumference (cm) | 75.18 ± 7.97 | 76.53 ± 7.86 | 6.199 | 0.00 |
| Hip Circumference (cm) | 93.95 ± 9.99 | 95.14 ± 6.98 | -1.682 | 0.09 |
| Mid Upper Arm Circumference (cm) | 29.44 ± 3.56 | 28.31 ± 2.67 | 7.257 | 0.00 |
| Waist-Hip Ratio | 0.83 ± 0.10 | 0.78 ± 0.07 | 6.826 | 0.00 |
| Chest Circumference (cm) | 83.70 ± 8.38 | 85.13 ± 7.46 | 0.884 | 0.37 |
| Head Circumference (cm) | 48.69 ± 8.34 | 43.71 ± 2.52 | -3.738 | 0.00 |
| Head length | 27.46 ± 4.30 | 27.14 ± 2.52 | 4.603 | 0.00 |
| Head width | 22.31 ± 4.30 | 22.49 ± 4.10 | -0.507 | 0.00 |
| Waist-Chest Ratio | 0.73 ± 0.11 | 0.90 ± 0.11 | 5.398 | 0.00 |
| Educational status | 0.16 ± 0.36 | 0.14 ± 0.19 | 4.806 | 0.00 |
| Waist-Height Ratio | 0.41 ± 0.05 | 0.40 ± 0.04 | 7.121 | 0.00 |

**Table 4.4: Comparison of digit ratio and anthropometric parameters of females from Bajju and Asholio ethnic groups**

| **Parameters** | **(Bajju)**<br>**Mean ± SD** | **(Asholio)**<br>**Mean ± SD** | ***T*** | ***P*** |
|---|---|---|---|---|
| Right 2D:4D | 0.96 ± 0.03 | 0.95 ± 0. 06 | 7.835 | 0.00 |
| Left 2D:4D | 0.98 ± 0.04 | 0.97 ± 0.04 | 3.581 | 0.00 |
| Systemizing quotient | 37.37± 10.16 | 36.53 ±10.27 | 10.601 | 0.00 |
| Empathy quotient | 51.86 ± 9.84 | 50.88 ± 13.17 | 4.181 | 0.00 |
| Weight (kg) | 62.68 ± 6.52 | 61.25 ± 4.94 | 3.019 | 0.00 |
| Height (cm) | 164 ± 0.08 | 167 ± 0.06 | 5.466 | 0.04 |
| Body Mass Index (kg/$m^2$) | 23.18 ± 3.00 | 22.57 ± 2.59 | 2.664 | 0.09 |
| Waist Circumference (cm) | 79.18 ± 7.97 | 74.53 ± 7.86 | 7.199 | 0.00 |
| Hip Circumference (cm) | 92.95 ± 9.99 | 94.14 ± 6.98 | -1.682 | 0.09 |
| Mid Upper Arm Circumference (cm) | 29.44 ± 3.56 | 28.31 ± 2.67 | 6.257 | 0.00 |
| Waist-Hip Ratio | 0.85 ± 0.10 | 0.79 ± 0.07 | 7.826 | 0.00 |
| Chest Circumference (cm) | 85.70 ± 8.38 | 85.13 ± 7.46 | 0.884 | 0.37 |
| Head Circumference (cm) | 47.69 ± 8.34 | 49.71 ± 2.52 | -3.738 | 0.00 |
| Head length | 28.46 ± 4.30 | 27.14 ± 2.52 | 4.603 | 0.00 |
| Head width | 22.31 ± 4.30 | 22.49 ± 4.10 | -0.507 | 0.00 |
| Waist-Chest Ratio | 0.79 ± 0.11 | 0.93 ± 0.11 | 5.398 | 0.00 |
| Educational status | 0.15 ± 0.36 | 0.04 ± 0.19 | 4.806 | 0.00 |
| Waist-Height Ratio | 0.38 ± 0.05 | 0.35 ± 0.04 | 6.121 | 0.00 |

**Table 4.5: Comparison of digit ratio and anthropometric parameters of Males and females of Asholio ethnic groups**

| **Parameters** | **(Males) Mean ± SD** | **(Females) Mean ± SD** | ***T*** | ***p*** |
|---|---|---|---|---|
| Right 2D:4D | 0.95 ± 0.33 | 0.96 ± 0. 16 | 7.835 | 0.00 |
| Left 2D:4D | 0.97 ± 0.14 | 0.99 ± 0.04 | 3.181 | 0.01 |
| Systemizing quotient | 37.17± 10.16 | 36.13 ± 9.27 | 10.60 | 0.00 |
| Empathy quotient | 51.86 ± 9.84 | 54.88 ± 13.17 | 4.181 | 0.00 |
| Weight (kg) | 62.68 ± 6.52 | 61.25 ± 4.94 | 3.019 | 0.00 |
| Height (cm) | 166 ± 0.08 | 165 ± 0.06 | -0.466 | 0.64 |
| Body Mass Index (kg/m$^2$) | 23.18 ± 3.00 | 22.57 ± 2.59 | 2.664 | 0.09 |
| Waist Circumference (cm) | 77.18 ± 7.97 | 79.53 ± 7.86 | 7.199 | 0.00 |
| Hip Circumference (cm) | 92.95 ± 9.99 | 94.14 ± 6.98 | -1.682 | 0.09 |
| Mid Upper Arm Circumference (cm) | 30.44 ± 3.56 | 28.31 ± 2.67 | 6.257 | 0.00 |
| Waist-Hip Ratio | 0.79 ± 0.10 | 0.83 ± 0.07 | 7.826 | 0.00 |
| Chest Circumference (cm) | 85.70 ± 8.38 | 85.13 ± 7.46 | 0.884 | 0.37 |
| Head Circumference (cm) | 47.69 ± 8.34 | 49.71 ± 2.52 | -3.738 | 0.00 |
| Head length | 28.46 ± 4.30 | 27.14 ± 2.52 | 4.603 | 0.00 |
| Head width | 22.31 ± 4.30 | 22.49 ± 4.10 | -0.507 | 0.00 |
| Waist-Chest Ratio | 0.79 ± 0.11 | 0.93 ± 0.11 | 5.398 | 0.00 |
| Educational status | 0.15 ± 0.36 | 0.04 ± 0.19 | 4.806 | 0.00 |
| Waist-Height Ratio | 0.38 ± 0.05 | 0.35 ± 0.04 | 6.121 | 0.00 |

**4.3 Relationships between SQ, EQ, 2D:4D and other variables**

Table 4.6 Shows the comparison of digit ratio and anthropometric parameters of males and females from Bajju ethnic groups in which the males have higher values in height, waist-height ratio, BMI, MUAC, but the females have higher values in waist-hip ratio, waist-chest ratio, waist circumference, and empathizing quotientsCorrelations between SQ, EQ and 2D:4D are shown in Table 4.7. SQ scores were significantly and positively correlated with right and left 2D:4D (Table. 4.8), the correlation matrix of Bajju ethnic group. Sixty percent (60%) of the variables from Bajju ethnic group have significant correlation in the matrix at $p < 0.01$ and $p < 0.05$. Waist circumference correlated with hip circumference, chest circumference, waist-hip ratio, waist-chest ratio and waist-height ratio. Also, height correlated with systemizing scores, empathy scores, BMI, waist-hip ratio and waist-height ratio. Although the correlations with left hand 2D:4D were significant only for males. EQ scores were positively correlated with right 2D:4D as well as positively correlated with left 2D:4D significant for left 2D:4D only for males. Likewise for the females but none is significantly correlated with 2D:4D. SQ and EQ are positively related, and right and left 2D:4D are positively correlated. Also ethnicity, educational status, SQ and EQ all have effects on both right and left 2D:4D (Table 4.9)presented the correlation matrix of Asholio ethnic group only. There is no significant correlation with digit ratio in both male and female. The present study further confirms a positive association between weight and 2D:4D ratio. For males a negative correlation in both right and left hands were obtained as expected due to the effect of fetal testosterone. In females a negative relationship was recorded too. This means that both testosterone and estrogen increases fetal growth and reduces 2D:4D ratio. Both Asholio and Bajju ethnic group shows negative correlations. In addition height, age, weight, bmi, hip-circumference, waist-hip ratio and waist-chest ratio correlate with SQ and EQ. Thus with regard to SQ, significant negative relationships with Ethnic group and sex, and non-significant positive relationships with right 2D:4D, age, height and education. Considering EQ, there were significant associations with sex, age and ethnic group but non-significant negative associations with height, right and left 2D:4D and education (Table 4.10).

**Table 4.6: Comparison of digit ratio and anthropometric parameters of males and females from Bajju ethnic groups**

| **Parameters** | **(Males)** **Mean ± SD** | **(Females)** **Mean ± SD** | ***T*** | ***P*** |
|---|---|---|---|---|
| Right 2D:4D | 0.94 ± 0.04 | 0.96 ± 0. 05 | 5.835 | 0.01 |
| Left 2D:4D | 0.97 ± 0.14 | 0.98 ± 0.24 | 3.681 | 0.00 |
| Systemizing quotient | 37.37± 10.16 | 36.53 ±10.27 | 10.601 | 0.03 |
| Empathy quotient | 51.86 ± 9.84 | 55.88 ± 4.17 | 4.181 | 0.00 |
| Weight (kg) | 62.68 ± 6.52 | 61.25 ± 4.94 | 3.019 | 0.00 |
| Height (cm) | 166 ± 0.08 | 165 ± 0.06 | -0.466 | 0.04 |
| Body Mass Index ($kg/m^2$) | 23.18 ± 3.00 | 22.57 ± 2.59 | 2.664 | 0.01 |
| Waist Circumference (cm) | 79.18 ± 7.97 | 74.53 ± 7.86 | 7.199 | 0.00 |
| Hip Circumference (cm) | 92.95 ± 9.99 | 94.14 ± 6.98 | -1.682 | 0.00 |
| Mid Upper Arm Circumference (cm) | 30.44 ± 3.56 | 28.31 ± 2.67 | 6.257 | 0.00 |
| Waist-Hip Ratio | 0.78 ± 0.10 | 0.79 ± 0.07 | 7.826 | 0.00 |
| Chest Circumference (cm) | 85.70 ± 8.38 | 80.13 ± 7.46 | 0.884 | 0.00 |
| Head Circumference (cm) | 47.69 ± 8.34 | 49.71 ± 2.52 | -3.738 | 0.00 |
| Head length | 28.46 ± 4.30 | 27.14 ± 2.52 | 4.603 | 0.10 |
| Head width | 22.31 ± 4.30 | 22.49 ± 4.10 | -0.507 | 0.20 |
| Waist-Chest Ratio | 0.79 ± 0.11 | 0.93 ± 0.11 | 5.398 | 0.00 |
| Educational status | 0.15 ± 0.36 | 0.04 ± 0.19 | 4.806 | 0.00 |
| Waist-Height Ratio | 0.38 ± 0.05 | 0.35 ± 0.04 | 6.121 | 0.00 |

**Table 4.7: Correlation matrix of digit ratios and anthropometrics parameters of both ethnic groups**

| | RR | LR | AGE | WT | HT | BMI | WC | HiC | WHR | CC | HC | HL | HW | WCR | WHTR | MUAC | SQ | EQ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RR | | | | | | | | | | | | | | | | | | |
| LR | 0.35** | _ | | | | | | | | | | | | | | | | |
| AGE | -0.01 | -0.10* | _ | | | | | | | | | | | | | | | |
| WT | 0.01 | -0.091* | 0.01 | _ | | | | | | | | | | | | | | |
| HT | -0.15** | -0.074 | 0.15** | 0.12** | _ | | | | | | | | | | | | | |
| BMI | 0.13** | -0.013 | -0.09* | 0.67** | -0.65** | _ | | | | | | | | | | | | |
| WC | 0.05 | -0.08 | 0.11** | 0.05 | 0.10* | -0.03 | _ | | | | | | | | | | | |
| HiC | 0.10* | 0.17** | -0.12** | -0.01 | -0.15** | 0.11* | 0.34** | _ | | | | | | | | | | |
| WHR | -0.02 | -0.20** | 0.19** | 0.05 | 0.21** | -0.11** | 0.63** | -0.50** | _ | | | | | | | | | |
| CC | -0.13** | -0.22** | 0.19** | 0.17** | 0.30** | -0.09* | 0.19** | -0.33** | 0.44** | _ | | | | | | | | |
| HC | -0.07 | 0.07 | -0.19** | -0.02 | 0.02 | -0.03 | 0.03 | 0.30** | -0.23** | -0.19** | _ | | | | | | | |
| HL | 0.10* | 0.03 | 0.03 | 0.08 | 0.02 | 0.04 | 0.00 | -0.02 | 0.02 | -0.05 | 0.09* | _ | | | | | | |
| HW | -0.06 | -0.06 | 0.13** | 0.12** | 0.10* | 0.01 | 0.03 | -0.06 | 0.06 | 0.13** | 0.03 | 0.55** | _ | | | | | |
| WCR | 0.15** | 0.10** | -0.04 | -0.08 | -0.14** | 0.05 | 0.70** | 0.52** | 0.22** | -0.56** | 0.15** | 0.04 | -0.07 | _ | | | | |
| WHTR | 0.11** | -0.04 | 0.05 | 0.00 | -0.31** | 0.25** | 0.91** | 0.39** | 0.52** | 0.06 | 0.02 | -0.00 | -0.02 | 0.73** | _ | | | |
| MUAC | 0.18** | 0.05 | 0.01 | 0.06 | -0.07 | 0.10* | 0.14** | 0.18** | 0.00 | -0.07 | 0.12** | 0.08 | -0.07 | 0.18** | 0.17** | _ | | |
| SQ | -0.18* | -0.08** | 0.15** | 0.15** | 0.12** | 0.03 | 0.20** | -0.19** | 0.34** | 0.39** | -0.18** | 0.02 | 0.01 | -0.11** | 0.14** | 0.07 | _ | |
| EQ | 0.13 | 0.11 | -0.09* | -0.06 | -0.24** | 0.13** | -0.03 | 0.26** | -0.22** | -0.49** | 0.05 | 0.08* | -0.03 | 0.34** | 0.08 | 0.11** | 0.21** | _ |

*RR= Right digit ratio LR= Left digit ratio, SQ= systemizing quotient EQ= empathy quotient, WT = Weight (kg), HT = Height (cm), WC = Waist circumference (cm), HC = Hip circumference (cm), BMI = Body mass index ($kg/m^2$), MUAC = mid upper arm circumference (cm), HiC = Hip circumference (cm),CC = Chest circumference (cm), HC = Head circumference (cm), HL= Head length (cm), HW= Head width (cm), WHR = waist-hip ratio, WCR = waist-chest ratio, WHTR = waist-height ratio. ** = $p < 0.01$ * = $p < 0.05$*

**Table 4.8: Correlation matrix of digit ratios and anthropometric characteristics for Bajju ethnic groups**

| | RR | LR | WT | HT | BMI | WC | HiC | WHR | MUAC | CC | HC | HL | HW | WCR | WHTR | SQ | EQ | Age |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RR | - | | | | | | | | | | | | | | | | | |
| LR | 0.32** | - | | | | | | | | | | | | | | | | |
| HT | -0.14* | 0.04 | 0.02 | - | | | | | | | | | | | | | | |
| BMI | 0.07 | -0.07 | 0.68** | -0.71** | - | | | | | | | | | | | | | |
| WC | 0.00 | 0.00 | -0.06 | 0.15** | -0.14* | - | | | | | | | | | | | | |
| HiC | 0.04 | 0.03 | 0.04 | -0.08 | 0.09 | 0.50** | - | | | | | | | | | | | |
| WHR | -0.03 | -0.02 | -0.11 | 0.22** | -0.23** | 0.71** | -0.24** | - | | | | | | | | | | |
| MUAC | 0.08 | 0.03 | -0.07 | 0.01 | -0.05 | 0.03 | 0.16** | -0.09 | - | | | | | | | | | |
| CC | -0.02 | 0.00 | 0.03 | 0.30** | -0.19** | 0.16** | -0.30** | 0.42** | -0.03 | - | | | | | | | | |
| HC | -0.05 | -0.02 | -0.10 | 0.14** | -0.16* | 0.15** | 0.04 | 0.14* | 0.22** | 0.05 | - | | | | | | | |
| HL | 0.06 | 0.05 | 0.13* | 0.07 | 0.04 | 0.00 | -0.06 | 0.05 | -0.06 | 0.12* | 0.03 | - | | | | | | |
| HW | -0.02 | 0.02 | 0.11 | 0.11 | 0.00 | -0.02 | -0.09 | 0.04 | -0.14* | 0.17** | 0.03 | 0.62** | - | | | | | |
| WCR | 0.01 | 0.00 | -0.06 | -0.08 | 0.02 | 0.73** | 0.62** | 0.32** | 0.06 | -0.55** | 0.08 | -0.07 | -0.13* | - | | | | |
| WHTR | 0.05 | -0.01 | -0.06 | -0.24** | 0.14** | 0.92** | 0.52** | 0.61** | 0.03 | 0.04 | 0.09 | -0.03 | -0.07 | 0.75** | - | | | |
| SQ | -0.22* | -.12* | 0.10 | 0.20* | -0.07 | 0.04 | -0.12* | 0.14* | -0.04 | 0.37** | 0.00 | -0.07 | -0.05 | -0.22** | -0.04 | - | | |
| EQ | 0.03 | 0.02 | -0.06 | -0.32** | 0.19** | -0.11 | 0.32** | -0.38** | -0.01 | -0.60** | -0.02 | -0.02 | 0.33** | 0.02 | -0.32** | 0.02 | - | |
| Age | 0.06 | 0.07 | 0.12* | 0.05 | 0.06 | -0.02 | -0.01 | -0.01 | 0.04 | 0.13* | -0.07 | 0.08 | 0.14 | -0.09 | -0.04 | 0.03 | -0.13* | - |

*RR= Right digit ratio LR= Left digit ratio, SQ= systemizing quotient EQ= empathy quotient, WT = Weight (kg), HT = Height (cm), WC = Waist circumference (cm), HC = Hip circumference (cm), BMI = Body mass index ($kg/m^2$), MUAC = mid upper arm circumference (cm), HiC = Hip circumference (cm), CC = Chest circumference (cm), HC = Head circumference (cm), HL= Head length (cm), HW= Head width (cm), WHR = waist-hip ratio, WCR = waist-chest ratio, WHTR = waist-height ratio. ** = $p < 0.01$ * = $p < 0.05$*

**Table 4.9 Correlations matrix of digit ratio and anthropometrics of Asholio Ethnic group**

| | **RR** | **LR** | **WT** | **HT** | **BMI** | **WC** | **HiC** | **WHR** | **MUAC** | **CC** | **HC** | **HL** | **HW** | **WCR** | **WHTR** | **SQ** | **EQ** | **Age** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RR | - | | | | | | | | | | | | | | | | | |
| LR | 0.58** | - | | | | | | | | | | | | | | | | |
| WT | -0.00 | -0.09 | - | | | | | | | | | | | | | | | |
| HT | -0.20** | -0.18** | 0.19** | - | | | | | | | | | | | | | | |
| BMI | 0.14* | 0.06 | 0.65** | -0.61** | - | | | | | | | | | | | | | |
| WC | -0.12* | -0.10 | 0.08 | 0.09 | 0.01 | - | | | | | | | | | | | | |
| HiC | 0.26** | 0.26** | -0.02 | -0.19** | 0.13* | 0.30** | - | | | | | | | | | | | |
| WHR | -0.32** | -0.30** | 0.07 | 0.24** | -0.11 | 0.53** | -0.64** | - | | | | | | | | | | |
| MUAC | 0.09 | 0.14* | 0.07 | -0.11 | 0.14* | 0.08 | 0.24** | -0.13* | - | | | | | | | | | |
| CC | -0.37** | -0.41** | 0.25** | 0.30** | -0.02 | 0.22** | -0.36** | 0.48** | -0.12* | - | | | | | | | | |
| HC | 0.01 | 0.09 | 0.04 | -0.04 | 0.06 | 0.04 | 0.39** | -0.32** | 0.17** | -0.31** | - | | | | | | | |
| HL | 0.04 | 0.05 | 0.02 | -0.01 | 0.01 | -0.09 | 0.01 | -0.08 | 0.05 | -0.15* | 0.15** | - | | | | | | |
| HW | -0.11 | -0.13* | 0.14* | 0.09 | 0.03 | 0.09 | -0.05 | 0.10 | -0.01 | 0.10 | 0.03 | 0.55** | - | | | | | |
| WCR | 0.19** | 0.25** | -0.14* | -0.18** | 0.03 | 0.64** | 0.52** | 0.06 | 0.16** | -0.60** | 0.25** | 0.04 | -0.01 | - | | | | |
| WHTR | -0.02 | -0.01 | -0.01 | -0.38** | 0.29** | 0.89** | 0.37** | 0.38** | 0.13* | 0.06 | 0.05 | -0.08 | 0.04 | 0.68** | - | | | |
| SQ | -0.47** | -0.32** | 0.12* | 0.10 | 0.02 | 0.13* | -0.22** | 0.29** | -0.12* | 0.45** | -0.20** | -0.07 | 0.09 | -0.25** | 0.08 | - | | |
| EQ | 0.21 | 0.30 | -0.12* | -0.16** | 0.03 | -0.04 | 0.26** | -0.25** | 0.13* | -0.41** | 0.21** | 0.12* | -0.05 | 0.30** | 0.05 | -0.33** | - | |
| Age | -0.12* | -0.11 | -0.05 | 0.19** | -0.17** | 0.15** | -0.14* | 0.23** | -0.04 | 0.23** | -0.21** | -0.01 | 0.14* | -0.05 | 0.06 | 0.18** | -0.11 | - |

*RR= Right digit ratio LR= Left digit ratio , SQ= systemizing quotient EQ= empathy quotient, WT = Weight (kg), HT = Height (cm), WC = Waist circumference (cm), HC = Hip circumference (cm), BMI = Body mass index (kg/m$^2$), MUAC = mid upper arm circumference (cm), HiC = Hip circumference (cm), CC = Chest circumference (cm), HC = Head circumference (cm), HL= Head length (cm), HW= Head width (cm), WHR = waist-hip ratio, WCR = waist-chest ratio, WHTR = waist-height ratio. ** = $p < 0.01$ * = $p < 0.05$*

**Table: 4.10 Anthropometrics Correlations for males**

| | SEX | AGE | WT | HT | BMI | WC | HiC | WHR | MUAC | RR | LR | WCR | WHTR | SQ | EQ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEX | - | | | | | | | | | | | | | | |
| AGE | -0.16** | - | | | | | | | | | | | | | |
| WT | -0.11* | 0.12* | - | | | | | | | | | | | | |
| HT | -0.29** | 0.05 | 0.02 | - | | | | | | | | | | | |
| BMI | 0.13* | 0.06 | 0.68** | -0.71** | - | | | | | | | | | | |
| WC | -0.05 | -0.02 | -0.06 | 0.15** | -0.14* | - | | | | | | | | | |
| HiC | 0.39** | -0.01 | 0.04 | -0.08 | 0.09 | 0.50** | - | | | | | | | | |
| WHR | -0.37** | -0.01 | -0.11 | 0.22** | -0.23** | 0.71** | -0.24** | - | | | | | | | |
| MUAC | 0.03 | 0.04 | -0.07 | 0.01 | -0.05 | 0.03 | 0.16** | -0.09 | - | | | | | | |
| RR | 0.05 | 0.06 | -0.05 | -0.14* | 0.07 | -0.00 | 0.04 | -0.03 | 0.08 | - | | | | | |
| LR | 0.04 | -0.07 | -0.06 | 0.04 | -0.07 | 0.00 | 0.03 | -0.02 | 0.03 | 0.32** | - | | | | |
| WCR | 0.43** | -0.09 | -0.06 | -0.08 | 0.02 | 0.73** | 0.62** | 0.32** | 0.06 | 0.01 | 0.00 | - | | | |
| WHTR | 0.07 | -0.04 | -0.07 | -0.25** | 0.14* | 0.92** | 0.52** | 0.61** | 0.03 | 0.05 | -0.02 | 0.75** | - | | |
| SQ | -0.40** | 0.03 | 0.10 | 0.20** | -0.07 | 0.04 | -0.12* | 0.14* | -0.04 | -0.32** | -0.16** | -0.22** | -0.04 | - | |
| EQ | 0.76** | -0.13* | -0.06 | -0.32** | 0.19** | -0.11 | 0.32** | -0.38** | -0.01 | 0.02 | 0.13 | 0.33** | 0.02 | -0.32** | - |

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). *RR= Right digit ratio LR= Left digit ratio , SQ= systemizing quotient EQ= empathy quotient, WT = Weight (kg), HT = Height (cm), WC = Waist circumference (cm), HC = Hip circumference (cm), BMI = Body mass index (kg/$m^2$), MUAC = mid upper arm circumference (cm), HiC = Hip circumference (cm), CC = Chest circumference (cm), HC = Head circumference (cm), HL= Head length (cm), HW= Head width (cm), WHR = waist-hip ratio, WCR = waist-chest ratio, WHTR = waist-height ratio*

## 4.3 CORRELATION BETWEEN ANTHROPOMETRIC VARIABLES

Table 4.11 shows correlation matrics of all body anthropometrics for overall females, the overall correlation matrix of all females and their anthropometric characteristics. Pearson's correlation coefficient was used to correlate the digit ratio to the other parameters,there is significant correlation with digit ratio in both hands negative in right positive in left. Fifty eight percent (80%) of the parameters correlated at $p < 0.01$ and $p < 0.05$. Digit ratio showed a positive correlation with BMI, sex, EQ, SQ, hip circumference, MUAC, WCR and head length. Hip circumference correlated with all the variables except ethnic group. Chest circumference correlated with all of the variables except with MUAC circumference. BMI correlated with, height, waist circumference, hip circumference, waist-chest circumference and waist-height circumference which is statistically significant except for EQ.

Table 4.12 presented the Systemizing, Empathy quotient and anthropometric characteristics of participants from both ethnic groups according to their Fathers' level of education, which is significant for both systemizing and empathizing quotient and increases with high educational level.Individuals whose father had university education scored on the average higher on anthropometric measurements than their counterparts whose father had no formal education. However, participants whose father had primary education had higher systemizing and empathy quotient. Table 4.13, showsSystemizing, Empathy quotient and anthropometric characteristics of participants from both ethnic groups according to their mothers' level of education which shows increasing significance with mothers level of education.

Table 4.14 presents the Socio-demographic status of Bajju and Asholio Ethnic groupwith the Asholio having higher individual with normal BMI, and the Bajju having higher BMI in general.

**Table 4.11: Correlations matrix for females**

| | SEX | AGE | WT | HT | BMI | WC | HiC | WHR | MUAC | RR | LR | WCR | WHTR | SQ | EQ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEX | - | | | | | | | | | | | | | | |
| AGE | -0.31** | - | | | | | | | | | | | | | |
| WT | -0.10 | -0.05 | - | | | | | | | | | | | | |
| HT | -0.30** | 0.19** | .19** | - | | | | | | | | | | | |
| BMI | 0.14* | -0.17** | 0.65** | -0.61** | - | | | | | | | | | | |
| WC | -0.18** | 0.15** | 0.08 | 0.09 | 0.01 | - | | | | | | | | | |
| HiC | 0.49** | -0.14* | -0.02 | -0.19** | 0.13* | 0.30** | - | | | | | | | | |
| WHR | -0.57** | 0.23** | 0.07 | 0.24** | -0.11 | 0.53** | -0.64** | - | | | | | | | |
| MUAC | 0.21** | -0.04 | 0.07 | -0.11 | 0.14* | 0.08 | 0.24** | -0.13* | - | | | | | | |
| RR | 0.53** | -0.12* | -0.00 | -0.20** | 0.14* | -0.12* | 0.26** | -0.32** | 0.09 | - | | | | | |
| LR | 0.60** | -0.11 | -0.09 | -0.18** | 0.06 | -0.10 | 0.26** | -0.30** | 0.14* | 0.58** | - | | | | |
| WCR | 0.44** | -0.05 | -0.14* | -0.18** | 0.03 | 0.64** | 0.52** | 0.06 | 0.16** | 0.19** | 0.25** | - | | | |
| WHTR | -0.03 | 0.06 | -0.01 | -0.38** | 0.29** | 0.89** | 0.37** | 0.38** | 0.13* | -0.02 | -0.01 | 0.68** | - | | |
| SQ | -0.47** | -0.18** | 0.12* | 0.10 | 0.02 | 0.13* | -0.22** | 0.29** | -0.12* | -0.17** | -0.32** | -0.25** | 0.08 | - | |
| EQ | 0.49 | 0.11 | -0.12* | -0.16** | 0.03 | -0.03 | 0.26** | -0.25** | 0.13* | 0.21** | 0.30** | 0.30** | 0.05 | -0.33** | - |

**. Correlation is significant at the 0.01 level (2-tailed). *.*Correlation is significant at the 0.05 level (2-tailed).*RR= Right digit ratio LR= Left digit ratio , SQ= systemizing quotient EQ= empathy quotient, WT = Weight (kg), HT = Height (cm), WC = Waist circumference (cm), HC = Hip circumference (cm), BMI = Body mass index (kg/$m^2$), MUAC = mid upper arm circumference (cm), HiC = Hip circumference (cm), CC = Chest circumference (cm), HC = Head circumference (cm), HL= Head length (cm), HW= Head width (cm), WHR = waist-hip ratio, WCR = waist-chest ratio, WHTR = waist-height rat*

**Table 4.12: Systemizing, Empathy quotient and anthropometric characteristics of participants from both ethnic groups according to their Fathers' level of education**

| Parameters | None (n = 60) | Primary (n = 24) | Secondary (n = 300) | Tertiary (n = 216) | F | p |
|---|---|---|---|---|---|---|
| Systemizing quotient | 30.57 ± 1.22 | 31.21 ± 1.51 | 32.45 ± 1.40 | 33.49 ± 1.42 | 32.07 | 0.00 |
| Empathy quotient | 48.70 ± 0.81 | 45.45 ± 0.76 | 45.56 ± 0.90 | 46.87 ± 1.00 | 42.81 | 0.02 |
| Height (cm) | 165 ± 5.34 | 167 ± 6.87 | 171 ± 5.29 | 168.03 ± 5.58 | 7.36 | 0.00 |
| Weight (kg) | 61.95 ± 2.48 | 61.95 ± 4.13 | 66.95 ± 3.48 | 68.95 ± 4.88 | 13.76 | 0.04 |
| BMI ($kg/m^2$) | 23.12 ± 1.78 | 23.57 ± 2.49 | 24.48 ± 1.91 | 27.81 ± 2.75 | 11.30 | 0.87 |
| Chest circumference (cm) | 82.59 ± 4.13 | 83.67 ± 4.64 | 82.04 ± 6.62 | 85.96 ± 6.73 | 8.69 | 0.03 |
| Hip circumference (cm) | 93.79 ± 4.20 | 96.63 ± 5.43 | 77.61 ± 7.28 | 90.46 ± 7.76 | 26.73 | 0.03 |
| Waist circumference (cm) | 73.29 ± 5.00 | 63.00 ± 3.83 | 73.82 ± 5.87 | 74.77 ± 5.65 | 21.92 | 0.73 |
| MUAC (cm) | 30.82 ± 1.29 | 28.60 ± 1.56 | 28.52 ± 1.42 | 28.52 ± 1.56 | 9.83 | 0.01 |
| Waist-hip ratio | 0.86 ± 0.08 | 0.82 ± 0.06 | 0.83 ± 0.09 | 0.81 ± 0.08 | 5.81 | 0.60 |
| Waist-chest ratio | 0.91 ± 0.06 | 0.86 ± 0.07 | 0.89 ± 0.08 | 0.89 ± 0.07 | 21.59 | 0.72 |
| Waist-height ratio | 0.86 ± 0.08 | 0.82 ± 0.06 | 0.83 ±0.09 | 0.81 ± 0.08 | 36.35 | 0.04 |

**Table 4.13: Systemizing, Empathy quotient and anthropometric characteristics of participants from both ethnic groups according to their mothers' level of education**

| Parameters | None (n = 99) | Primary (n = 56) | Secondary (n = 299) | Tertiary (n = 146) | F | p |
|---|---|---|---|---|---|---|
| Systemizing quotient | 30.57 ± 1.22 | 31.21 ± 1.51 | 31.45 ± 1.40 | 32.49 ± 1.42 | 0.69 | 0.03 |
| Empathy quotient | 43.70 ± 0.81 | 44.45 ± 0.76 | 45.56 ± 0.90 | 45.87 ± 1.00 | 2.24 | 0.00 |
| Height (cm) | 165 ± 5.34 | 167 ± 5.87 | 161 ± 5.29 | 168.03 ± 5.58 | 4.67 | 0.02 |
| Weight (kg) | 61.95 ± 2.48 | 61.95 ± 4.13 | 66.95 ±3.48 | 68.95 ± 4.88 | 18.74 | 0.01 |
| BMI ($kg/m^2$) | 22.12 ± 1.79 | 23.57 ± 2.49 | 23.48 ± 1.90 | 26.81 ± 2.77 | 5.05 | 0.51 |
| Chest circumference (cm) | 80.04 ± 4.95 | 85.74 ± 5.59 | 82.40 ± 6.84 | 82.94 ± 6.62 | 8.55 | 0.02 |
| Hip circumference (cm) | 95.24 ± 5.27 | 94.47 ± 5.89 | 90.95 ± 7.37 | 92.08 ± 8.07 | 38.10 | 0.04 |
| Waist circumference (cm) | 73.15 ± 5.10 | 75.99 ± 6.46 | 64.16 ± 5.71 | 75.03 ± 5.60 | 5.45 | 0.00 |
| MUAC (cm) | 26.08 ± 1.34 | 30.40 ± 1.56 | 28.57 ± 1.53 | 28.50 ± 1.51 | 12.02 | 0.02 |
| Waist-hip ratio | 0.84 ± 0.08 | 0.78 ± 0.08 | 0.83 ± 0.08 | 0.80 ± 0.09 | 18.10 | 0.00 |
| Waist-chest ratio | 0.93 ± 0.07 | 0.87 ± 0.07 | 0.79 ± 0.08 | 0.82 ± 0.07 | 8.96 | 0.82 |
| Waist-height ratio | 0.84 ± 0.07 | 0.88 ± 0.08 | 0.86 ± 0.08 | 0.80 ± 0.09 | 14.80 | 0.01 |

**Table 4.14: Body mass index of Bajju and Asholio Ethnic group**

| | Bajju(n) | Asholio(n) |
|---|---|---|
| 0 <= 18.5 | 57.00 | 60.00 |
| 18.5 <= 24.9 | 233.00 | 238.00 |
| 24.9 <= 29.9 | 9.00 | 2.00 |
| 29.9 <= 30.0 | 1.00 | - |
| Body Mass Index (%) | | |
| Underweight | 19% | 20% |
| Normal weight | 77.6% | 79.3% |
| Overweight | 3% | 0.7% |
| Obesity | 0.3% | - |

Table 4.15 shows relationship of systemizing with order of birth and family size Bajju and Asholio Ethnic group, which increases with birth order and decreases with family size.The results of the influence of birth order and family size on Systemizing quotient(SQ) for all the subjects and for subjects from Bajju and Asholio ethnicity. The results revealed that SQ increases with both increase in family size but decreases with birth order. One way analysis of variance showed statistical significance ($p < 0.01$) when the difference in means were for all the subjects put together, Bajju and Asholio ethnicity.

Table 4.16 shows the results of the influence of birth order and family size on Empathy quotient (EQ) for all the subjects for subjects from Bajju and Asholio ethnicity.Table 4.17 shows Linear regression of Systemizing quotient from right 2D:4D, left 2D:4D, birth order and family size of participants from Bajju and Asholio ethnic groups which is significant for both right and left 2D:4D.Linear regression equations of systemizing quotient and empathy quotient from right 2D:4D, left 2D:4D, birth order and family size of participants from Bajju and Asholio ethnic groups. From the table, birth order is a stronger possible predictor of SQ and EQ of participants from both ethnicity than the other variables. The value of $R^2$ for predicting SQ and EQ using birth order from Bajju and Asholio ethnic groups are respectively 0.338 and 0.595, for SQ and 0.238 and 0.490 for EQ, $p < 0.0001$. For participants from Bajju ethnic group, family size is another predictor of SQ and EQ than right and left 2D:4D, with $R^2 = 0.122$ and 0.132 for SQ and EQ , $p < 0.0001$. On the other hand, for participants from Asholio ethnic group, family size is also a predictor of SQ and EQ than right and left 2D:4D, with $R^2 = 0.275$ and 0.375, for both SQ and EQ $p < 0.000$. Table 4.18 shows Linear regression of

Empathy quotient from right 2D:4D, left 2D:4D, birth order and family size of participants from Bajju and Asholio ethnic groups but not significant for both right and left digit ratio.Table 4.19 shows Linear regression of anthropometric variables of participants from Bajju and Asholio ethnic groups, which shows significance for all the variables. Table 4.20 shows Comparison of observed and estimated values of some variables using generated linear regression equations for participants from Bajju ethnicity. Table 4.21shows Comparison of observed and estimated values of some variables using generated linear regression equations for participants from Asholio ethnicity.

**Table 4.15: Showing relationship of systemizing with order of birth and family size of Bajju and Asholio Ethnic group**

| | | All Subjects | Asholio | Bajju | | |
|---|---|---|---|---|---|---|
| **Parameters** | **n** | **Mean ± SD** | **Mean ± SD** | **Mean ± SD** | **t** | **p** |
| ***Order of birth*** | | | | | | |
| 1 | 93 | 38.82 ± 0.63 | 38.67 ± 0.55 | 39.04 ± 0.73 | 3.36 | 0.00 |
| 2 | 142 | 37.45 ± 0.92 | 38.39 ± 0.89 | 39.51 ± 0.95 | 3.74 | 0.02 |
| 3 | 176 | 43.56 ± 0.91 | 41.57 ± 0.88 | 38.64 ± 1.01 | 2.34 | 0.03 |
| ≥ 4 | 189 | 39.09 ± 0.58 | 40.89 ± 0.73 | 41.10 ± 0.60 | 1.76 | 0.00 |
| | | F = 71.81 | F = 34.90 | F = 25.73 | | |
| | | p = 0.001 | p = 0.01 | p = 0.01 | | |
| ***Family size*** | | | | | | |
| 1 | 193 | 32.78 ± 0.57 | 37.69 ± 0.56 | 38.97 ± 0.57 | 3.04 | 0.01 |
| 2 | 85 | 39.40 ± 0.94 | 38.32 ± 0.88 | 36.44 ± 0.97 | 2.56 | 0.02 |
| 3 | 96 | 33.38 ± 0.90 | 36.47 ± 0.83 | 39.76 ± 0.96 | 3.54 | 0.00 |
| ≥ 4 | 226 | 36.02 ± 0.68 | 36.00 ± 0.68 | 36.00 ± 0.76 | 0.65 | 0.23 |
| | | F = 65.34 | F = 37.72 | F = 44.13 | | |
| | | p = 0.01 | p = 0.01 | p = 0.01 | | |

**Table 4.16: Showing relationship of Empathy with order of birth and family size of Bajju and Asholio Ethnic group**

| | | All Subjects | Asholio | Bajju | | |
|---|---|---|---|---|---|---|
| **Parameters** | **n** | **Mean ± SD** | **Mean ± SD** | **Mean ± SD** | **t** | **p** |
| ***Order of birth*** | | | | | | |
| 1 | 93 | 37.72 ± 0.58 | 37.53 ± 0.59 | 37.04 ± 0.69 | 2.36 | 0.60 |
| 2 | 142 | 35.55 ± 0.66 | 36.79 ± 0.81 | 38.76 ± 0.46 | 3.34 | 0.02 |
| 3 | 176 | 34.46 ± 0.52 | 35.67 ± 0.41 | 37.54 ± 0.15 | 2.62 | 0.03 |
| ≥ 4 | 189 | 30.09 ± 0.65 | 31.09 ± 0.59 | 35.10 ± 0.80 | 2.76 | 0.00 |
| | | F = 65.81 | F = 34.78 | F = 20.46 | | |
| | | p = 0.001 | p = 0.01 | p = 0.01 | | |
| ***Family size*** | | | | | | |
| 1 | 193 | 29.72 ± 0.68 | 32.57 ± 0.50 | 34.04 ± 0.79 | 3.54 | 0.01 |
| 2 | 85 | 32.55 ± 0.72 | 33.69 ± 0.88 | 35.56 ± 0.96 | 2.36 | 0.04 |
| 3 | 96 | 31.46 ± 0.42 | 34.67 ± 0.71 | 36.74 ± 1.10 | 2.54 | 0.02 |
| ≥ 4 | 226 | 37.09 ± 0.55 | 36.99 ± 0.79 | 33.10 ± 0.60 | 2.25 | 0.00 |
| | | F = 60.81 | F = 30.84 | F = 18.43 | 2.36 | 0.60 |
| | | p = 0.001 | p = 0.01 | p = 0.01 | | |

**Table 4.17: Linear regression of Systemizing quotient from right 2D:4D, left 2D:4D, birth order and family size of participants from Bajju and Asholio ethnic groups**

| **Parameters** | **Predictive equation** | ***SEE*** | ***R*** | ***$R^2$*** | ***P*** |
|---|---|---|---|---|---|
| *Bajju* | | | | | |
| R2D:4D | SQ = 14.172 + 17.695 x RD | 0.754 | 0.284 | 0.081 | 0.0001 |
| L2D:4D | SQ = 78.518 + (-47.187) x LD | 0.854 | 0.232 | 0.054 | 0.2301 |
| Birth order | SQ = 0.998 + 0.326 x BO | 0.854 | 0.372 | 0.338 | 0.0001 |
| Family size | SQ = 0.998 + 0.330 x FS | 0.870 | 0.323 | 0.122 | 0.0001 |
| *Asholio* | | | | | |
| R2D:4D | SQ = 13.171+ 16.342 x RD | 0.868 | 0.283 | 0.083 | 0.0001 |
| L2D:4D | SQ = 75.456+ (-45.231) x LD | 0.941 | 0.432 | 0.064 | 0.0731 |
| Birth order | SQ = 0.998 + 0.430 x BO | 0.729 | 0.599 | 0.595 | 0.0001 |
| Family size | SQ = 0.997 + 0.407 x FS | 0.850 | 0.535 | 0.275 | 0.0001 |

SQ = Systemizing quotient, R2D:4D = Right digit ratio, L2D:4D = Left digit ratio, BO = birth order, FS = family size, SSE = standard error of the estimate

**Table 4.18: Linear regression of Empathy quotient from right 2D:4D, left 2D:4D, birth order and family size of participants from Bajju and Asholio ethnic groups**

| Parameters | Predictive equation | ***SEE*** | ***R*** | $R^2$ | ***p*** |
|---|---|---|---|---|---|
| *Bajju* | | | | | |
| R2D:4D | EQ = 21.714 + 28.853 x RD | 0.754 | 0.274 | 0.081 | 0.778 |
| L2D:4D | EQ = 19.265 + 30.666 x LD | 0.854 | 0.262 | 0.054 | 0.2341 |
| Birth order | EQ = 0.998 + 0.326 x BO | 0.854 | 0.472 | 0.238 | 0.0001 |
| Family size | EQ = 0.998 + 0.330 x FS | 0.870 | 0.383 | 0.132 | 0.0001 |
| *Asholio* | | | | | |
| R2D:4D | EQ = 20.675 + 24.567 x RD | 0.868 | 0.283 | 0.083 | 0.4567 |
| L2D:4D | EQ = 19.433 + 28.564 x LD | 0.941 | 0.432 | 0.064 | 0.3211 |
| Birth order | EQ = 0.998 + 0.430 x BO | 0.829 | 0.599 | 0.490 | 0.0001 |
| Family size | EQ = 0.997 + 0.407 x FS | 0.750 | 0.535 | 0.375 | 0.0001 |

SQ = Systemizing quotient, R2D:4D = Right digit ratio, L2D:4D = Left digit ratio, BO = birth order, FS = family size, SSE = standard error of the estimate

**Table 4.19: Linear regression of anthropometric variables of participants from Bajju and Asholio ethnic groups**

| Parameters | Predictive equation | *SEE* | *R* | $R^2$ | *p* |
|---|---|---|---|---|---|
| *Bajju* | | | | | |
| Hip circumference (cm) | HT = 142.750 + 0.365 * HC | 5.550 | 0.365 | 0.07 | 0.0001 |
| Waist circumference (cm) | HC = 62.393 + 0.185 * WC | 5.016 | 0.325 | 0.060 | 0.0001 |
| Chest circumference (cm) | WC = 27.109 + 0.506 * CC | 5.575 | 0.507 | 0.176 | 0.0001 |
| Weight (kg) | BMI = 2.574 + 0.390 * WT | 1.658 | 0.722 | 0.387 | 0.0001 |
| Height(cm) | BMI = 59.966 + (-0.251) * HT | 1.347 | 0.843 | 0.553 | 0.0001 |
| *Asholio* | | | | | |
| Hip circumference (cm) | HT = 153.574 + 0.132 * HC | 5.363 | 0.270 | 0.09 | 0.0001 |
| Waist circumference (cm) | HC = 76.017 + 0.369 * WC | 7.176 | 0.323 | 0.055 | 0.0001 |
| Chest circumference (cm) | WC = 26.242 + 0.634 * CC | 4.862 | 0.710 | 0.373 | 0.0001 |
| Weight (kg) | BMI = 0.533 * WT + (-0.969) | 1.501 | 0.906 | 0.669 | 0.0001 |
| Height (cm) | BMI = 65.83 + (-28.659) * HT | 1.926 | 0.735 | 0.443 | 0.0001 |

HT = height, HC = hip circumference, WC = waist circumference, CC = chest circumference

**Table 4.20: Comparison of observed and estimated values of some variables using generated linear regression equations for participants from Bajju ethnicity**

| RS | HT | | HC | | WC | | *SQ | | **SQ | | *EQ | | **EQ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Obs** | **Est** | **Obs** | **Est** | **Obs** | **Est** | **Obs** | **Est** | **Obs** | **Est** | **Obs** | **Est** | **Obs** | **Est** |
| **1** | 164 | 163.06 | 95.70 | 94.07 | 74.20 | 73.48 | 36.30 | 36.55 | 36.30 | 32.32 | 55.11 | 56.55 | 55.11 | 55.43 |
| **2** | 162 | 162.24 | 90.20 | 95.16 | 73.10 | 73.28 | 28.40 | 28.44 | 28.40 | 20.56 | 45.30 | 48.44 | 45.30 | 45.71 |
| **3** | 160 | 162.74 | 94.70 | 94.05 | 71.40 | 71.05 | 32.04 | 32.01 | 32.04 | 37.80 | 46.20 | 42.01 | 46.20 | 46.85 |
| **4** | 168 | 165.51 | 96.40 | 94.12 | 77.00 | 76.21 | 35.23 | 35.09 | 35.23 | 32.57 | 50.30 | 45.09 | 50.30 | 50.41 |
| **5** | 166 | 164.41 | 93.60 | 93.38 | 77.50 | 78.57 | 29.00 | 29.78 | 29.00 | 22.07 | 48.40 | 29.78 | 48.40 | 48.36 |
| **6** | 163 | 162.28 | 90.90 | 92.61 | 75.20 | 79.18 | 35.40 | 35.32 | 35.40 | 31.07 | 53.44 | 45.32 | 53.44 | 53.93 |
| **7** | 165 | 164.66 | 97.40 | 95.20 | 70.10 | 79.84 | 27.40 | 27.24 | 27.40 | 21.82 | 55.30 | 57.24 | 55.30 | 55.70 |
| **8** | 163 | 164.66 | 97.40 | 95.18 | 76.80 | 75.96 | 34.06 | 34.09 | 34.06 | 30.56 | 52.20 | 44.09 | 52.20 | 52.32 |
| **9** | 161 | 162.56 | 94.40 | 94.46 | 70.00 | 79.18 | 33.70 | 33.21 | 33.70 | 30.06 | 45.30 | 43.21 | 45.30 | 45.83 |
| **10** | 167 | 169.23 | 91.80 | 92.68 | 74.30 | 79.23 | 29.60 | 29.29 | 29.60 | 21.57 | 49.43 | 49.29 | 49.43 | 49.48 |
| | **r = 0.79** | | **r = 0.82** | | **r = 0.83** | | **r = 0.79** | | **r = 0.62** | | **r = 0.50** | | **r = 0.52** | |
| | **p = 0.001** | | **p = 0.001** | | **p = 0.001** | | **p = 0.001** | | **p = 0.001** | | **p = 0.675** | | **p = 0.562** | |

*HT = height estimated from hip circumference (HC), HC estimated using waist circumference (WC), WC estimated from chest circumference, *SQ and **SQ = systemizing quotient using right 2D:4D and left 2D:4D. *EQ and **EQ= empathy quotient estimated using right 2D:4D and left 2D:4D respectively. RS = random sample, Obs = observed value, Est = estimated value and r = Pearson's correlation coefficient.*

**Table 4.21: Comparison of observed and estimated values of some variables using generated linear regression equations for participants from Asholio ethnicity**

| RS | HT | | HC | | WC | | *SQ | | **SQ | | *EQ | | **EQ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Obs** | **Est** | **Obs** | **Est** | **Obs** | **Est** | **Obs** | **Est** | **Obs** | **Est** | **Obs** | **Est** | **Obs** | **Est** |
| **1** | 165.00 | 164.35 | 96.30 | 95.68 | 72.60 | 73.81 | 36.30 | 36.55 | 36.30 | 29.32 | 55.11 | 56.55 | 55.11 | 53.43 |
| **2** | 160.00 | 167.91 | 91.90 | 92.83 | 72.20 | 70.35 | 28.40 | 28.44 | 28.40 | 20.56 | 45.30 | 38.44 | 45.30 | 44.71 |
| **3** | 164.00 | 165.60 | 92.20 | 92.66 | 73.10 | 69.25 | 32.04 | 32.01 | 32.04 | 27.80 | 46.20 | 32.01 | 46.20 | 46.85 |
| **4** | 160.00 | 164.66 | 95.10 | 96.60 | 78.40 | 77.57 | 35.23 | 35.09 | 35.23 | 22.57 | 50.30 | 35.09 | 50.30 | 51.41 |
| **5** | 167.00 | 166.01 | 97.30 | 95.49 | 76.70 | 75.47 | 29.00 | 29.78 | 29.00 | 22.07 | 48.40 | 39.78 | 48.40 | 44.36 |
| **6** | 168.00 | 166.15 | 94.70 | 94.33 | 81.20 | 80.75 | 35.40 | 35.32 | 35.40 | 32.07 | 53.44 | 55.32 | 53.44 | 53.93 |
| **7** | 166.00 | 166.21 | 99.80 | 92.23 | 72.70 | 72.69 | 27.40 | 27.24 | 27.40 | 21.82 | 55.30 | 37.24 | 55.30 | 53.70 |
| **8** | 168.00 | 166.31 | 90.20 | 90.57 | 81.30 | 81.71 | 34.06 | 34.09 | 34.06 | 20.56 | 52.20 | 34.09 | 52.20 | 52.32 |
| **9** | 162.00 | 165.81 | 99.40 | 94.28 | 83.10 | 81.95 | 33.70 | 33.21 | 33.70 | 20.06 | 45.30 | 38.21 | 45.30 | 43.83 |
| **10** | 166.00 | 165.52 | 89.60 | 89.50 | 78.20 | 78.35 | 29.60 | 29.29 | 29.60 | 21.57 | 49.43 | 39.29 | 49.43 | 44.48 |
| | **r = 0.61** | | **r = 0.81** | | **r = 0.70** | | **r = 0.82** | | **r = 0.73** | | **r = 0.79** | | **r = 0.62** | |
| | **p = 0.14** | | **p = 0.02** | | **p = 0.01** | | **p = 0.01** | | **p = 0.01** | | **p = 0.41** | | **0.74** | |

*. HT = height estimated from hip circumference (HC), HC estimated using waist circumference (WC), WC estimated from chest circumference, *SQ and **SQ = systemizing quotient using right 2D:4D and left 2D:4D. *EQ and **EQ= empathy quotient estimated using right 2D:4D and left 2D:4D respectively. RS = random sample, Obs = observed value, Est = estimated value and r = Pearson's correlation coefficient.*

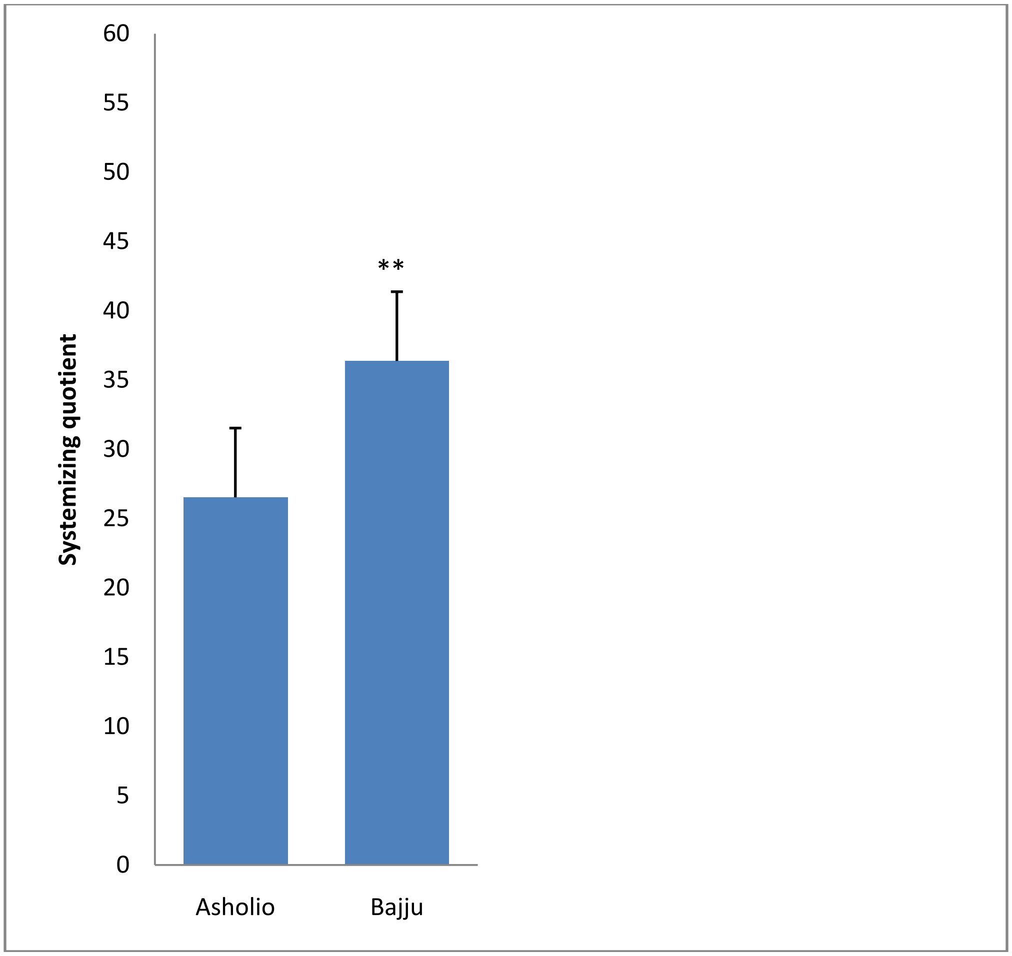


Fig. 4.1: Comparison of Systemizing quotient (SQ) with Bajju ethnic group higher than Asholio. P<0.01

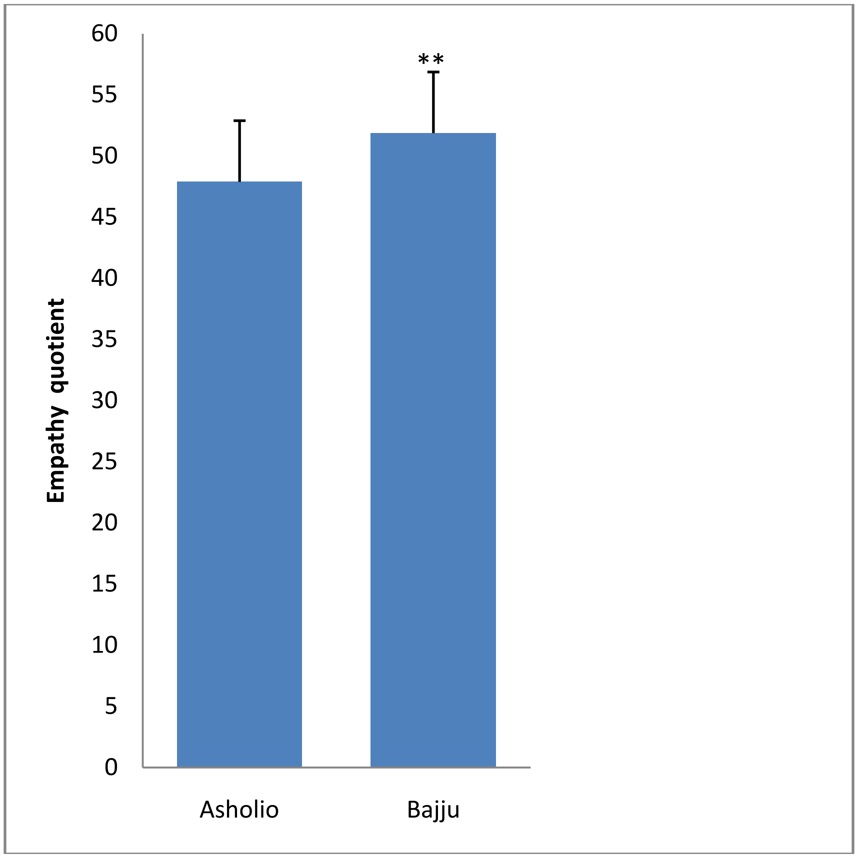


Fig. 4.2: Comparison of Empathizing quotient (EQ) with Bajju ethnic group higher than Asholio. P<0.01

.

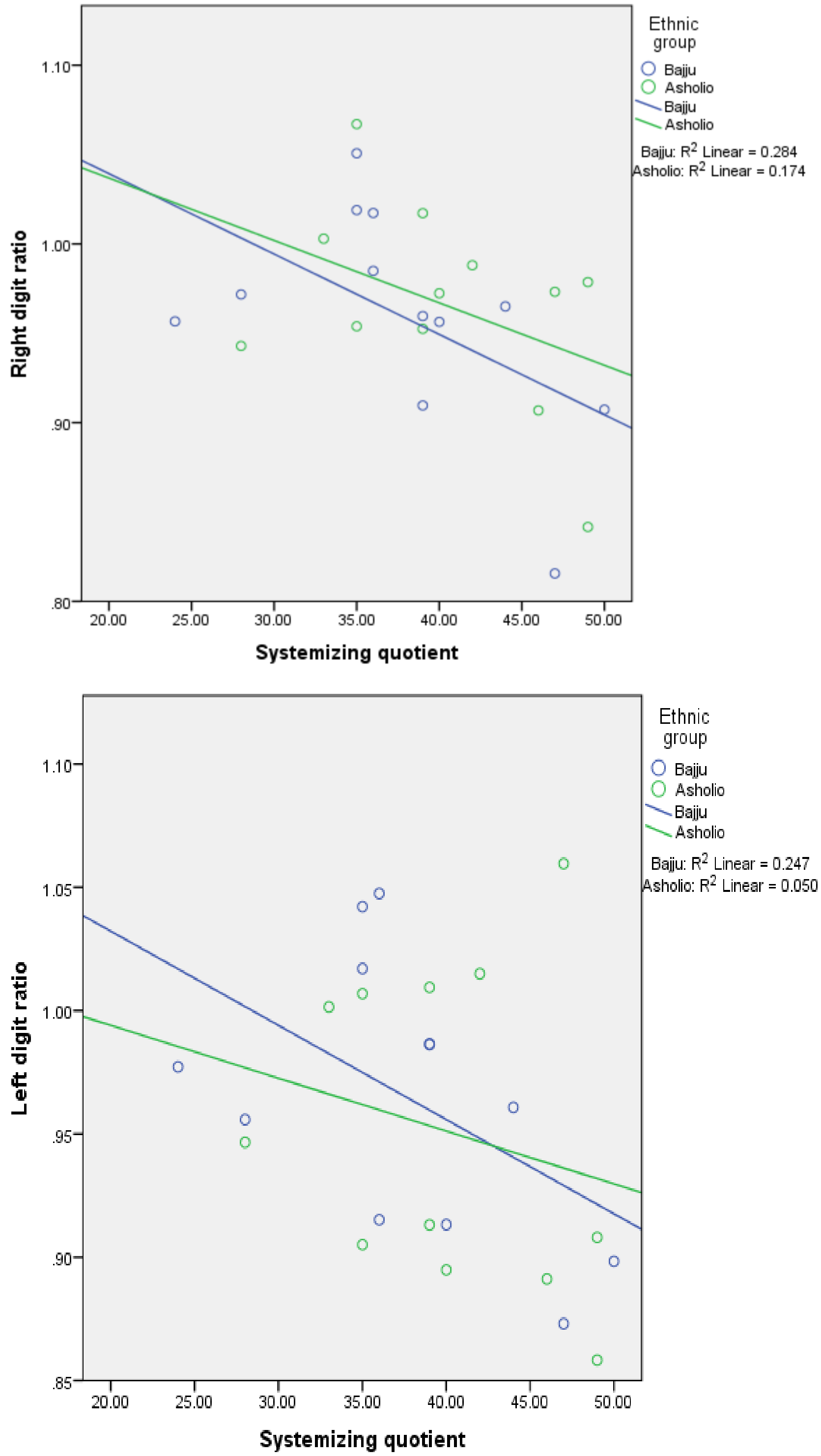


Fig. 4.3: The relationship between mean right and left 2D:4D and mean Systemizing quotient SQ in males and females.

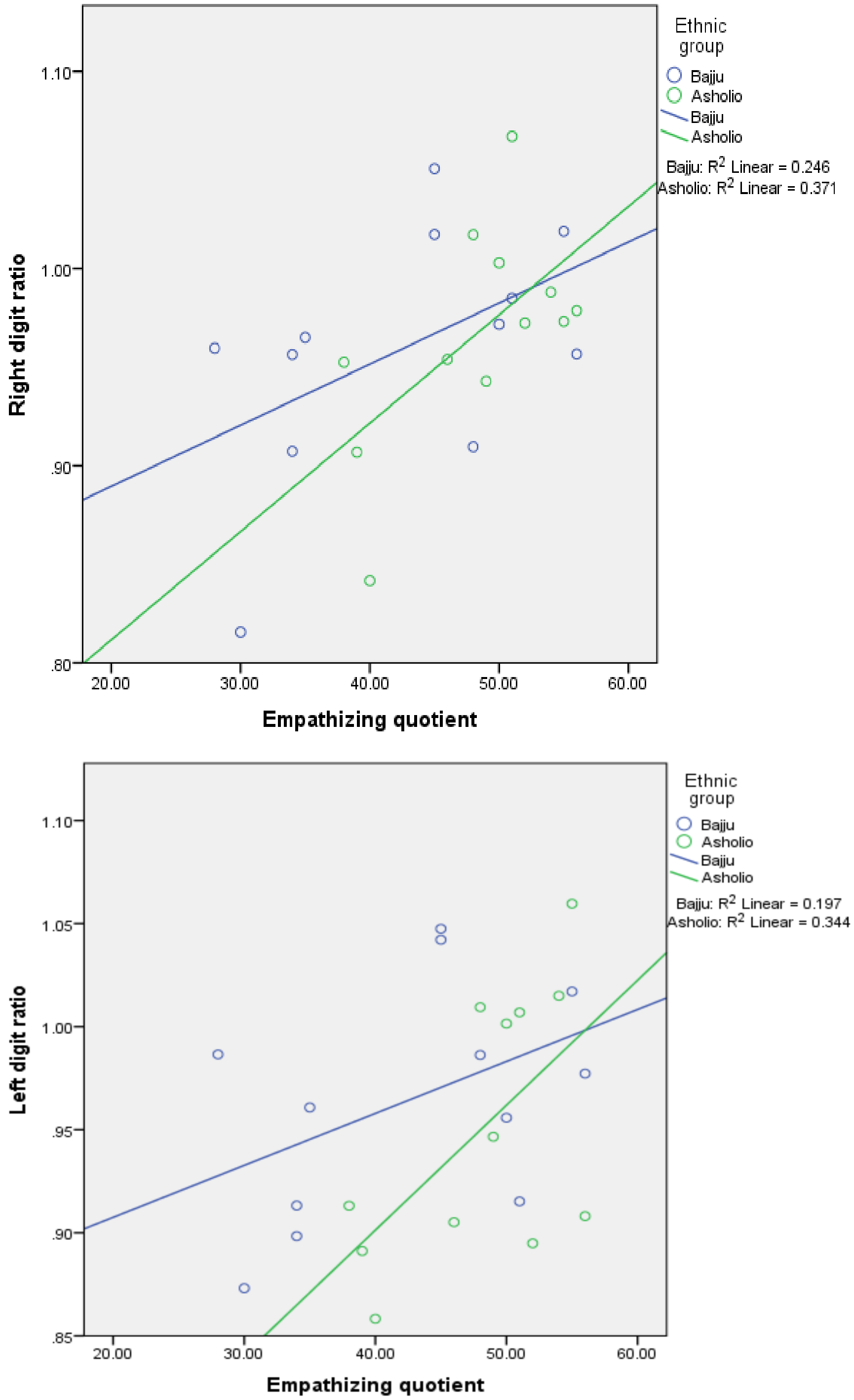


Fig. 4.4: The relationship between mean left and right 2D:4D and mean Systemizing quotient SQ in males and females.

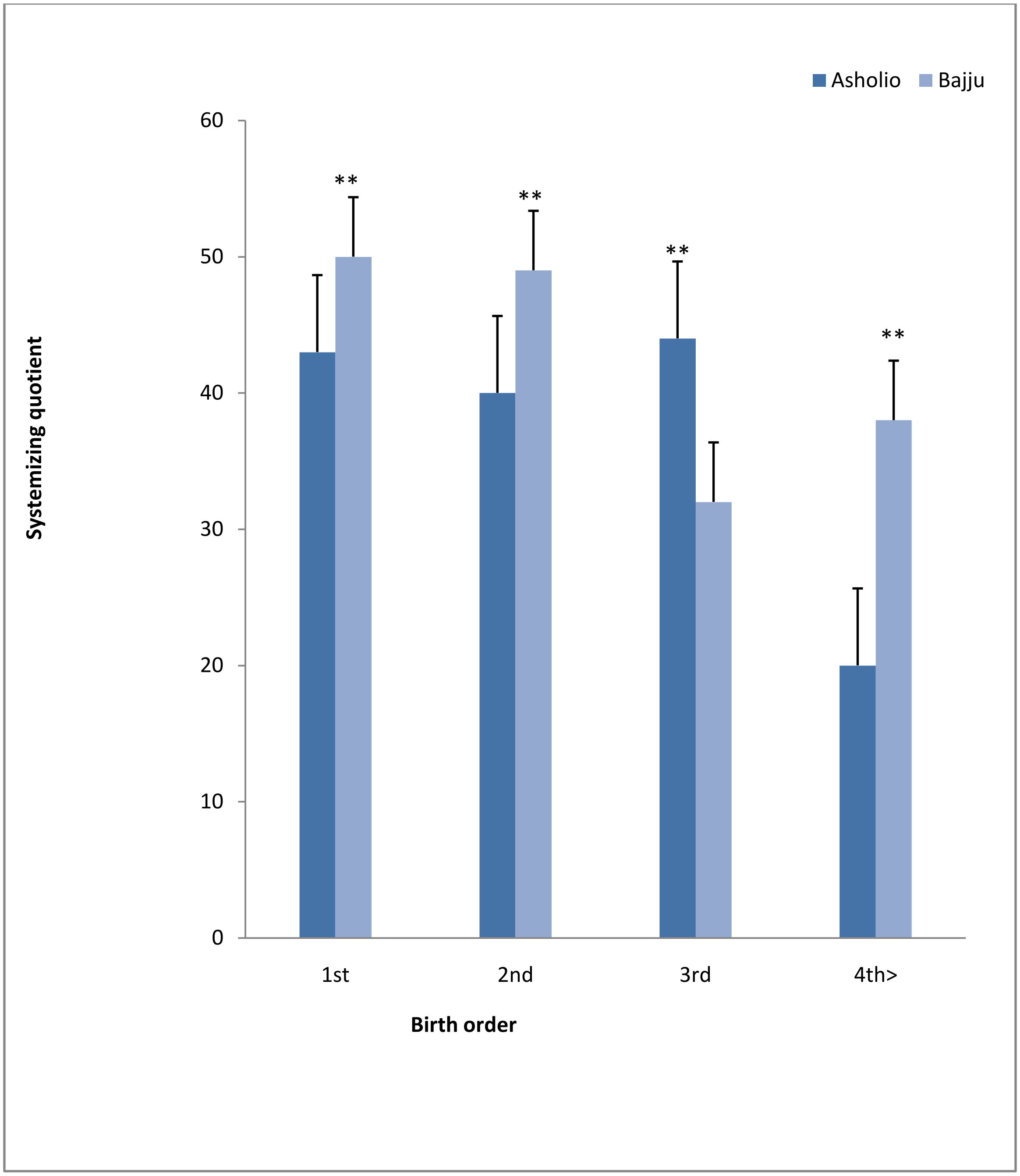


Fig.4.5:Mean ± SD of systemizing quotient with decreasing order of birth. One way analysis of variance indicates significant difference in systemizing quotient based on order of birth, with F = 34.78, and F = 20.73, Bajju ethnic group having higher than Asholio. P < 0.01 for the categories

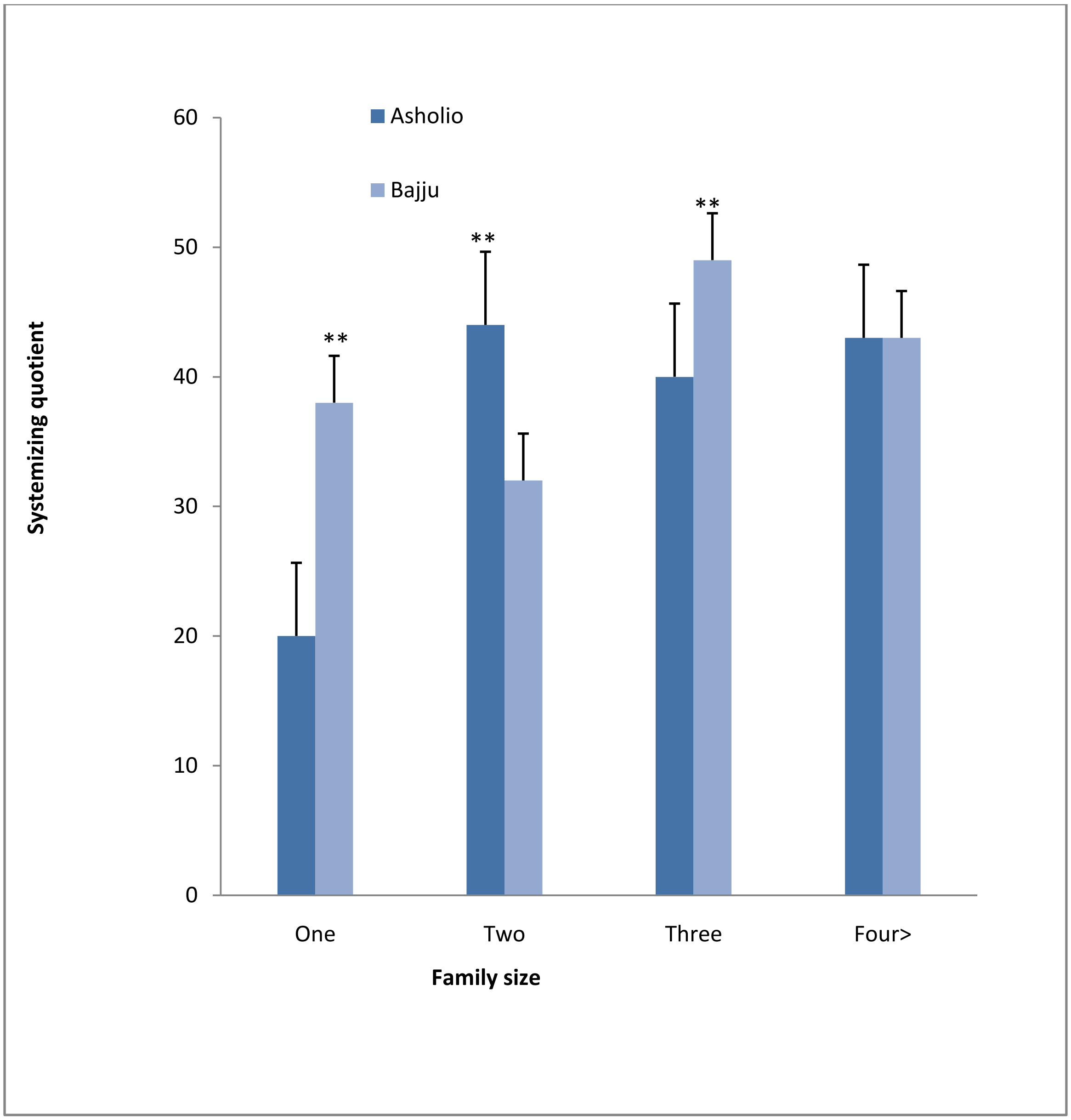


Fig.4.6:Mean ± SD of systemizing quotient with increase in family size. One way analysis of variance indicates significant difference in systemizing quotient based on order of birth, with F = 30.84, and F = 18.43, Bajju having higher than Asholio ethnic group. $P < 0.01$ for the categories

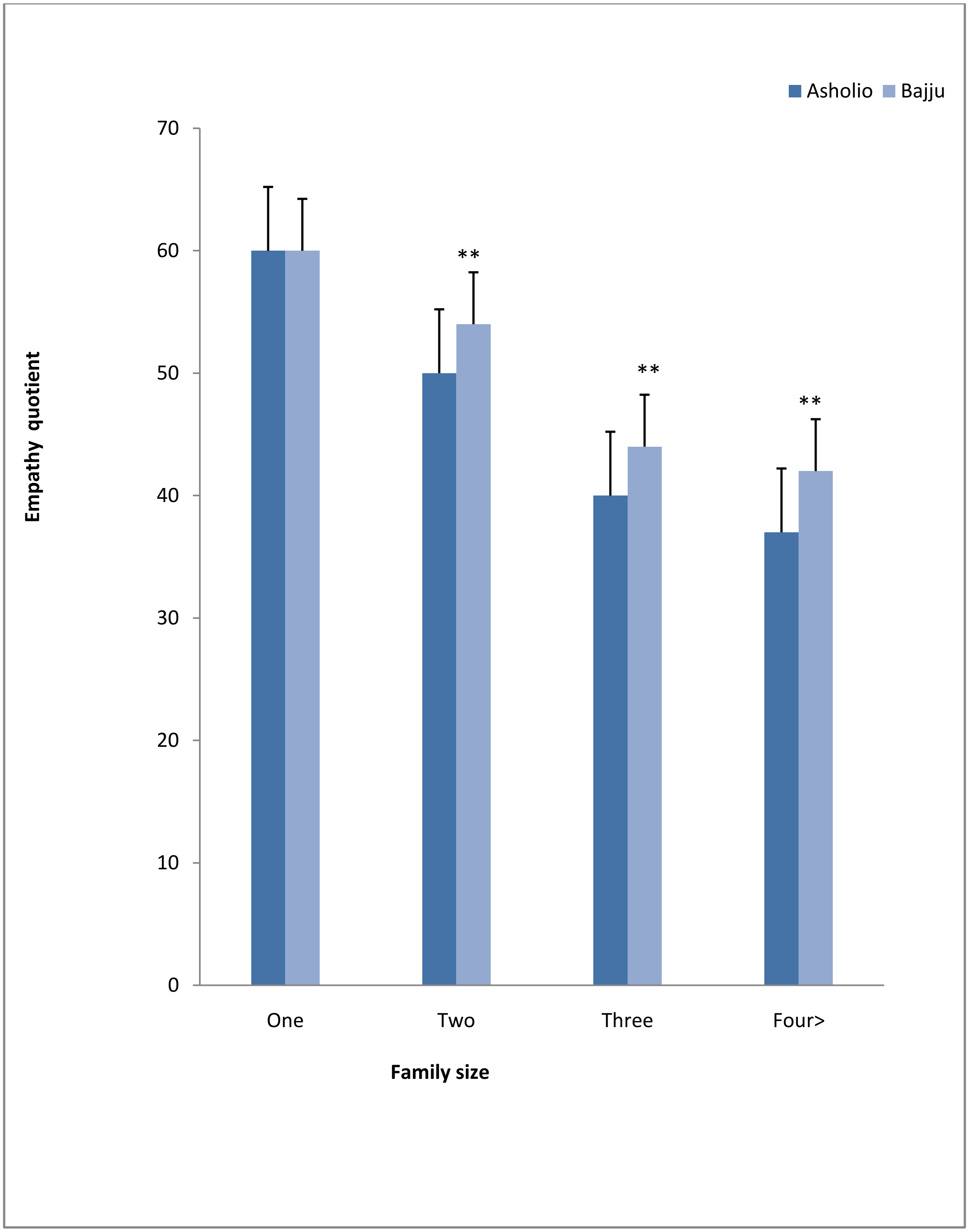


Fig.4.7:Mean ± SD of Empathy quotient with decrease in family size. One way analysis of variance indicates significant difference in systemizing quotient based on order of birth, F = 37.72, and F = 44.13, Asholio and Bajju ethnic group. P < 0.01 for the three categories

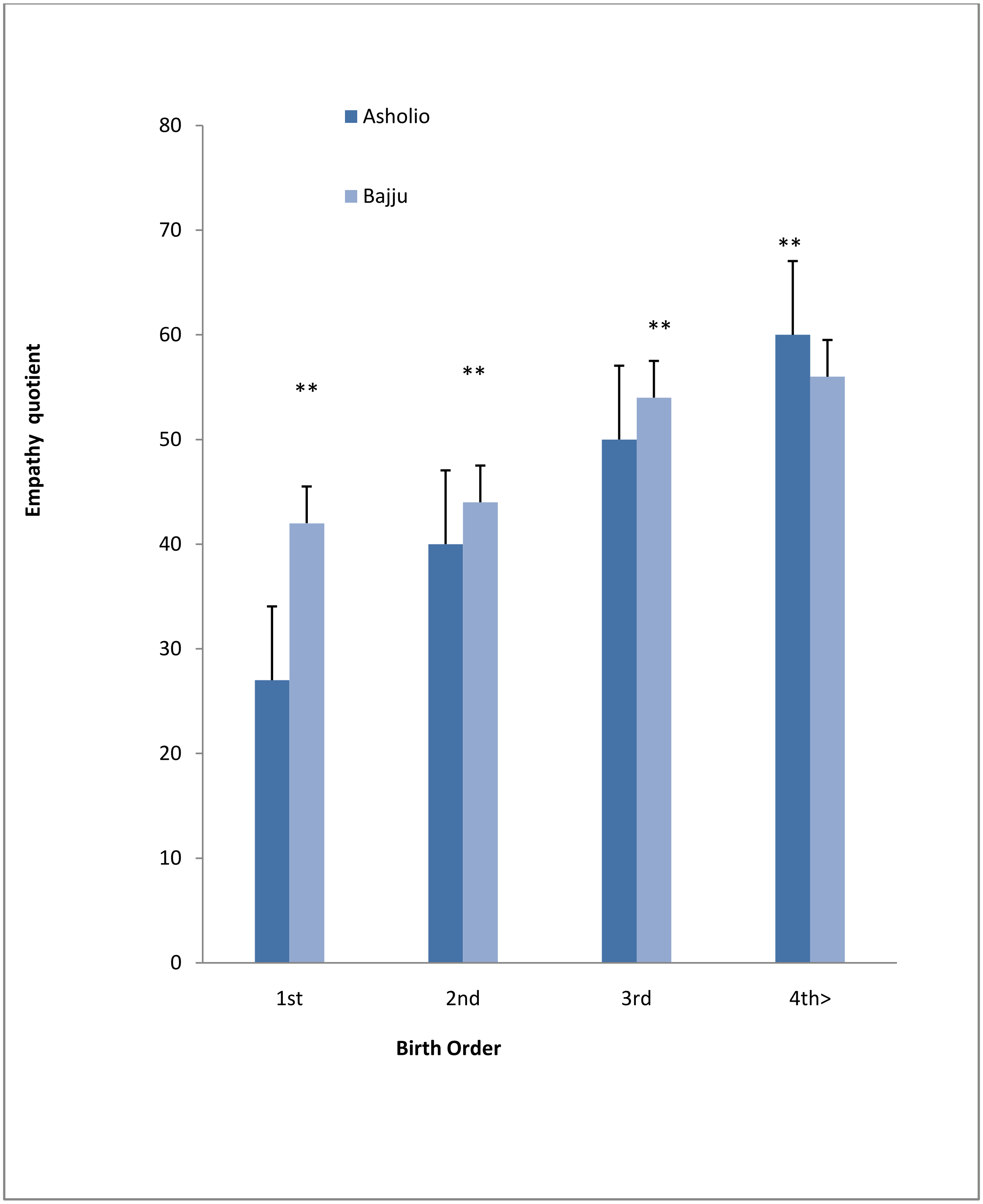


Fig.4.8:Mean ± SD of Empathy quotient with decrease in family size. One way analysis of variance indicates significant difference in systemizing quotient based on order of birth, F = 34.90, and F = 25.73, Asholio and Bajju ethnic group. P < 0.01 for the categories

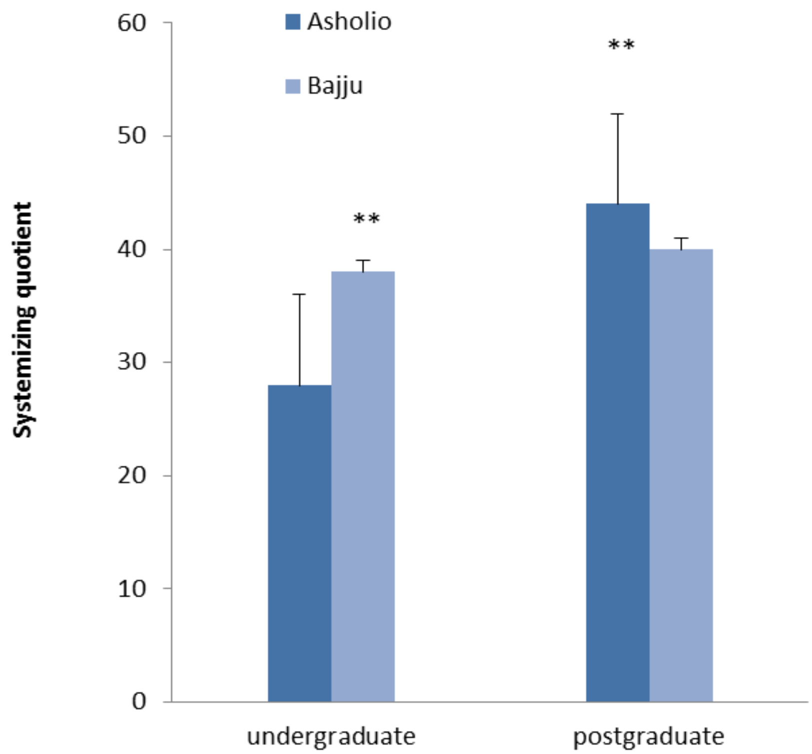


Fig. 4.9: Comparison of SQ  postgraduate participants higher than undergraduate. P<0.01

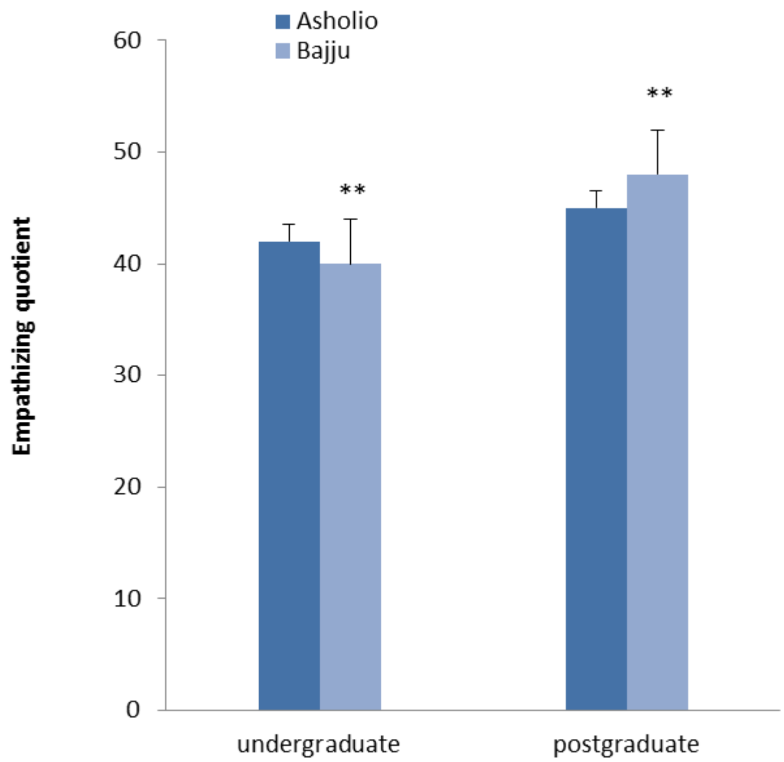


Fig. 4.10: Comparison of EQ  postgraduate participants higher than undergraduate. P<0.01

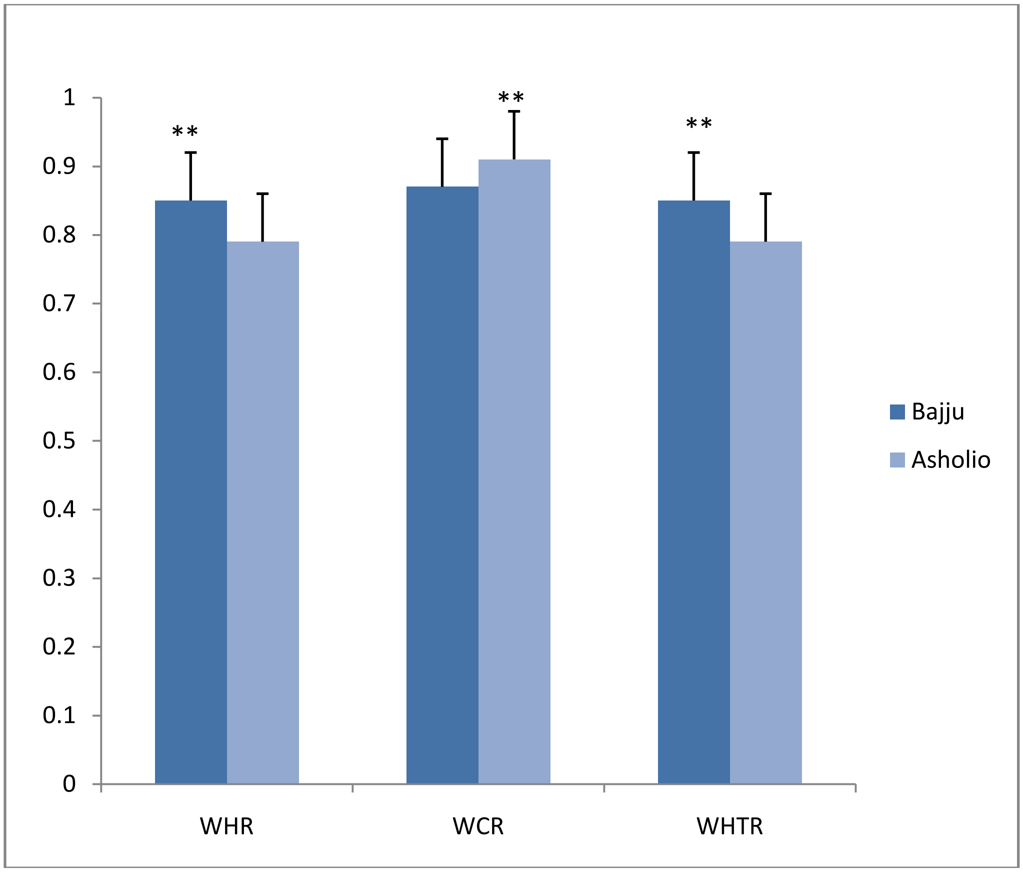


Fig. 4.11: Comparison of waist-hip ratio, waist-chest ratio and waist-height ratio between Bajju and Asholio participants. Student t-test indicates significant difference between Bajju and Asholio ethnic groups, $p < 0.05$. WHR = waist-hip ratio, WCR = waist-chest ratio, WHTR = waist-height ratio.

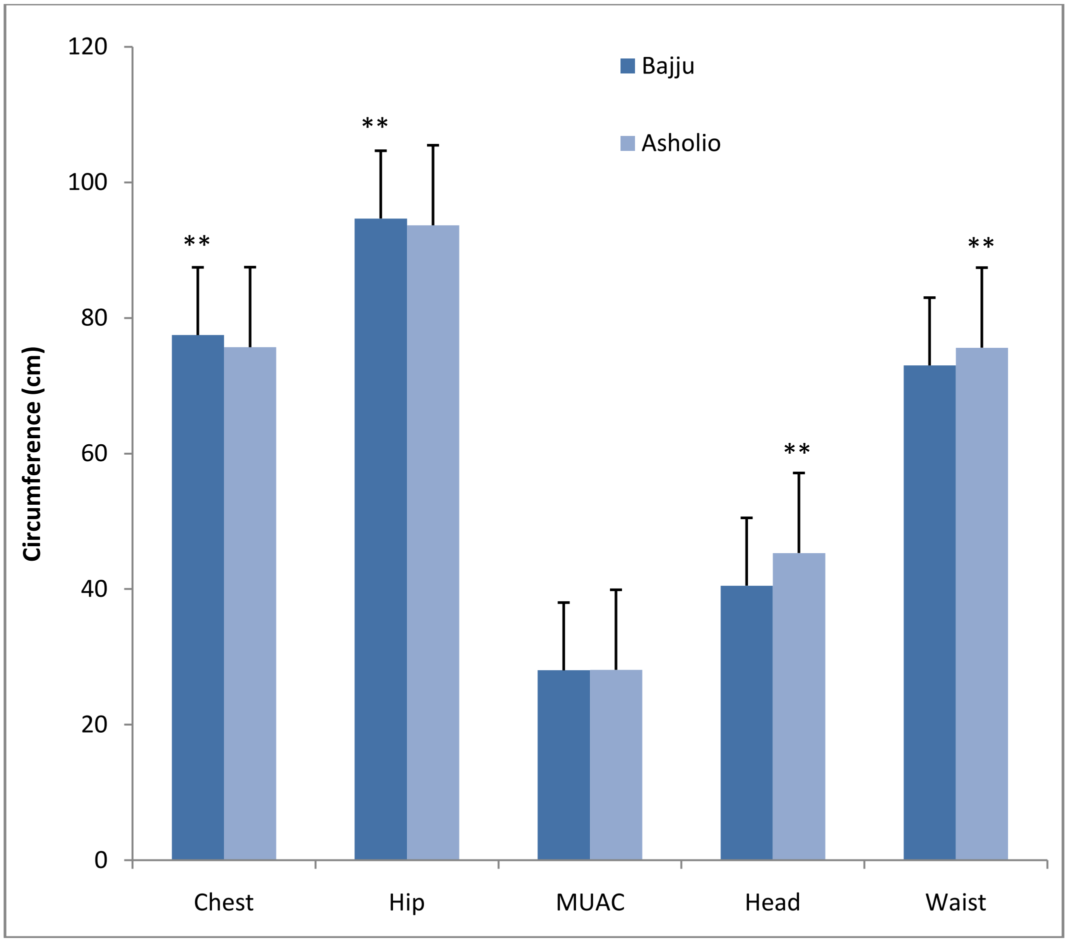


Fig. 4.12: Comparison of body circumference between Bajju and Asholio participants. Student t-test indicates significant difference in chest, head, waist circumference and MUAC between Bajju and Asholio ethnic groups, $p < 0.05$

Fig 4.1 and 4.2 shows a comparison in total systemizing and empathy quotient in both ethnic groups with Bajju ethnic group having a higher score than Asholio. Fig. 4.3 shows a graphical relationship of right and left digit ratio with systemizing quotient, showing a negative relationship higher on the right hand. Fig. 4.4shows graphs that shows relationship of right and left digit ratio with empathizing quotient, showing a positive relationship higher on the right hand but not statistically significant. Fig. 4.5 and 4.6 showsthe gradation of order of birth and family size with systemizing quotient. Systemizing quotient increases with family size but decreases with birth order. Fig. 4.7 and 4.8 shows the trends in empathy quotient decrease in family size but increase with birth order. The results revealed that EQ increases with both increase in birth order but decreases with family size. One way analysis of variance showed statistical significance ($p < 0.01$) when the difference in means were for all the subjects put together, Bajju and Asholio ethnic groups.Fig.4.9 and 4.10 shows the postgraduate students having higher systeming and empathizing as compared to the undergraduate. Fig 4.11shows Comparison of waist-hip ratio, waist-chest ratio and waist-height ratio between Bajju and Asholio participants. Student t-test indicates significant higher difference in Bajju than Asholio ethnic groups, $p < 0.05$.

Fig. 4.12. shows Comparison of body circumference between Bajju and Asholio participants, with the Bajjus having higher values in chest and hip ratios.

# CHAPTER FIVE

## DISCUSSION

It has been suggested that 2D:4D is negatively related to prenatal testosterone and that the association is particularly strong for the right hand (Manning *et al.*, 2008). Digit ratio shows sex differences. Thus, males tend to have lower values of 2D:4D than females and this arises in utero (Galis *et al.*, 2010).Therefore, the ratio between the length of second and fourth digits (2D:4D) is a sexually dimorphic trait—males tend to have lower 2D:4D values that females (Scuttet al.,1998) and it is a cross-cultural trait (Henzi *et al.*, 2003; Manning *et al.*, 2004). 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). In this sample of Bajju and Asholio Ethnic group of Kaduna state, the means for right and left 2D:4D, Systemizing Quotient, Empathy Quotient and height showed sex differences such that males had lower 2D:4D which agrees with (Scutt *et al.*, 1998) work, higher systemizing quotient (SQ), lower empathy quotient (EQ) and were taller than females, (Manning *et al.*, 2010) support that.

This is seen in both ethnic group, which concur with (Henzi *et al.*, 2003; Manning *et al.*, 2004) that it is a cross-cultural trait. The correlations between 2D:4D, SQ and EQ showed a weak but highly significant positive association between 2D:4D (particularly right hand 2D:4D) and systemizing, while the left hand 2D:4D shows negative significant association. There is also weak but highly significant positive association between 2D:4D (both right and left hand) and Empathy Quotient. For Asholio Ethnic group participants, both right hand 2D:4D and left 2D:4D remained significantly related to SQ, while Bajju ethnic group shows no relation with SQ for both hands.   The results of this study provide further evidence that the ratio between the length of the second digit and the fourth digit (2D:4D) is a sexually dimorphic trait with males having a significantly lower ratio than females. 2D:4D correlates with indices of sexually dimorphic traits of the human body. These relationships were found to be stronger for females than for males and also stronger for Asholio ethnic group as compared to Bajju ethnic group. Since 2D:4D is supposedly related to prenatal hormonal levels (Manning *et al.*, 1998, Manning 2002) the present data suggest 2D:4D is not significantly correlated with SQ in males but negatively correlated in females.

The relationship was strong to the effects of BMI, age, height and sex. This suggests that 2D:4D and SQ are influenced by PT at similar developmental times. There was positive association between 2D:4D and EQ. Which suggest an early organizational effect of sex hormones—at least for females and Asholio ethnic group—through the association between indices of body shape and finger length patterns.The results of this study provide further evidence that the ratio between the length of the second digit and the fourth digit (2D:4D) is a sexually dimorphic trait with males having a significantly lower ratio than females. In addition, there are some evidence that 2D:4D also correlates with indices of sexually dimorphic traits of the human body. These relationships were found to be stronger for females than for males in both ethnic groups. Since 2D:4D is supposedly related to prenatal hormonal levels (Manning *et al.*,1998, Manning 2002) the present data suggest an early organizational effect of sex hormones—at least for females—through the association between indices of body shape and finger length patterns.

Previous work has shown that testosterone is related negatively to 2D:4D whereas oestrogen correlates positively with 2D:4D (Manning *et al.*, 1998). Consequently, this work hypothesized that androgenized forms of the 2D:4D would correlate with androgenized forms of BMI, WHR and WCR. Basically, the present data provide some further evidence that this supposition holds true in both sexes for the physical characteristics described in this study, though we must note that the strongest asso-ciations were found between body circumferences, and WCR in females and 2D:4D. Body fat distribution as measured by WHR has been repeatedly shown to correlate with levels of testosterone, oestrogen, and risk for major diseases such as diabetes, hypertension, ovarian disorders and carcinomas (Singh 1993).

Healthy females have higher levels of oestrogen than testosterone. This causes more fat to be deposited on the buttocks and hips than on the waist, giving a low WHR (Beck *et al.*, 1976). Consequently, WHR has been suggested to be an 'honest' signal to an individual's fertility and health. Although, men and women differ in the values of their WHR as testosterone stimulates fat deposition in the stomach region and inhibits a build up in the buttocks and thighs, and oestrogen produces the contrasting effect, it seems that this assertion is valid for both sexes. Previous studies have shown that digit ratio underlies this relationship as lower 2D:4D (the androgenized form) correlates negatively with WHR (Manning 2002). The present study did, however, not find a significant association for male and female digit ratio with WHR. Singh (1995) pointed out that the size of adult male WHR might be indicative of adverse developmental conditions. They found that women judged normal weight male figures with WHR in the typical male range (i.e. around 0.90) more attractive and healthy.

Medical studies have shown that oestrogen significantly increases with obesity in men and women (Kley *et al.*, 1980, Kirschner *et al.*, 1981) leading to the suggestion that fat tissue is able to aromatize androgens. The results of the present study did not supports this argument to some extent as BMI was related insignificantly negative and positive to left and right hand 2D:4D respectively in males. In females the reversed relationship was found with BMI significantly positively related to right hand 2D:4D. It is supposed that men who express lower levels of androgens tend to have a higher BMI whereas female 2D:4D ratio follows the suggestion that oestrogens relate positively to body fat, but this hypothesis needs to be proved in future studies.

This work did not find a significant relationship between WCR and 2D:4D in males, but in women WCR related significantly positively with 2D:4D, i.e. a higher value of 2D:4D (less androgenized) correlated with a higher value of WCR. This is not consistent with the literature, as oestrogens should largely influence female chest circumference. This may be due to environmental factors, which calls for further studies. This results on the relationship of 2D:4D in men do not support this assertion, i.e. 2D:4D was related positively with WCR as for females, which is supposed to be seen in males. Male muscles are built under the influence of testosterone and will be of use for male–male competition. Therefore it is assumed that WCR would correlate negatively with 2D:4D in males as this may indicate a muscular upper body. However, this relationship was not found.

The results of this study are consistent to some extent with the sexual dimorphism of physical traits and cognitive styles developed under the influence of sex hormones at puberty which is cross- cultural. Male and female body shape is influenced by sex-steroid ratios. Whereas organizational effects are supposed to modify an organism early in life—primarily influencing its anatomy as well as its brain—activational effects are apparent later in life and influence the way previously established structures function. If the assertion of an organizational and activational effect of hormones were true, it is suppose that evidence will accumulate that this finds its expression also in finger length patterns. The result of this study also showed that both birth order and family size of the subjects have strong influence on systemizing and empathy quotient.

Higher systemizing quotient was associated with larger family size while reverse is the case for empathy quotient. Result on birth order showed that higher systemizing quotient was associated with a higher position in the family but lower empathy quotient. The likely reason for the influence of family size and position in the siblingship on systemizing and empathy quotient is not clear. However, it may not be unconnected to the time interval between births. (Malina *et al.*, 1997) and Padez (2003) reported that family size and birth order were important indicators in determining the menarcheal age though not systemizing and empathy quotient.It could also be that an increase in the size of a family may result in lesser nutritional quality.

Increase in systemizing quotient with family size might be as a result of struggle within the family for survival while the decrease in the birth order can be due to the much pamper parents give to their children in their old age. The reverse seems to be the case with empathy as individuals with high birth order tends to be more of empathic. In this sample of Bajju and Asholio ethnic groups, systemizng and empathy quotient showed statistical significance based on ethnicity and demography. Genetics and nutrition may be responsible to the variation that occurred. Generally, the Bajju ethnic group show higher systemizing and empathy ($p < 0.001$), which may be genetic or environmental. For the effect of parents' educational level on the various anthropometric measurements taken from the study showed that, participants whose parents are tertiary institution graduates scored higher than those whose parents had no education. Meanwhile, such clear difference in terms of scores was not seen for participants whose parents had primary or secondary school education when compared with those whose parents had tertiary education. For instance, in terms of height, chest circumference, and MUAC, participants whose father had primary education had 3.03cm height, 2.92cm chest circumference, and 2.52cm MUAC respectively, higher than participants whose father had tertiary education.

For participants whose mother had primary school education, they scored higher in chest circumference, hip circumference, waist circumference, and weight than participants whose mother had tertiary education. Also, Bajju ethnic group that have higher level of education tends to do better in their systemizing, empathy quotient and other variables. The present data suggest this, but further investigation is required to obtain a more detailed picture of possible associations.

# CHAPTER SIX

## 6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

### 6.1 SUMMARY

Prenatal sex steroids have been broadly discussed in terms of their possible effect on brain differentiation, whereas pubertal/adult sex hormones are thought to be the main regulators of sexually dimorphic physical features in males and females. Assessing prenatal steroid exposure has previously been difficult but evidence now suggests that finger length ratio may provides insight into prenatal hormone exposure. There is evidence that sex differences in 2D:4D arise from in utero concentrations of sex steroids, with a low 2D:4D (male typical ratio) being positively related to prenatal testosterone, while a high 2D:4D (female typical ratio) is positively associated with prenatal oestrogen. the present cross-sectional study investigated the influence of cognitive style, ethnicity, anthropometric parameters, and socio-demographic factors on digit ratio.

To determine whether, and to what extent, systemizing and empathy, adult sexually dimorphic physical traits, which are largely determined at puberty, relate to traits that are largely determined in utero (digit ratio). This work examined the relationship between systemizing and empathy, sexually dimorphic traits—body mass index (BMI), waist-to-hip ratio (WHR) and waist-to-chest ratio (WCR)—and digit ratio. The above traits were assessed in 600 male and female participants of Bajju and Asholio ethnic groups of Kaduna state by recording their body height, weight, and measuring their waist, hip and chest circumference. Digit lengths of the second and fourth fingers were measured directly from the ventral surface of the hand and by actual finger measurements.Digit ratio was found to be significantly lower in men than in women in both ethnic groups, with the males relatively taller than the females. SQ scores were significantly and negatively correlated with right and left 2D:4D, although the correlations with right hand 2D:4D were stronger. EQ scores were positively correlated with both right 2D:4D and left 2D:4D but not significant.

Our data support a negative correlation between 2D:4D and SQ in men and women, the relationship is very weak. The results is in concordant with theory, with negative relationships between 2D:4D and SQ(that were stronger for right 2D:4D than left) and positive relationships between 2D:4D and EQ(Caswell and Manning, 2009).In contrast, the Voracek and Dressler (2006) study reported higher effect sizes but with a patternof relationships that were theory-discordant across the wholeof their study including negative associations between 2D:4D andboth SQ and EQ.With regard to the EQ, the finding of no significant associationdoes not necessarily mean that EQ is unrelated to PT. There is evidence that the sex difference in 2D:4D is established at the end ofthe first trimester (Manning, 2002). The sex difference in EQ mayarise as a result of PT levels outside this developmental window.

Significant positive correlations were found between female's left and right hand 2D:4D, waist and hip circumference, and WCR. In males, BMI has no relation with right ratio but negatively related to left hand 2D:4D but insignificant. Generally, the relationships were stronger for females than for males in both ethnic groups. Although not all relationships were found to be significant, they were in accord with the predictions. In addition to an activational effect of sex hormones at puberty, the present data suggest an early organizational effect of sex hormones through the association between systemizing and empathy, indices of female body shape and human finger length patterns. This suggests that 2D:4D and SQ are influenced by PT at similar developmentaltimes. There was no association between 2D:4D and EQ.

## 6.2 CONCLUSION

The result of this studies shows that the ratio of 2nd to 4th digit length (2D:4D) is sexually dimorphic with males having lower digit ratio than females. This holds true for both of the ethnic group. It also shows that:

i. Negative relationship exist between left, right digit ratio and systemizing quotient in both ethnic groups but stronger for the right hand.

ii. Right hand digit ratio is the major predictor of systemizing quotient and shows negative correlation.

ii. Systemizing quotient is higher in males while empathizing quotient is higher in females

iii. The Bajju ethnic groups had higher digit ratios, systemizing and empathizing quotient as compared to the Asholio ethnic groups

iv. Systemizing quotient decreases with birth order and increases with family size.

v. Participants with educated parents have high level of systemizing and empathizing quotient.

vi. There is significant correlation between digit ratio and systemizing quotient which is higher in the Bajju ethnic group than the Asholio ethnic group. Hence systemizing and empathizing can be predicted fromdigit ratio vice versa.

## 6.3 RECOMMENDATIONS

Based on the findings of the present study, the following recommendations are formulated:

i. The population should be extended to validate the relationship between digit ratio and the cognitive styles.

ii. The study should be carried out using individuals of other tribes for wider coverage in Nigeria.

iii. Studies that provide a direct test of the link between 2D:4D and Prenatal testosterone should be done among these tribes.

iv. The studies should be done among individuals of other age group.

## REFERENCES


Adair, L.S. and Gordon, L. (2001). Size at birth predicts age at menarche. *Pediatrics 107(4):E59.*

Adriani, W., Boyer, F., Gioiosa, L., Macrì, S., Dreyer, J.-L., and Laviola, G., (2009). Increased impulsive behavior and risk proneness following lentivirus-mediated dopamine transporter over-expression in rats' nucleus accumbens. *Neuroscience* 159, 47–58.

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

Alexander, G., and Hines, M. (2002). Sex differences in response to children's toys in nonhuman primates (Cercopithecus aethiops sabaeus). *Evolution and Human Behavior*, *23*(6), 467-479.

Alice S. Carter, David O. Black, Sonia Tewani, Christine E. Connolly, Mary Beth Kadlec, and Helen T. (2007). "Sex Differences in Toddlers with Autism Spectrum Disorders". *Journal of Autism Development Disorder,* 37, 86–97.

Allison, A., Bailey, P. and Hurd, L. (2004). Finger Length Ratio (2D:4D) Correlates with Physical Aggression in Men but not in Women. *Journal of Biopsychology,* 5, 10-12.

Aluja, A., and García, L.F., (2005). Sensation seeking, sexual curiosity and testosterone in inmates. *Neuropsychobiology* 51, 28–33.

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.

Andersson, A.-M., Toppari, J., Haavisto, A.-M., Petersen, J. H., Simell, T., and Simell, O. (1998). Longitudinal reproductive hormone profiles in infants: Peak of inhibin B levels in infant boys exceeds levels in adult men. *The Journal of Clinical Endocrinology and Metabolism,* 83, 675–681.

Andreas, S., Regina, H., and Johannes, H. (2010). Digit ratio (2D:4D) is associated with traffic violations for male frequent car drivers. *Science Direct*. Volume 42(1): 269-274.

Andrew J, Cooke M, and Muncer S.J (2008). The relationship between empathy and Machiavellianism: an alternative to empathizing–systemizing theory. *Personality of Individual Differences,* 44 (5).

Apicella, C.L., Dreber, A., Campbell, B., Gray, P.B., Hoffman, M., and Little, A.C., (2008). Testosterone and financial risk preferences. *Evolution and Human Behavior* 29, 384–390.

Arató, M., Frecska, E., and Beck, C. (2004). Digit length pattern in schizophrenia suggests disturbed prenatal hemispheric lateralization. *Progress in Neuro-psychopharmacology and Biological Psychiatry*28 (1): 191–4.

Arthur Jr., and Day, E.A., (2008). Information processing, personality, and demographic variables as predictors of crashes and moving violations. In: Bartley, G.P. (Ed.), Traffic Accidents: Causes and Outcomes. *Nova Science Publishers, New York*, pp. 97–121.

Auger J, and Eustache F (2010). Second to fourth digit ratios, male genital development and reproductive health: a clinical study among fertile men and testis cancer patients. *International Journal of Andrology*, 1–10.

Auger J., and Eustache F.. *2010. Second* to fourth digit ratios, male genital development and reproductive health: a clinical study among fertile men and testis cancer patients. *International Journal of Andrology, 1365-2605.*

Auyeung, B., Baron-Cohen, S., Ashwin, E., Knickmeyer, R., Taylor, K., and Hackett, G. (2009). Fetal testosterone predicts sexually differentiated childhood behavior in girls and in boys. *Psychological Science*, 20, 144–148.

Badcock, C. and Crespi, B. (2008). "Battle of the sexes may set the brain". *Nature*, 454 (7208), 1054–1055.

Bailey, A. A. and Hurd, P. L., ( 2005). Finger length ratio (2D:4D) correlates with physical aggression in men butnot in women. *Biological Psychology*, 68(3), 215-22.

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

Bang, A.K., Carlsen, C.E., Holm ,M., Petersen, J.H., Skakkebæk, N.E., and Jørgensen, N. (2005) .A study of finger lengths, semen quality and sex hormones in 360 young men from the general Danish population. *Human Reproduction,* 20(11), 3109–13.

Bardin, C. W. and Caterall, C. F.(1981). Testosterone*:* a major determinant of extragenital sexual dimorphism. *Science*, 211, 1285-1294.

Bardin, C. W., and Catterall, C. F. (1981). Testosterone: a major determinant of extragenital sexual dimorphism. *Behavioral endocrinology*, (pp. 497–526). Cambridge (MA): MIT Press.

Barker, D. J. B. (1992). *Fetal* and infant origins of adult disease. London: *Biologiacl Modern Journal Publishing Group.*

Baron-Cohen, S. (2002). The extreme male brain theory of autism. Trends in Cognitive Sciences, 6, 248–254.

Baron-Cohen, S. (2003). The essential difference: men, women and the extreme malebrain. London: Allen Lane.

Baron-Cohen, S. (2012). Are geeky couples more likely to have kids with autism?. *Scientific American*.

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., and Chakrabarti, B. (2009). Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1522), 1377-1383.

Baron-Cohen, S., Knickmeyer, R. C., and Belmonte, M. K. (2005). Sex differences in the brain: Implications for explaining autism. *Science*, 310, 819–823.

Bartlett R, (2007). Introduction to sports biomechanics. Analyzing human movement patterns. 2nd edn.USA and Canada. basketball players. *Journal Strength Conditional Response*, 21(3), 923-92.

Barut, C., Tan, U. and Dogan, A. (2008): Association of height and weight with second to fourth digit ratio (2D:4D) and sex differences. *Perception and Motor Skills,* 106, 627–632.

Beck, S. B., Ward-Hull, C. I., and McLear, P. M., (1976). Variables related to women's somaticpreferences of the male and female body. *Journal of Personality and Social Psychology*, 34,1200−1210.

Becker, J. B. (2002). Hormonal influences on sensorimotor function. In J. B. Becker, S. M. Breedlove, D. Crews, and M. M. McCarthy (Eds.), *Behavioral endocrinology,* (pp. 497–526). *Cambridge (MA): MIT Press*.

Beech, J. R., and MacKintosh, I. C. (2005). Do differences in sex hormones affect handwriting style? Evidence from digit ratio and sex role identity as determinants of the sex of handwriting. *Personality and Individual Differences*39 (2): 459–68.9.

Bellington, J., Baron-Cohen, S., and Wheelwright, S. (2007). Cognitive style predicts entry into physical sciences and humanities: Questionaire and performance tests of empathy and systemizing. *Learning and Individual Differences*, 17, 260-268.

Benderlioglu, Z., Nelson, R. J. (2004). Digit length ratios predict reactive aggression in women, but not in men. *Hormones and Behavior*46 (5): 558–64.

Benenson, J. F., (2003). Sex on the brain. *Nature*, 424(6945): 132-133.

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): 5119–24.

Blanchard, A., and Lyons, M. (2010). An Investigation into the Relationship between Digit Length Ratio and Psychopathy. *British Journal of Forensic Practice*12 (2): 23–31.

Bogaert A. F., Fawcett C. C., Jamieson L. K. (*2009).* Attractiveness, body size, masculine sex roles and 2D:4D ratios in men. *Personality of Individual Difference, 47, 273–278.*

Borst, G., Thompson, W. L., and Kosslyn, S. M. (2011). Understanding the dorsal and ventral systems of the human cerebral cortex: Beyond dichotomies. *American Psychologist, 66(7),* 624-632.

Bowman, J. E., and Lee, P. C. (2004). Growth and threshold weaning weight among captive rhesus macaques. *American Journal of Physiological Anthropology*, 96:159-175.

Breedlove, S. M., and Hampson, E. (2002). Sexual differentiation of the brain and behavior. In J. B. Becker, S. M. Breedlove, D. Crews, and M. M. McCarthy (Eds.), *Behavioral endocrinology,* (pp. 75–114). Cambridge (MA): MIT Press.

Brown, M. (2008). Skeletal muscle and bone: effect of sex steroids and aging. *Advance 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.

Bryden, M. P. (1982). *Laterality: Functional asymmetry in the intact brain*. New York: Academic Press.

Bryden, M. P., McManus, I. C., and Bulman-Fleming, M. B. (1994). Evaluating the empirical support for the Man. *Behavioral endocrinology,* (pp. 497–526). Cambridge (MA): MIT Press.

Buchen, L. ( 2011). *"Scientists and autism: When geeks meet".Nature,* 479 (7371), 25–7.

Buck, J. J., Williams, R. M., Hughes, I. A., and Acerini, C. L. (2003). In-utero androgen exposure and 2nd to 4th digit length ratio-comparisons between healthy controls and females with classical congenital adrenal hyperplasia. *Human Reproduction,* 18, 976–979.

Burriss, R. P., Little, A. C., and Nelson, E. C. (2007). 2D:4D and sexually dimorphic facial characteristics. *Archives of Sexual Behavior*.36 (3): 377–84.

Buss, D. M. (1994). The evolution of desire: Strategies of human mating. *New York Basic*

Buss, D. M. (2000). The dangerous passion: Why jealousy is as necessary as love and sex. *New York Basic*

Buss, D. M., Shackelford, T. K., Choe, J., Buunk, B. P., and Dijkstra, P. (2000). Distress about characteristics. *European Journal of Social Psychology, 32,* 829-852.

Buunk, A. P., Massar, K., and Dijkstra, P. (2007). A social cognitive evolutionary approach to jealousy: The automatic evaluation of one's romantic rivals. In J. P. Forgas, M. G. Haselton, and W. von Hippel (Eds.), *Evolution and the social mind: Evolutionarypsychology and social cognition* (pp. 213-228). New York: Psychology Press.

Caswell, N., and Manning, J. T. (2009). A comparison of finger 2D:4D by self-reportdirect measurement and experimenter measurement from photocopy:methodological issues. Archives of Sexual Behavior, 38(1), 143–148.

Cattrall, F. R., Vollenhoven, B. J., and Weston, G. C. (2005). Anatomical evidence for in utero androgen exposure in women with polycystic ovary syndrome. *Fertility and Sterility*, 84, 1689–1692.

Chapman, E., Baron-Cohen, S., Auyeung, B., Knickmeyer, R., Taylor, K., and Hackett, G. (2006). Fetal testosterone and empathy: Evidence from the Empathy Quotient (EQ) and the'Reading the Mind in the Eyes' Test. *Social Neuroscience*, *1*(2), 135.

Christopher, J., and David, A. (1998). Is there really a link betwwen engineering and autism? Autism 2(3): 281-289.

Churchchill, A.J.G., Manning, J.T., Peters, M., and Reimers (2007). The effects of sex, ethnicity, and sexual orientation on self-measured digit ratio (2D:4D). *Archives of Sexual Behavior* 36 (2): 251–260.

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.

Coates, J. M., Gurnell, M., and Rustichini, A. (2009). Second-to-fourth digit ratio predicts success among high-frequency financial traders. *Proceedings of the National Academy of Science*, 106, 623–628.

Cohen, J. (1994). The earth is round (p < .05). *American Psychologist*, 49(99), 7–1003.

Cohen-Bendahan, C. C. C., van de Beek, C., and Berenbaum, S. A. (2005). Prenatal sex hormone effects on child and adult sex-typed behavior: Methods and findings.*Neuroscience and Biobehavioral Reviews*, 29, 353–384.

Collaer, M. L.,and Hines, M. (1995). Human behavioral sex differences: A role for gonadal hormones during early development? *Psychological Bulletin*, 118, 55–107.

Connellan, J., Baron-Cohen, S., Wheelwright, S., Batki, A., and Ahluwalia, J. (2000). Sex differences in human neonatal social perception. *Infant Behavior and Development, 23*(1), 113-118.

Cook, C., and Saucier, D. (2010). Mental rotation, targeting ability and Baron-Cohen's Empathizing-Systemizing Theory of Sex Differences. *Personality and Individual Differences*, *49*(7), 712-716.

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): 3604–10.

Csathó, A., Osváth, A., Bicsák, E., Karádi, K., Manning, J., and Kállai, J. (2003). Sex role identity related to the ratio of second to fourth digit length in women. *Biological Psychology*62 (2): 147–56.

Dabbs Jr, 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.

Dahlen, E.R., Martin, R.C., Ragan, K., and Kuhlman, M.M., (2005). Driving anger, sensation seeking, impulsiveness, and boredom proneness in the prediction of unsafe driving. Accident Analysis and Prevention 37, 341–348.

Daitzman, R., and Zuckerman, M., (1980). Disinhibitory sensation seeking, personality and gonadal hormones. *Personality and Individual Differences* 1, 103–110.

Danborno, B., Adebisi, S. S. Adelaiye A. B. and S.A. Ojo (2010): Relationship between Digit Ratio (2D:4D) and Birth Weight in Nigerians. *Anthropologist*, 12(2), 127-130

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 International Journal of Biological Anthropology*, Volume 1 Number 2.

Darwin, C. (1871). The descent of man, and selection in relation to sex.*London, Raven Press*

Del Vecchio, F.B., Goncalves, A., Franchini, E., and Padovani, C.R., (2011). The canonicalcorrelation between the biological markers of performance and physical fitness in high leveljudo athletes. *Physical Education and Sport*, 9, 121 – 129.

Derval, D. (2010). The Right Sensory Mix: Targeting Consumer Product Development Scientifically. *Springer.* p. 129-130.

Derval, D. (2011). Hormonal Quotient and tactile sensitivity: a segmentation model to understand and predict individuals' texture preferences based on prenatal exposure to hormones. *Proceedings of Society for Behavioral Neuroendocrinology 15th Annual Meeting, Queretaro, Mexico*, p.125.

Dickman, S. (1997). HOX gene links limb, genital defects. *Science.* 275 (5306): 1568–9.

Dijkstra, P., and Buunk, B. P. (2002). Sex differences in the jealousy-evoking effect of rival. *Physiology of Behaviour,* 93, 783–788.

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.

Ebstein, R.P., Novick, O., Umansky, R., Priel, B., Osher, Y., Blaine, D., Bennett, E.R., Nemanov, L., Katz, M., Belmaker, R.H., (1996). Dopamine D4 receptor (D4DR) exon III polymorphism associated with the human personality trait of novelty seeking. *Nature Genetics* 12, 78–80.

Eker, J. A. (1875). Anthropology notes on the human hand. *American Anthropologist*. 70, 43-50.

Elizabeth S. Spelke (2005). "Sex Differences in Intrinsic Aptitude for Mathematics and Science? A Critical Review". *American Psychologist,* 60 (9), 950–958.

Enemeugwem, J. H. (2006 ). Obolo and the peopling of the Niger Delta.Otukpo: *Aboki Publishers*, pp. 2-5.

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.

Evans S., Neave N., Wakelin D., and Hamilton C.(*2008).* The relationship between testosterone and vocal frequencies in human males. *Physiology of Behaviour, 93*, 783–788.

Evardone, Alexander, Milagros, and Gerianne, M. (2009). Anxiety, Sex-linked Behavior, and Digit Ratios. *Archives of Sexual Behaviour. 38* (3): 442–55.

Falter, C. M., Arroyo, M., and Davis, G. J. (2006). Testosterone: Activation or organization of spatial cognition? *Biological Psychology*, 73, 132–140.

Faul, F., and Erdfelder, E. (1992).GPOWER: A priori post-hoc, and compromise power analysis for MS-DOS.Bonn: Bonn University.

Ferdenzi, C., Lemaître, J.-F., Leongómez, J. D., and Roberts, S. C. (2011). Digit ratio (2D:4D) predicts facial, but not voice or body odour attractiveness in men. *Proceedings of the Royal Society B, 278*, 3551-3557.

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

Fink, B., Manning, J.T., Williams, J.H.G., and Podmore-Nappin C.(2007). The 2nd to 4th digit ratio developmental psychopathology in school-aged children. *Personality of Individual Differences*, 369-379.

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.

Firman, R.C., Simmons, L.W., Cummins, J.M., and Matson, P.L. (2003). Are body fluctuating asymmetry and the ratio of 2nd to 4th digit length reliable predictors of semen quality? *Human Reproduction*, 18(4), 808–12.

Flegal, K., M. and Troiano, R. P. (2000). Changes in the distribution of body mass index of adults and children in the US population: *International Journal of Obesity and Related Metabolic Disorders*, 24, 807–818. Christopher Jarrold, David A. Routh (September 1998). "Is There Really a Link Between Engineering and Autism?". *Autism* 2 (3).

Folstad, I., and Karter, A. J. (1992). Parasites, bright males, and the immunocompetence handicap. *The American Naturalist, 139*, 603-622.

Furnham, A.F., Saipe, J., (1993). Personality correlates of convicted drivers. *Personality and Individual Differences* 14, 329–336.

Galis, F., Ten Broek, C. M., Van Dongen, S., and Wijnaendts, L. C. (2010). Sexual dimorphism in the prenatal digit ratio (2D:4D). *Archives of Sexual Behavior*, 39(1), 57–62.

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

Gangestad, S. W., and Thornhill, R. (2007). The evolution of social inference processes: *Personality of Individual Differences*; 369-379.

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

Garner, D. M. (1991). Eating Disorder Inventory-2 professional manual. Odessa, FL: *Psychological Assessment Resources Inc*.

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

Geschwind, N. and Levitsky, W. (1968). Human brain: left-right asymmetries in temporal speech region. *Science, 161*(3837), 186.

Geschwind, N., and Galaburda, A. M. (1985). Cerebral lateralization – Biological mechanisms, associations, and pathology. 1. A hypothesis and program for research. *Archives of Neurology,* 42(42), 428–459.

Gobrogge, K.L., Breedlove, S. M. and Klump, K. L. (2008). Genetic and environmental influences on 2d:4d finger length ratios: a study of monozygotic and dizygotic male and female twins. *Archives Sexual Behavior*37 (1): 112–118.

Golan, O., Baron-Cohen, S., and Hill, J. J. (2006). The Cambridge mindreading (CAM) face-voice battery: testing complex emotion recognition in adults with and without Asperger Syndrome. *Journal of Autism and development disorder*, 36, 169-183.

Golombok, S., and Rust, J. (1993). The pre-school activities inventory: A standardized assessment of gender role in children. *Psychological Assessment,* 5, 131–136.

Goswami, U. (2006). Neuroscience and education: from research to practice? *Nature Reviews Neuroscience*, *7*(5), 406-413.

Goy, R. W., Bercovitch, F. B., and McBrair, M. C. (1988). Behavioral masculinization is independent of genital masculinization in prenatally androgenized female rhesus macaques. *Hormones and Behavior,* 22, 552–571.

Goy, R.W. and McEwen, B.S., (1980). Sexual differentiation of the brain: Based on a work session of the neurosciences research program. *MIT Press, Cambridge*.

Graber, J. A., Brooks-Gunn, J., Paikoff, R. L., and Warren, M. P. (1994*).* Prediction of eating problems. An 8-year study of adolescent girls. *Developmental Psychology*,30, 823–834.

Grimbos, T., Dawood, K., Burriss, R. P., Zucker, K., and Puts, D. A. (2010). Sexual orientation and the second to fourth finger length ratio: A meta-analysis in men and women. *Behavioral Neuroscience,* 124, 278–287.

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*(9), 998-1003

Gwunireama, I. U., Osunwoke, E. A and OrishChinna, N. (2010): Anthropometrical study of the second and fourth digit ratio of Andoni (Obolo) groups of Ijaw ethnic nationality in Nigeria. *Journal of Applied Biosciences,* 27, 1732 – 1735.

Häfner, H. (2002). Schizophrenia: do men and women suffer from the same disease? *Revista de Psiquiatria Clínica, 29*(6), 267-292.

Hall, L. S., and Love, C.T.(2003). Finger-length ratios in female monozygotic twins discordant for sexual orientation. *Archives of Sexual Behavior*32 (1): 23–8.

Halpern, D., Benbow, C., Geary, D., Gur, R., Hyde, J., and Gernsbacher, M. (2007). The science of sex differences in science and mathematics. *Psychological Science in the Public Interest*, *8*(1), 1.

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

Hampson, E, and Sankar, J. S. (2012). "Re-examining the Manning hypothesis: androgen receptor polymorphism and the 2D:4D ratio". *Evolution of Human Behaviour*33 (4): 557–561.

Hampson, E., Ellis, C. L., and Tenk, C.M. (2008). On the relation between 2D:4D and sex-dimorphic personality traits. *Archives of Sexual Behavior,* 37, 133–144.

Hatfield, J., Fernandes, R., (2009). The role of risk-propensity in the risky driving of younger drivers. Accident Analysis and Prevention 41, 25–35.

Havlicek, J., Saxton T. K., Roberts S. C., Jozifkova E., Lhota S., Valentova J., Flegr J. (*2008.)* He sees, she smells? Male and female reports of sensory reliance in mate choice and non-mate choice contexts. *Personality of Individual. Differences, 45, 565–570.*

Hawkins, J., and Blakeslee, S. (2004). *On intelligence*. New York: Owl Books.

Heinonen, O. P., Slone, D., Monson, R. R., Hook, E. B., and Shapiro, S. (1977). Cardiovascular birth defects and identification model in youth handball. *Journal of Sports Science*. 27, 257–266. importance of signaling theory. In J. P. Forgas, M. G. Haselton, and W. von Hippel (Eds.).

Henley, C. L., Nunez, A. A., and Clemens, L. G. (2009). Estrogen treatment during development alters adult partner preference and reproductive behavior in female laboratory rats. *Hormones and Behavior,* 55, 68–75.

Hermelin, B. (2001). Bright splinters of the mind: a personal story of research with autistic savants. *London: Jessica Kingsley Publishers*.

Hicks, A.L., Kent-Braun, J., Ditor, D.S., (2001). Sex differences in human skeletal muscle fatigue. *Exercise and Sport Science* Rev. 29:109-112.

Hines, M. (2003). Sex steroids and human behaviour: Prenatal androgen exposure and sex-typical play behaviour in children. *Annals of the New York Academy of Science,* 1007, 272–282.

Hines, M. (2004).Androgen, estrogen, and gender. In A. H. Eagly, A. E. Bell, and R. J. Sternberg (Eds.), The psychology of gender(pp. 9–37). *New York: Guilford Press*.

Hirashi, K., Sasaki, S., Shikishima, C., Ando, J. (2012). The second to fourth digit ratio (2D:4D) in a Japanese twin sample: heritability, prenatal hormone transfer, and association with sexual orientation. *Archive Sexual Behaviour* 41 (3): 711–24.

Hoenekopp J, Manning JT, Muller C.(2006). Digit ratio and physical fitness in males and females: evidence for effects of prenatal androgens on sexually selected traits. *Hormonal Behaviour*, 49, 545-549.

Hönekopp, J., and Schuster, M. (2010). A meta-analysis on 2D:4D and athletic prowess: Substantial relationships but neither hand out-predicts the other. *Hormonal Behaviour*, 49, 545-549.

Honekopp, J., and Watson, S. (2010). Meta-analysis of digit ratio 2D:4D shows greater sex difference in the right hand. *American Journal of Human Biology*. (5): 619–30.

Hönekopp, J., Bartholdt, L., Beier, L., andLiebert, A. (2007). Second to fourth digit length ratio (2D:4D) and adult sex hormone levels: New data and a metaanalytic review. *Psychoneuroendocrinology,* 32, 313–321.

Hönekopp, J., Manning, J. T., and Müller, C. (2006). Digit ratio (2D:4D) and physical fitness in males and females: Evidence for effects of prenatal androgens on sexually selected traits. *Hormones and Behavior,* 49, 545–549.

Hurd, P.L, Vaillancourt, K.L, Dinsdale, N.L (2011). Aggression, digit ratio and variation in androgen receptor and monoamine oxidase a genes in men. *Behavioural Genetics,* 41, 543–56.

Hyde, J. S. (2005). The gender similarities hypothesis. *American psychologist*, *60*(6), 581.

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.

Ingudomnukul, E., Baron-Cohen, S., Wheelwright, S., and Knickmeyer, R. (2007). Elevated rates of testosterone-related disorders in women with autism spectrum conditions. *Hormones and Behaviour*, 51(5), 597-604.

Jacobi, C., Hayward, C., de Zwann, M., Kraemer, H. C., and Agras, W. S. (2004). Coming to terms with risk factors for eating disorders: Application of risk terminology and suggestions for a general taxonomy. *Psychological Bulletin,* 130, 19–65.

Jonah, B.A., (1997). Sensation seeking and risky driving: a review and synthesis of the literature. Accident Analysis and Prevention 29, 651–665.

Jonah, B.A., Thiessen, R., Au-Yeung, E.,( 2001). Sensation seeking, risky driving and behavioral adaptation. Accident Analysis and Prevention 33, 679–684.

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

Kaltiala-Heino, R., Rimpel, M., Rissanen, A., and Rantanen, P. (2001*)*. Early puberty and early sexual activity are associated with bulimic-type eating pathology in middle adolescence. *Journal of Adolescent Health*, 28, 346–352.

Kanazawa, S., and Vandermassen, G. (2005). Engineers have more sons, nurses have more daughters: an evolutionary psychological extension of Baron-Cohen's extreme male brain theory of autism. *Journal of Theoretical Biology, 233*(4), 589-599.

Kimura, D. (1996). Sex, sexual orientation and sex hormones influence human cognitive function. *Proceedings of Royal Society of London. B 271, S296–S298.*

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

Kimura, D. (2000). *Sex and cognition*. Massachusetts: The MIT Press.

Kirschner, M. A., Ertel, N., and Schneider, G., (1981). Obesity, hormones, and cancer. *Cancer Research, 41, 3711−3717.*

Kley, H. K., Edelmann, P., and Kruskemper, H. L., (1980). Relationship of plasma sex hormones to different parameters of obesity in male participants. Metabolism, 29, 1041−1045.

Klimek, M., Galbarczyk, A., Nenko, I., Alvarado, L. C., and Jasienska, G. (2014). Digit ratio (2D:4D) as an indicator of body size, testosterone concentration and number of children in human males. *Annals of Human Biology*. *41*: 1.

Klump, K. L., Gobrogge, K. L., Perkins, P. S., Thorne, D., Sisk, C. L., and Breedlove, S.M. (2006). Preliminary evidence that gonadal hormones organize and activate disordered eating. *Psychology of Medicine* 36 (4): 539–546.

Knafo, A., Zahn-Waxler, C., Van Hulle, C., Robinson, J. A. L., and Rhee, S. H. (2008). The developmental origins of a disposition toward empathy: Genetic and environmental contributions. *Emotion; Emotion, 8*(6), 737.

Knickmeyer, R. C., and Baron-Cohen, S. (2006). Fetal testosterone and sex differences. *Early Human Development*, 82, 755–760.

Knickmeyer, R. C., Wheelwright, S., Taylor, K., Raggatt, P., Hackett, G., and Baron- Cohen, S. (2005). Gender-typed play and amniotic testosterone. *Developmental Psychology,* 41, 517–528.

Koehler N., Simmons L. W., and Rhodes G. (2004).How well does second-to-fourth-digit ratio in hands correlate with other indications of masculinity in males? *Proceedings of Royal Society of London. B 271, S296–S298.*

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

Kondo, T., Zakany, J., Innis, J.W. and Duboule D. (1997). Fingers, toes and penises.*Nature*; 390(6655), 29.

Kornhuber, J., Erhard, G., Lenz, B., Kraus, T., Sperling, W., Bayerlein, K., Biermann, T., and Stoessel, C. (2011). Zhang, Xiang Yang, ed. Low Digit Ratio 2D:4D in Alcohol Dependent Patients. *PLoS ONE* 6(4): e19332.

Kornhuber, J., Zenses, E. M., Lenz, B., Stoessel, C., Bouna-Pyrrou, P., Rehbein, F., Kliem, S., and Möble, T. (2013): Low digit ratio 2D:4D associated with video game addiction. *PLoS One* Vol. 8, Nr. 11: e79539

Kozhevnikov, M., (2007). Cognitive styles in the context of modern psychology: Toward an integrated framework. *Psychological Bulletin*, 133, 464-481.

Kraemer, B., Noll, T., Delsignore, A., Milos, G., Schnyder, U., and Hepp, U. (2006). "Finger length ratio (2D:4D) and dimensions of sexual orientation". *Neuropsychobiology* 53 (4): 210–4.

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

Krieser, N. (2011). ASD in females: are we overstating the sex discrepancy in diagnosis. (unpublished doctoral dissertation). Virginia technology, Blacksburg, VA.

Lagarde, E., Chastang, J.-F., Gueguen, A., Coeuret-Pellicer, M., Chiron, M., Lafont, S., (2004). Emotional stress and traffic accidents: the impact of separation and divorce. Epidemiology 15, 762–766.

Lawson-Tancred, H. (2004). "What little boys and girls are made of". p. 67. Retrieved 2013-1

Levy, E. P, Cohen, A., and Fraser, F. C. (1973). Hormone treatment during pregnancy and congenital heart defects.Lancet, 1, 611. mating rivals. *Personal Relationships, 7,* 235-243

Levy, Neil (2004). "Book review: Understanding blindness". Phenomenology and the cognitive *sciences*, 3 (3), 315–24.

Lindstrøm, T. C. (1999). Coping with bereavement in relation to different feminine gender roles. *Scandinavian journal of psychology, 40*(1), 33-41.

Loehlin J. C., McFadden, D., Medland, S. E. and Martin, N. G. (2006). Population Differences in Finger-Length Ratios: Ethnicity or Latitude? *Archive of Sexual Behaviour; DOI: 10.1*

Lohman TG, Roche AF, Martorell R.(1988). Anthropometric Standardization reference manual.Champaign, IL: *Human Kinetics* .

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

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, 23–28.

Luxen, M. F., and Buunk, B. P. (2005). Second-to-fourth digit ratio related to Verbal and Numerical Intelligence and the Big Five. *Personality and Individual Differences, 39*, 959-966.

LWudy, S. A., Dorr, H. G., Solleder, C., Djalali, M., and Homoki, J. (1999). Profiling steroid hormones in amniotic fluid of midpregnancy 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.

Machin, M.A., Sankey, K.S., (2008). Relationships between young drivers' personality characteristics, risk perceptions, and driving behaviour. Accident Analysis and Prevention 40, 541–547.

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.

Malina, K., and Claude, B. (1997). Sexual maturation in Eastern region. *Early Human Development*, 54, 345-348.

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

Manning ,J.T. (2011). *Resolving* the role of prenatal sex steroids in the development of digit ratio*. Proceedings of National Academics of Sciences,* 108(39), 16143–4.

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., 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 JT, Henzi P, Venkatramana P, Martin S, 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, Leinster S. (2001). The ratio of 2nd to 4th digit length and age at presentation of breast cancer: a link with prenatal oestrogen. *Breast*, 22, 61–9.

Manning, J. T., Baron-Cohen, S., Wheelwright, S., and Sanders, G. (2001). The 2nd to 4th digit ratio and autism. *Developmental Medicine and Child Neurology*, 43, 160–164.

Manning, J. T., Bundred, P. E., and Flanagan, B. F. (2002). The ratio of 2nd to 4th digit length: A proxy for transactivation activity of the androgen receptor gene? *Medical Hypotheses*, 59, 334–336.

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.Adair, L., S. and Gordon-Larsen, P. (2001). Maturational timing and overweight prevalence in US adolescent girls: *American Journal of Public Health*, 91, 642–644.

Manning, J. T., Trivers, R. L., Singh, D., and Thornhill, R., (1999). The mystery of female beauty. *Nature*, 399, 214−215.

Manning, J.T., Barley, L., Walton, J., Lewis-Jones, D.I., Trivers, R.l., and Singh, D.,(2000). The 2nd:4th digit ratio, sexual dimorphism, population differences, and reproductive success: evidence for sexually antagonistic genes. *Evolution of Human Behaviour*, 21, 163–83.

Manning, J.T., Callow, M., and Bundred, P.E. (2003). Finger and toe ratios in humans and mice: implications for the aetiology of diseases influenced by HOX genes. *Medical Hypotheses*, 60, 340–431.

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

Manning, J.T., Scutt, D. Wilson , J., 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), 3000–4.

Manning, J.T., Scutt, D., and Lewis-Jones, D.I.(1998). Developmental stability, ejaculate size and sperm quality in men. *Evolution of Human Behaviour*, 19, 273–82.

Manning, J.T., Stewart, A., Bundred, P.E., and Trivers, R.L. (2004) .Sex and ethnic differences in 2nd to 4th digit ratio of children. *Early Human Development*, 80, 161–8.

Martel, M. M, Gobrogge, K. L., Breedlove, S. M. and Nigg, J. T.  (2008). Masculinized Finger-Length Ratios of Boys, but Not Girls, Are Associated With Attention-Deficit/Hyperactivity Disorder. *Behavioral Neuroscience* 122 (2): 273–281.

Martel, M. M. (2009). Conscientiousness as a mediator of the association between masculinized finger-length ratios and attention-deficit/hyperactivity disorder (ADHD). *Journal of Child Psychologica Psychiatry*, 52 (7): 790–798.

Martin SM, Manning JT, Dowrick CF (1999). Fluctuating asymmetry, relative digit length, and depression in men. *Evolution of Human Behaviour*, 20, 203–14.

Matchock, R. (2008). Low digit ratio (2D:4D) is associated with delayed menarche. *American Journal of Human Biology*, 20, 487–489.

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*(3), 424.

McEwen, B. S. (1981). Neural gonadal steroid actions. Science, 211, 1303-1311.

McFadden D, Loehlin JC, Breedlove MC, Lippa RA, Manning JT, Rahman Q. (2005). A reanalysis of five studies on sexual orientation and the relative length of the 2nd and 4th fingers (the 2D:4D ratio). *Archive of Sexual Behaviour*, 34, 341-356.

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

McGough, R. ( 2003). "Is the autistic brain too masculine?". *Wall Street Journal*. p. B1.

McIntyre, M. H., Barrett, E. S., McDermott, R., Johnson, D. D. P., Cowden, J., and Rosen, S. P. (2007). Finger length ratio (2D:4D) and sex differences in aggression during a simulated war game. *Personality and Individual Differences*, 42, 755–764.

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.

McIntyre, M., Ellison, P. T., Lieberman, D., Demerath, E. W., and Towne, B. (2005). The development of sex differences in digital formula from infancy in the Fels longitudinal study. *Proceedings of the Royal Society London* B, 272, 1473–1479.

Meaney, M.J., (1988). The sexual differentiation of social play. Trends in Neurosciences 11, 54–58.

Medland, S. E., Loehlin, J. C., and Martin, N. G. (2008). No effects of prenatal hormone transfer on digit ratio in a large sample of same- and opposite-sex dizygotic twins. *Personality and Individual Differences,* 44, 1225–1234.

Medland, S. E., Loehlin, J. C., and Martin, N. G. (2008). No effects of prenatal hormone transfer on digit ratio in a large sample of same- and opposite-sex dizygotic twins. *Personality and Individual Differences*, 44, 1225–1234.

Mehdizadeh, R, Abbasi S, Hosseni M, (2011). Relationship between Second to fourth digit ratio andphysical fitness factors in immature girl students. Paper presented at the 1st National Mohamed H, Vaeyens R, Matthys S, Multael M, Lefevre J, Lenoir M, Philippaerts R, 2009.

Mehdizadeh, R., Abbasi, S., Hosseni, M. (2011). Relationship between Second to fourth digit ratio and physical fitness factors in immature girl students. *Paper presented at the 1st National Conference sports talent. Tehran. Iran.*

Millet, K., and Dewitte, S. (2006). Second to fourth digit ratio and cooperative behavior. *Biological Psychology*, 71, 111-115.

Milner, B. (1975). Psychological aspects of focal epilepsy and its neurosurgical management. *Advances in neurology, 8*, 299-321.

Mohamed, H., Vaeyens, R., Matthys, S., Multael, M., Lefevre, J., Lenoir, M., and Philippaerts, R, (2009). Anthropometric and performance measures for the development of a talent detection and identification model in youth handball. *Journal of Sports Science*. 27: 257–266.

Mueser, K. T., Bellack, A. S., Morrison, R. L., and Wixted, J. T. (1990). Social competence in schizophrenia: premorbid adjustment, social skill, and domains of functioning. *Journal of Psychiatric Research, 24*(1), 51-63.

Naing, L., Winh, T. and Rusli, B. N. (2006). Practical issues in calculating the sample size for prevalence studies. Archives of Orofacial Sciences 1(1), 9-14.

Nash, A., and Grossi, G. (2007). "Picking Barbie's brain: inherent sex differences in scientific ability?" *Journal of Interdisciplinary Fem Thought,* 2 (1), 5.

Neave, N. (2008). Hormones and behaviour: A psychological approach. *Cambridge: Cambridge University Press.*

Neave, N., Laing, S., Fink, B., and Manning J. T. (2003). Second to fourth digit ratio, testosterone and perceived male dominance. *Proceedings of Royal Society of London. B 270, 2167–2172* New York: Psychology Press.

Nicolay, C. W, and Walker, A. L., (2005). Grip strength and endurance: Influences of anthropometric variation,hand dominance, and gender. *International Journal of Industrial Ergonom*. 35: 605–618. Opinion in Neurobiology, 6, 259-263. pathology: a hypothesis and a program for research. *Archives of Neurology*, 42, 428-654.

Ogden, C. L., Flegal, K. M., and Caroll, M. D. (2002). Prevalence and trends in overweight among US children and adolescent. *JAMA* 228(14):1728-1732.

Ökten, 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.

Oladipo, G. S; Olotu E. J. and Gwunireama I. U. (2006).“Ethnic and Sexual Differences in the Second to Fourth Digit Ratios (2D:4D) of Igbos and Urhobos in Nigeria”. *Journal of Biomedical Sciences in Africa,* 4, 51-52.

Ostrow, M., Hammer, E., Renard, M., and Knight, D. (1997). Effects of Race and Sex on Work Group Cooperation Vs. Competition. *International Journal of Group Tensions*, *27*(2), 109-132.

Padez, C.and Rocha, M. A. (2003). Age at menarche in coibra school girls: A note on the secular changes. *Annals of Human Biology*.

Pang, S., Levine, L. S., Cederqvist, L. L., Fuentes, M., Riccardi, V. M., Holcombe, J. H., *et al.*, (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.

Paul, S.N., Kato, B.S., Hunkin, J.L., Vivekanandan, S., and Spector, T. D., (2006). The Big Finger: the second to phalangeal rankings and proportions. *American Journal of Physical Anthropology*, 43, 327-332.

Peichel, C.L., Prabhakaran ,B., and Vogt, T.F. (1997) .The mouse Ulnaless mutation deregulates posterior Hoxd genes expression and alters appendicular patterning. *Development*, 124(18), 3481–92.

Pellis, S. M. (2002). Sex differences in play fighting revisited: Traditional and non-traditional mechanisms of sexual differentiation in rats.*Archives of Sexual Behavior*, 31, 17–26.

Penton-Voak, I. S., Perrett, D. I., Castles, D. L., Kobayashi, T., Burt, D. M., Murray, L. K., and Minamisawa, R. (1999). Menstrual cycle alters face preference. *Nature, 399*, 741-742.

Peters, M., Mackenzie, K., and Bryden, P. (2002). Finger length and distal finger extent patterns in humans. *American Journal of Physical Anthropology*, 117, 209–217.

Phelps, V.R. (1952). "Relative Index Finger Length as a sex Influenced Trait in Man".*American Journal of Human Genetics*, 4, 72-89.

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

Pokrywka, L., Rachon, D., Suchecka-Rachon, K., and Bitel, L. (2005). The second to fourth digit ratio in elite and non-elite female athletes. *American Journal of Human Biology, 17,* 796-800.

Polak M. (2003.) Developmental Instability: Causes and Consequences. New York, USA: *University Press*.

Popkin (2002). Adolescence and breast carcinoma risk. *Cancer* 85: 2400-2409.

Putz, D. A., Gaulin, S. J. C., Sporter, R. J., and McBurney, D. H. (2004). Sex hormones and finger length: What does 2D:4D indicate? *Evolution of Human Behaviour,* 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.

Rahman, A. A., Lophatananon, A., Brown, S. S., Harriss, D., Anderson, J., Parker, T., (2011). Hand pattern indicates prostate cancer risk. *British Journal of Cancer*, 104, 175–177. Rösler, H.-D.(2007). *Journal of Individual Differences*, 28, 98–101.

Rahman, Q. (2005). Fluctuating asymmetry, second to fourth finger length ratios and human sexual orientation. Psychoneuroendocrinology. 30:382-391.

Rahman, Q., and Wilson, G.D., (2003). Sexual orientation and the 2nd to 4th finger length ratio: evidence for organising effects of sex hormones on developmental instability? *Psychoneuroendocrinology* 28, 288–303.

Rammsayer, T.H. and Troche, S.J. (2007). Sexual dimorphism in second-to-fourth digit ratio and its relation to gender-role orientation in males and females. *Perspective of Individual Differences,* 42, 911-920

Rashidlamir, A., Ebrahimi, A. A., Godarzi, M. and Saadatnia, A. (2009). The Investigation of a Possible Relationship between Specific Hand Dimensions and Handgrip Strength in Preadolescent. *Journal of Individual Differences*, 28, 98–101.

Rasmussen, T., and Milner, B. (1977). The role of early left brain injury in determining lateralization of cerebral speech functions. *Annals of the New York Academy of Sciences*, *299*(1), 355-369.

Rennie P. J., Holland K. T., Mallet A. I., Watkins W. J., Gower D. B. (*1989).* Testosterone metabolism by human axillary bacteria. *Biochemical Society of Transformation, 17, 1017–1018.*

Resnick, S.M., Gottesman, I.I., and McGue, M., (1993). Sensation seeking in opposite-sex twins: An effect of prenatal hormones? *Behavior Genetics* 23, 323–329.

Richard, D., McAnulty, M. and Michele, B. (2006). Sex and sexuality. Volume 1, *Greenwood Publishing* Group, p. 165.

Ringman, J., Saver, J., Woolson, R., Clarke, W., and Adams, H. (2004). Frequency, risk factors, anatomy, and course of unilateral neglect in an acute stroke cohort. *Neurology, 63*(3), 468.

Rizwan, S., Manning, J. T., and Brabin, B. J. (2007). Maternal smoking during pregnancy and possible effects of in utero testosterone: Evidence from the 2D:4D finger length ratio. *Early Human Development,* 83, 87–90.

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

Romano, M., Leoni, B., and Saino, N. (2006). Examination marks of male university students positively correlate with finger length ratios (2D:4D)". *Biological Psychology* 71 (2): 175–82.

Ronalds, G., Phillips, D. W., Godfrey, K. M. and Manning, J. T. (2002).The ratio of second to fourth digit lengths: a marker of impaired fetal growth? *Early Human Development*. 68:21–6.

Roney, J. R. and Maestripieri D. (*2004).* Relative digit lengths predict men's behavior and attractiveness during social interactions with women*. Nature. 15, 271–282.*

Roney, J.R., Whitham ,J.C., Leoni, M., Bellem, A., Wielebnowski, N. and Maestripieri, D. (2004). Relative digit lengths and testosterone levels in Guinea baboons. *Hormonal Behaviour*, 45, 285–90.

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

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

Ruuskanen, S., Helle, S., Ahola, M., Adamczyck, F., Möstl, E., and Laaksonen, T. (2011). Digit ratios have poor indicator value in a wild bird population. *Behavioral Ecology and Sociobiology*, 65, 983–994.

Salem, J. E., and Kring, A. M. (1998). The role of gender differences in the reduction of etiologic heterogeneity in schizophrenia. *Clinical Psychology Review*, *18*(7), 795-819.

Schaap, L.A., Pluijm, S.M.F., Smit, J.H., van Schoor, N.M., Visser, M., Gooren, L.J.G., Lips, P. (2005). *The Science*, 211, 1285-1294.

Schmukle, S.C., Liesenfeld, S., Back, M.D., and Egloff, B., (2007). Second to fourth digit ratios and the implicit gender self-concept. Personality and Individual Differences 43, 1267–1277.

Schneider, H.J., Pickel, J., and Stalla, G.K. (2006). Typical female 2nd-4th finger length (2D:4D) ratios in male-to-female transsexuals-possible implications for prenatal androgen exposure. *Psychoneuroendocrinology*, 31 (2): 265–9.

Schwerdtfeger, A., and Heer, J., (2008). Second to fourth digit ratio (2D:4D) of the right hand is associated with nociception and augmenting-reducing. Personality and Individual Differences 45, 493–497.

Schwerdtfeger, A.,( 2007). Individual differences in auditory, pain, and motor stimulation: The case of augmenting-reducing. Journal of Individual Differences 28, 165–177.

Scott HM, Mason JI, Sharpe RM.(2009). Steroidogenesis in the fetal testis and its susceptibility to disruption by exogenous compounds. *Endocrinology Review*, 30(7), 883–925.

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

Shtasel, D., Gur, R., Gallacher, F., Heimberg, C., and Gur, R. (1992). Gender differences in the clinical expression of schizophrenia. *Schizophrenia Research, 7*(3), 225-231.

Simon, F., Corbett, C., (1996). Road traffic offending, stress, age, and accident history among male and female drivers. *Ergonomics* 39, 757–780.

Singh, D., (1993). Adaptive significance of female physical attractiveness: role of waist-to-hip ratio. *Journal of Personality and Social Psychology*, 65, 293−307.

Singh, D., (1995). Female judgment of male attractiveness and desirability for relationships: role of waist-to hip ratio and financial status. *Journal of Personality and Social Psychology,* 69, 1089−1101.

Skuse, D. (2000). Imprinting, the X-chromosome, and the male brain: explaining sex differences in the liability to autism. *Pediatric Research, 47*(1), 9.

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

Smith, A. R., Hawkeswood, S. E., and Joiner, T. E. (2009). "The measure of a man: Associations between digit ratio and disordered eating in males". *International Journal of Eating Disorder,* 28 (1): 191–4.

Speiser, P. W., and White, P. C. (2003). Congenital adrenal hyperplasia. *New England Journal of Medicine*, 349, 776–788.

Stevenson, J. C., Everson, P. M., Williams, D. C., Hipskind, G., Grimes, M., and Mahoney, E. R. (2007). Attention deficit disorder (ADHD) symptoms and digit ratios in a college sample. *Journal of Human Biology,* 19, 41-50.

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

Terrance, J., Williams, Michelle, E., Scott, E., Christensen, and Bradley, M. (2000). Finger-length ratios and sexual orientation. *Nature*, volume 404, 30.

Tester, N., and Campbell, A., (2007). Sporting achievement: What is the contribution of digit ratio? *Journal of Personality* 75, 663–677.

Thomas, G., and Maio, G. R. (2008). Man, I feel like a woman: When and how gender-role motivation helps mind-reading. *Journal of Personality and Social Psychology, 95*(5), 1165.

Titus-Ernstoff, (2003). Psychosexual Characteristics of Men and Women Exposed Prenatally to Diethylstilbestrol. *CDC*.

Tobet, S.A., and Baum, M.J., (1987). Role for prenatal estrogen in the development of masculine sexual behavior in the male ferret. *Hormones and Behavior* 21, 419–429.

Tobler, M., Healey, M., and Olsson, M. (2011). Digit ratio, color polymorphism and egg testosterone in the Australian painted dragon. *Public Library of Science ONE*, 6, e16225

Tortorice, J. L. (2002). Butch vs. femme lesbian gender identity and biological correlates of low digit ratio. *Rutgers University*.OCLC 80234273transporter over-expression in rats' nucleus accumbens. *Neuroscience* 159,

Treffert, D. (2009). The savant syndrome: an extraordinary condition. A synopsis: past, present, future. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1522), 1351.

Trivers, R., Manning, J., and Jacobson, A. (2006). A longitudinal study of digit ratio (2D:4D) and other finger ratios in Jamaican children. *Hormones and Behavior*, 49, 150–156.

Troiano, R., Fegal, K., and Kuczmarski, R. (1995). Body masss index and Age at menarche in Adolescents. Journal of Clinical Pediatrics. 149(10): 1085-1091.

Van Anders SM, Hampson E, (2005). Testing the prenatal androgen hypothesis: measuring digit ratios, sexual orientation, and spatial abilities in adults. *Hormonal Behaviour*, 47, 92-98.

Van Anders, S. M., Vernon, P. A., and Wilbur, C. J. (2006). Finger-length ratios show evidence of prenatal hormone-transfer between opposite-sex twins. *Hormones and Behavior*, 49, 315–319.

van Honk, J., Schutter, D.J.L.G., Hermans, E.J., Putman, P., Tuiten, A., and Koppeschaar, H., (2004). Testosterone shifts the balance between sensitivity for punishment and reward in healthy young women. *Psychoneuroendocrinology* 29, 937–943.

Van Meter, K. C. (2010). Geographic distribution of autism in California: a retrospective birth cohort analysis. *Autism Respondents*. 3, 19-29 easy to understand article

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

Visnapo, M., and Jurimae, T. (2007). Handgrip strength and hand dimensions in young handball and basketballers. *York: Free Press.*

Voracek, M., and Dressler, S. G. (2007). Digit ratio (2D:4D) in twins: Heritability estimates and evidence for a masculinized trait expression in women from opposite-sex pairs. *Psychological Reports*, 100, 115–126.

Voracek, M., and Loibl, L. M. (2009). Scientometric analysis and bibliography of digit ratio (2D:4D) research, 1998-2008. *Psychological Reports*, 104, 922–956.

Voracek, M., Reimer, B., Ertl, C., and Dressler, S. G. (2006). Digit ratio (2d:4d), lateral preferences, and performance in fencing. *Perceptual and Motor Skills*, 103, 427–446.

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

Vuilleumier, P. O., and Rafal, R. D. (2000). A systematic study of visual extinction. Between- and within-field deficits of attention in hemispatial neglect. *Brain, 123*(6), 1263-1279.

Wakabayashi, A., Baron-Cohen, S., and Wheelwright, S. (2006). Individual and gender differences in Empathizing and Systemizing: measurement of individual differences by the Empathy Quotient (EQ) and the Systemizing Quotient (SQ)]. *Shinrigaku kenkyu: The Japanese journal of psychology, 77*(3), 271.

Wallien, M. S., Zucker, K. J., Steensma, T. D., Cohen-Kettenis, P. T. (2008). 2D:4D finger-length ratios in children and adults with gender identity disorder. *Hormones and Behavior*54 (3): 450–4.

Walsh, F. (2010). Index finger length prostate cancer clue. *BBC News*

Warner, J. (2011). "Autism's lone wolf". *Time*. Retrieved 2013-12-28.

Weinberger, D., Luchins, D., Morihisa, J., and Wyatt, R. (1982). Asymmetrical volumes of the right and left frontal and occipital regions of the human brain. *Annals of Neurology, 11*(1), 97-100.

Whiting, W.C., and Zernicke, R. F. (1998). Biomechanics of musculoskeletal injury. Human Kinetics. Champaign, IL.

Williams, T. J., Pepitone, M. E., Christensen, S. E., Cooke, B. M., Huberman, A. D., Breedlove, N. J., et al., (2000). Finger length patterns and human sexual orientation.*Nature*, 404, 455–456.

Williams, T.J., Pepitone, M.E., Christensen, S.E., Cooke, B.M., Huberman ,A.D., and Breedlove, N.J. (2000). Finger length ratio and sexual orientation—measuring people finger patterns may reveal some surprising information. *Nature,* 404, 455–6.

Williamson, A., (2003). Why are young drivers over represented in crashes? Available at http://www.maa.nsw.gov.au/getfile.aspx?Type=document&ID= 7275&ObjectType=3&ObjectID=1035, last accessed on 23.03.2009.

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.

Windy, M. Brown Melissa Hines, Brioy F. Fane and S. Mark Breedloves (2002). “Masculinized Finger Length Patterns in Human Males and Females with Congenital Adrenal Hyperplasia” *Hormones and Behaviours*, 42, 380-386.

Wood S, Vang E, Manning J, Walton J, Troup S, Kingsland C, *et al.,(*2003). The ratio of second to fourth digit length in azoospermic males undergoing surgical sperm retrieval: predictive value for sperm retrieval and on subsequent fertilization and pregnancy rates in IVF/ICSI cycles.*Journal of Andrology*, 24(6), 871–7.

Word, R. A., George, F. W., Wilson, J. D., and Carr, B. R. (1989). Testosterone synthesis and adenylatecyclase activity in the early human fetal testis appear to be independent of human chorionic gonadotropin control. Journal of Clinical *Endocrinology and Metabolism*, 69, 204–208.

World Health Organization (1999) .Laboratory Manual for the Examination of Human Semen and Sperm–cervical Mucus Interaction.*Cambridge, UK: Cambridge University Press.*

Zheng, Z., and Martin, J. C. (2011). Developmental basis of sexually dimorphic digit ratios. *Proceedings of National Academic of Sciences* Early Edition;. p. 1–6.

Zuckerman, M., (1994). Behavioral expressions and biosocial bases of sensation seeking. *Cambridge University Press*, Cambridge.

**APPENDIX I**

# HEALTH RESEARCH ETHICS COMMITTEE

## AHMADU BELLO UNIVERSITY TEACHING HOSPITAL

### SHIKA - ZARIA, NIGERIA.

*E-mail: abuth@yahoo.com* *Website: www.abuth.org*

Chairman of Board: Chief. Shuaib Oyedokun Afolabi *Fnli*
Chief Medical Director: Prof. Lawal Khalid, *MBBS, FMCS, FWACS, FRCS(ED) mni*
Chairman, Medical Advisory Committee: Prof. Abdullahi Mohammed, *MBBS, FWACP, FICS*
Director of Administration: Barr. Ishak Bello, *LL.B, BL., LL.M, PGDM, AHAN, FCAI*

*Our Ref:* ABUTH/HREC/TRG /36

*Your Ref:*

*Date:* 17th January, 2014

**ABUTH HREC FULL ETHICAL CLEARANCE CERTIFICATE**

Re: ***"Evaluation of the relationship between Breast Cancer and some anthropometric variables in women, in Zaria, Nigeria."***

| | | |
|---|---|---|
| **ABUTH Ethics Committee assigned number:** | - | ABUTH/HREC/C33/2012 |
| **Name of the principal Investigator:** | - | Hadiza Rilwan Alhassan |
| **Address of the Principal Investigator:** | - | Dept. of Human Anatomy<br>Faculty of Medicine, ABU, Zaria |
| **Date of receipt of valid application:** | - | **5th December, 2013** |
| **Date of meeting when final determination on ethical approval was made:** | - | **7th January, 2014** |

This is to inform you that the research described in the submitted protocol, the consent forms, and other participant information materials have been reviewed and ***given full approval by the ABUTH Ethics Committee.***

Please note: this approval dates from 17th **January, 2014 - 17th January, 2015**

No participant recruitment into this research may be conducted outside these dates.

All informed consent forms in this study must carry the ABUTH HREC number assigned to this research and the duration of ABUTH HREC approval of the study.

This HREC expects that you submit your application as well as an annual report for ethical clearance renewal 3 months prior to expiration of study dates. This is to enable you obtain renewal of your approval and avoid interruption of your research.

If there is delay in starting the research, please inform the ABUTH HREC so that starting dates can be adjusted accordingly.

No changes are permitted in the research without prior approval by ABUTH HREC, except in circumstances outlined in national code for Health Research Ethics: http://www.nhrec.net.

ABUTH HREC reserves the right to conduct compliance assessment visits to your research site without prior notification.

**Prof. A. I. Mamman**
**Chairman, ABUTH HREC**

## APPENDIX II

**DEPARTMENT OF HUMAN ANATOMY**
**FACULTY OF MEDICINE**
**AHMADU BELLO UNIVERSITY, ZARIA**

**CONSENT FORM**

Dear Mr/Mrs/Miss,

You are kindly being asked to participate in a research study conducted by Solomon Abel, an MSc candidate in the Department of Human Anatomy of the above named institution, carrying out a research on Second to fourth digit ratio in relation to systemizing and empathizing in Bajju and Asholio population of Kaduna state. Participation is voluntary. It involves collection of certain information about your fingers, weight, age and your BMI: which will take you about 15minutes.

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,

Solomon Abel

**CONSENT TO PARTICIPATE IN RESEARCH**

Second to fourth digit ratio in relation to systemizing and empathizing in Bajju and Asholio population of Kaduna state

You are asked to participate in a research study conducted by Dr. B Danborno, Dr. J N. Alawa, and Solomon Abel, Faculty of medicine, Ahmadu Bello University Zaria.

If you have any questions or concerns about the research, please feel free to contact: Solomon Abel, Faculty of Medicine, Tel: 08130355930, Dr. B. Danborno, Faculty of medicine, Tel: 08139429300, Dr. J.N.Alawa

**PURPOSE OF THE STUDY**

The present study is aimed at Correlating Second to fourth digit ratio in relation to systemizing and empathizing in Bajju and Asholio population of Kaduna state.

**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 Correlations between Second to fourth digit ratio in relation to systemizing and empathizing in Bajju and Asholio population of Kaduna state and the conclusions that will be drawn will aidin providing information about the youths of these ethnic groups .

**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:

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

Dr. J. N. Alawa,
Department of Anatomy,
Faculty of Medicine,
Ahmadu Bello University.
Tel: 08056775374
E-mail: judyalawa@yahoo.com

**SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE**

I have read the information provided for the study "Second to fourth digit ratio in relation to systemizing and empathizing in Bajju and Asholio population of Kaduna state." 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 in relation to systemizing and empathizing in Bajju and Asholio population of Kaduna state.**

**Name**: Abel Yashim SOLOMON.

**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

**APPENDIX II**

## Questionnaire for the study of Second to fourth digit ratio in relation to systemizing and empathizing in Bajju and Asholio population of Kaduna state.

*Please tick or circle the appropriate letter where necessary below*:

### DEMOGRAPHY OF PARTICIPANT

1. Place of birth: ______________________
2. Have you spent your whole life there? Yes [ ] No [ ]
3. If no, where else have you lived? ______________
4. Where do you live now? ____________________
5. Date of birth (DD/MM/YYYY)
6. Age__________ (yrs)

7. Number of siblings:

   a. Brothers: ______________________ (from your mother only)

   b. Sisters: ______________________ (from your mother only)

8. What's your birth order?

   a. Firstborn [ ] b. Second born [ ] c. Third born [ ] d. Last born [ ]

**9. ETHNIC BACKGROUND**

Mother's Ethnic Group :___________________________________

Grand Mother's Ethnic Group :____________________________

Father's Ethnic Group: ___________________________________

Grand Father's Ethnic Group :_____________________________

**ANTHROPOMETRIC ASSESSMENT**

10. Weight: ______________________ (kg)

11. Height: ______________________ (m)

12. BMI: ______________________ ($kg/m^2$)

13. Waist-Hip ratio_______________

14. Waist circumference :______________________ (cm)

15. Hip circumference :______________________ (cm)

16. Waist-Hip ratio :______________________ (cm)

17. Mid upper arm circumference: ______________________ (cm)

18. Chest circumference :______________________ (cm)

19. Head circumference :______________________ (cm)

20. Head length: ______________________ (cm)

21. Head width:________________(cm)

**22. HAND ANTHROPOMETRY**

Length of digits (mm)

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

**23. PARENTS' OCCUPATION**

1. Mother's occupation ___________________
2. Father's occupation ____________________

**24. 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 [ ]

**The Systemizing Quotient**

*Please tick (✓) one box ONLY per line*

| **Questions** | Strongly agree | Slightly agree | Slightly disagree | Strongly disagree |
|---|---|---|---|---|
| **1**. When I listen to a piece of music, I always notice | | | | |

| | | | | |
|---|---|---|---|---|
| the way it's structured**.** | | | | |
| **2.**I adhere to common superstitions**.** | | | | |
| **3**.I often make resolutions, but find it hard to stick to them | | | | |
| **4**.I prefer to read non-fiction than fiction. | | | | |
| **5.**If I were buying a car, I would want to obtain specific information about its engine capacity. | | | | |
| **6.**When I look at a painting, I do not usually think about the technique involved in making it. | | | | |
| **7.**It there was a problem with the electrical wiring in my home, I'd be able to fix it myself**.** | | | | |
| **8.**When I have a dream, I find it difficult to remember precise details about the dream the next day**.** | | | | |
| **9.**When I watch a film, I prefer to be with a group of friends, rather than alone. | | | | |
| **10.**I am interested in learning about different religions. | | | | |
| **11.**I rarely read articles or web pages about new technology. | | | | |
| **12.**I do not enjoy games that involve a high degree of strategy**.** | | | | |
| **13.**I am fascinated by how machines work. | | | | |
| **14.**I make it a point of listening to the news each morning. | | | | |
| **15.**In maths, I am intrigued by the rules and patterns governing numbers. | | | | |
| **16.**I am bad about keeping in touch with old friends. | | | | |
| **17.**When I am relating a story, I often leave out details and just give the gist of what happened**.** | | | | |
| **18.**I find it difficult to understand instruction manuals for putting appliances together. | | | | |
| **19.**When I look at an animal, I like to know the precise species it belongs to. | | | | |
| **20.**If I were buying a computer, I would want to know exact details about its hard drive capacity and processor speed. | | | | |
| **21.**I enjoy participating in sport. | | | | |
| **22.**I try to avoid doing household chores if I can. | | | | |
| **23.**When I cook, I do not think about exactly how different methods and ingredients contribute to the final product. | | | | |
| **24.**I find it difficult to read and understand maps. | | | | |
| **25.**If I had a collection (eg. CDs, coins, stamps), it would be highly organized. | | | | |

| | | | | |
|---|---|---|---|---|
| **26.**When I look at a piece of furniture, I do not notice the details of how it was constructed. | | | | |
| **27.**The idea of engaging in 'risk-taking' activities appeals to me. | | | | |
| **28.**When I learn about historical events, I do not focus on exact dates. | | | | |
| **29.**When I read the newspaper, I am drawn to the tables of information, such as football league scores or stock market indices. | | | | |
| **30.**When I learn a language, I become intrigued by its grammatical rules. | | | | |
| **31.**I find it difficult to learn my way around a new city. | | | | |
| **32.**I do not tend to watch science documentaries on television or read articles about science and nature. | | | | |
| **33.**If I were buying a stereo, I would want to know about its precise technical features. | | | | |
| **34.**I find it easy to grasp exactly how odds work in betting. | | | | |
| **35.**I am not very meticulous when I carry out D.I.Y. | | | | |
| **36.**I find it easy to carry on a conversation with someone I've just met. | | | | |
| **37.**When I look at a building, I am curious about the precise way it was constructed. | | | | |
| **38.**When an election is being held, I am not interested in the results for each constituency. | | | | |
| **39.**When I lend someone money, I expect them to pay me back exactly what they owe me. | | | | |
| **40.**I find it difficult to understand information the bank sends me on different investment and saving systems. | | | | |
| **41.**When travelling by train, I often wonder exactly how the rail networks are coordinated. | | | | |
| **42.**When I buy a new appliance, I do not read the instruction manual very thoroughly. | | | | |
| **43.**If I were buying a camera, I would not look carefully into the quality of the lens. | | | | |
| **44.**When I read something, I always notice whether it is grammatically correct. | | | | |
| **45.**When I hear the weather forecast, I am not very interested in the meteorological patterns. | | | | |
| **46.**I often wonder what it would be like to be someone else. | | | | |
| **47.**I find it difficult to do two things at once. | | | | |

| | | | | |
|---|---|---|---|---|
| **48.**When I look at a mountain, I think about how precisely it was formed. | | | | |
| **49.**I can easily visualize how the expressways in my region link up. | | | | |
| **50.**When I'm in a restaurant, I often have a hard time deciding what to order. | | | | |
| **51.**When I'm in a plane, I do not think about the aerodynamics. | | | | |
| **52.**I often forget the precise details of conversations I've had. | | | | |
| **53.**When I am walking in the country, I am curious about how the various kinds of trees differ. | | | | |
| **54.**After meeting someone just once or twice, I find it difficult to remember precisely what they look like. | | | | |
| **55.**I am interested in knowing the path a river takes from its source to the sea. | | | | |
| **56.**I do not read legal documents very carefully. | | | | |
| **57.**I am not interested in understanding how wireless communication works. | | | | |
| **58.**I am curious about life on other planets. | | | | |
| **59.**When I travel, I like to learn specific details about the culture of the place I am visiting. | | | | |
| **60.**I do not care to know the names of the plants I see. | | | | |

**The Empathizing Quotient**

*Please tick (✓) one box ONLY per line*

| **Questions** | Strongly agree | Slightly agree | Slightly disagree | Strongly disagree |
|---|---|---|---|---|
| **1.** I can easily tell if someone else wants to enter a conversation. | | | | |
| **2**.I prefer animals to humans. | | | | |
| **3.**I try to keep up with the current trends and fashions. | | | | |
| **4.**I find it difficult to explain to others things that I understand easily, when they don't understand it first time. | | | | |
| **5.**I dream most nights. | | | | |
| **6.**I really enjoy caring for other people. | | | | |
| **7.**I try to solve my own problems rather than discussing them with others. | | | | |
| **8.**I find it hard to know what to do in a social | | | | |

| | | | | |
|---|---|---|---|---|
| situation. | | | | |
| **9.**I am at my best first thing in the morning. | | | | |
| **10.**People often tell me too much if I went too far in driving my point home in a discussion. | | | | |
| **11.**It doesn't bother me too much if I am late meeting a friend. | | | | |
| **12.**Friendships and relationships are just too difficult, so I tend not to bother with them. | | | | |
| **13.**I would never break a law, no matter how minor. | | | | |
| **14.**I often find it difficult to judge if something is rude or polite. | | | | |
| **15.**In a conversation, I tend to focus on my own thoughts rather than on what my listener might be thinking. | | | | |
| **16.**I prefer practical jokes to verbal humor. | | | | |
| **17.**I live life for today rather than the future. | | | | |
| **18.**When I was a child, I enjoyed cutting up worms to see what would happen. | | | | |
| **19.**I can pick up quickly if someone says one thing but means another. | | | | |
| **20.**I tend to have very strong opinions about morality. | | | | |
| **21.**It is hard for me to see why some things upset people so much. | | | | |
| **22.**I find it easy to put myself in somebody else's shoes. | | | | |
| **23.**I think that good manners are the most important thing a parent can teach their child. | | | | |
| **24.**I like to do things on the spur of the moment. | | | | |
| **25.**I am good at predicting how someone will feel. | | | | |
| **26.**I am quick to spot when someone in a group is feeling awkward or uncomfortable. | | | | |
| **27.**If I say something that someone else is offended by, I think that that's their problem, not mine. | | | | |
| **28.**If anyone asked me if I liked their haircut, I would reply truthfully, even if I didn't like it. | | | | |
| **29.**I can't always see why someone should have felt offended by a remark. | | | | |
| **30.**People often tell me that I am very unpredictable. | | | | |

| | | | | |
|---|---|---|---|---|
| **31.** I enjoy being the centre of attention at any social gathering. | | | | |
| **32.** Seeing people cry doesn't really upset me. | | | | |
| **33.** I enjoy having discussions about politics. | | | | |
| **34.** I am very blunt, which some people take to be rudeness, even though this is unintentional. | | | | |
| **35.** I don't tend to find social situations confusing. | | | | |
| **36.** Other people tell me I am good at understanding how they are feeling and what they are thinking. | | | | |
| **37.** When I talk to people, I tend to talk about their experiences rather than my own. | | | | |
| **38.** It upsets me to see an animal in pain. | | | | |
| **39.** I am able to make decisions without being influenced by people's feelings. | | | | |
| **40.** I can't relax until I have done everything I had planned to do that day. | | | | |
| **41.** I can easily tell if someone else is interested or bored with what I am saying. | | | | |
| **42.** I get upset if I see people suffering on news programmes. | | | | |
| **43.** Friends usually talk to me about their problems as they say that I am very understanding. | | | | |
| **44.** I can sense if I am intruding, even if the other person doesn't tell me. | | | | |
| **45.** I often start new hobbies but quickly become bored with them and move on to something else. | | | | |
| **46.** People sometimes tell me that I have gone too far with teasing. | | | | |
| **47.** I would be too nervous to go on a big roller-coaster. | | | | |
| **48.** Other people often say that I am insensitive, though I don't always see why. | | | | |
| **49.** If I see a stranger in a group, I think that it is up to them to make an effort to join in. | | | | |
| **50.** I usually stay emotionally detached when watching a film. | | | | |
| **51.** I like to be very organized in day to day life and often make lists of the chores I have to do. | | | | |
| **52.** I can tune into how someone else feels rapidly and intuitively. | | | | |

| | | | | |
|---|---|---|---|---|
| **53.**I don't like to take risks. | | | | |
| **54.**I can easily work out what another person might want to talk about. | | | | |
| **55.**I can tell if someone is masking their true emotion. | | | | |
| **56.**Before making a decision I always weigh up the pros and cons. | | | | |
| **57.**I don't consciously work out the rules of social situations. | | | | |
| **58.**I am good at predicting what someone will do. | | | | |
| **59.**I tend to get emotionally involved with a friend's problems. | | | | |
| **60.**I can usually appreciate the other person's viewpoint, even if I don't agree with it. | | | | |

**THANKS FOR YOUR CO-OPERATION**