2019-08-28

Assessment of Human Morphogenetic Traits and Blood Groups in Amhara, Awi and Negede, Ethiopia.

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BY

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June, 2018

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Assessment of Human Morphogenetic Traits and Blood Groups in Amhara, Awi and Negede, Ethiopia.

Thesis Submitted to the Department of Biology in Partial Fulfilment of the Requirements for the Award of Master's Degree in Genetics of Bahir Dar University

BY

Zeneb Awoke

_____ _____

Signature Date

Advisor

Dr. Ziyine Mihretie

DECLARATION

First, I declare and affirm that this Thesis is my independent work. I have faithfully and accurately cited all my sources, including books, journals, handouts and unpublished manuscripts, as well as any other media, such as the Internet, letters or significant personal communication. This Thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

Zeneb Awoke Getu	_____	_____
Name	Signature	Date

This thesis titled **"Assessment of Human Morphogenetic Traits and Blood Groups in Amhara, Awi and Negede, Ethiopia"** by Zeneb Awoke is submitted for defense with my approval as her research advisor.

Dr. Ziyin Mihretie	_____	_____
Name of Advisor	Signature	Date

DEDICATION

This thesis is dedicated to my beloved husband Yalemsew Yigzaw for his endless love, support and encouragements for my success.

ACKNOWLEDGMENTS

It gives me great pleasure in expressing my gratitude to my advisor Dr. Ziyin Mihretie for his valuable advice, constructive ideas and proper guidance during the work and critical reading of the manuscript and valuable suggestions during the write up of this thesis.

I express my deepest gratitude to Ghion secondary and preparatory school and Alem children support organization in Bahir Dar and Agew Midir secondary and preparatory school in Injibara for their positive cooperation and giving me all valuable data. And also I acknowledge Debre Tabor University for the financial support.

I am greatly thankful to all personals who gave me their valuable criticism and assistance at all stages of this work. Above all, I praise the almighty LORD GOD who gave me the ability to confirm this study work and also the entire program.

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LIST OF ABBREVIATIONS

DNA	Deoxyribonucleic acid
HDFN	hemolytic disease of the fetus and newborn
IgG	Immunoglobulin G
MC1R	Melanocortin1
MPH	Mid-phalangeal hair
PTC	phenylthiocarbamide
RBC’s	Red blood cells
Rh	Rhesus factor
SPSS	Statistical packaging for social sciences
U.S	United States
X 2	Chi-square

ABSTRACT

Morphogenetic traits are physical characters of an individual and the pattern of inheritance. Morphogenetic traits of simple inheritance indicate ethnic variation and have been widely employed in population variation studies. Ten morphogenetic traits, ABO and Rh (D) blood phenotypes were investigated. The aim of this study was to find out and document data on prevalence and possible combination patterns of morphogenetic traits and ABO blood groups in three ethnic groups .Purposive sampling was used to select the ethnic groups. Data was collected randomly from 270 individuals of three ethnic groups (Awi, Amhara & Negede ethnic groups). Morphogenetic traits were observed and recorded. Blood grouping was carried out by the slide agglutination method using anti-sera (anti-A, B and D) reagents. The data were analyzed with the aid of SPSS 21.The result showed that the right handed, straight hair line shape, non-freckles, absence of cheek dimple, the ability to tongue rolling, the absence of mid digital hair, straight thumb and straight little finger were more prevalent traits in all the three study groups. Right hand clasper, and free ear lobe attachment were more prevalent in Awi and Amhara; and the invers is true in Negede. Right Hand clasper, the ability to tongue rolling and free ear lobe attachment were high in males than females while straight thumb, straight hair line shape and absence of mid digital hair were high in females. Hand clasping, handedness, cheek dimple, mid digital hair, hitchhiker's Thumb, little finger and ear lobe attachment were significantly associated with ethnicity and hair line shape, tongue rolling and mid digital hair with gender ($p<0.05$) while others were not associated. Most prevalent morphogenetic trait were associated with blood group O followed by A in Awi and Amhara while blood group B in Negede. There was a significant association between hand clasping and ear lobe attachment with ABO blood groups phenotype while others were not significantly associated. Blood group O was the most prevalent (41.1%) followed by B (26.7 %), A (25.2%), while the least was AB (7.0%) in Awi and Amhara while blood group B most prevalent (54.28 %) followed by A (24.29%), O (12.86%), while the least AB (8.57%) in Negede people. The majorities (84.8%) were rhesus (D) positive and (15.2%) were rhesus (D) negative. It forms the basis for genetic counseling, genetic marker as well as make informed decisions for mothers. Further studies with large sample size at different places are more recommended to get an accurate result.

Key words/Phrases: Blood group, Ethnic group, Morphogenetic traits, Rhesus factor

1. INTRODUCTION

1.1 Background

A trait is a distinct variant of a phenotypic character of an organism that may be inherited, environmentally determined or a mixture of the two. Morphogenetic traits are physical characters of an individual. Population diversity provides a unique opportunity to study the morphogenetic variation among the endogamous populations living in different geographical and ecological conditions (Jaswant and Sarthak, 2004).

Morphogenetic traits are observable characteristics determined by genes. Multiple genes are grouped together to form chromosomes, which reside in the nucleus of the cell. Every cell (except eggs and sperm) in an individual contains two copies of each gene. Morphogenetic traits are also known as hereditary traits, these traits may be dominant or recessive traits. Most of the genes are transmitted in the Mendelian pattern and a few are multiple genes are grouped together and transmitted through the non-Mendelian pattern that includes: co-dominance, sex-linked genes and polygenes (Onyije *et al.*, 2012).

Parent organisms pass traits to their offspring so there are often similar characteristics seen in both parent and offspring. Inherited human traits include: ability to roll tongue or not, attached or unattached earlobes, dimples, freckles, naturally curly or straight hair, Hitchhiker's or straight thumb, color-blindness or normal color vision, widow's peak or straight hairline, color of skin and hair, and cleft or smooth chin etc. However, humans have numerous traits, but some traits are more frequently seen in population such as free-hanging earlobes, rolling their tongue, right-handedness and tasting PTC (a bitter tasting chemical that can be placed on the tongue).The study of morphogenetic traits have an enormous value in the study of evolution, human diversity and taxonomy (Dennis, 2017).

ABO blood grouping system is the classification of human blood based on the inherited properties of red blood cells (erythrocytes) as determined by the presence or absence of the antigens A and B, which are carried on the surface of the red cells. Human red blood cells that contain antigen D are known as Rhesus positive, while those without antigen D in their RBC's are Rhesus negative. Genotype is the genetic

makeup of a cell, an organism, or an individual. Individual's genotype and blood group (A, B, AB, and O/ Rhesus factor [Rh+ and Rh]) differ amongst the world's population (Vinutha *et al.*, 2018)

In 1900 Karl Landsteiner reported a series of tests, which identified the ABO Blood Group System. In 1910 he won Nobel Prize for medicine for this discovery. He mixed the serum and cells of all the researchers in his lab and found four different patterns of agglutination. Interestingly, it was the description of the ABO blood groups that signaled the beginning of blood banking and transfusion medicine. The ABO and Rh blood groups are among the most important blood groups and even after 100 years, the single most important test performed in blood banking services and blood transfusion (Farhud *et al.*, 2013).

Red blood cells carry markers called antigens on their surface that determine one's blood type. Therefore it is essential that the donor diversity match the patient diversity. For example, U-negative and Duffy-negative blood types are unique to the African-American community. So Sickle cell patients with these blood types must rely on donors with matching blood types in the African-American community. When blood is phenotypically matched (i.e., close blood type match), patients are at a lower risk of developing complications from transfusion therapy. For this reason, it is extremely important to increase the number of available blood donors from all ethnic groups (Özyurt *et al.*, 2013).

Over years, blood groups have been projected as a useful marker in studying variations in family, linkage analysis and population study. Blood groups are inherited from both parents and approximately 300 different types of blood groups are identified so far, however, the Rh and ABO antigens are still the clinically most significant (Klein and Anstee, 2005)

The ABO and rhesus (Rh) phenotypes vary widely between ethnic groups and both within and between geographical areas. It is interesting to note that the distribution of ABO and Rh blood groups varies from one individual to others; therefore, the distribution of the blood groups A, B, O, and AB varies across and within human subpopulations, eg, in United Kingdom, the distribution of blood type frequencies in the population still shows some correlation to the distribution of place names and to

the successive invasions and migrations, including Vikings, Danes, Saxons, Celts, and Normans, who contributed the morphemes to the place names and the genes to the population (Rajshree and Raj, 2013).

Blood group distribution in different groups of population is important in health care and blood transfusion. Knowing of phenotype distribution of ABO system in a given population is important for planning procurement of blood supplement and associated diseases with blood group and to know if any significant phenotype dispersion is present when comparing with other population (Abdullah, 2010).

1.2 Statement of the problem

Since, morphogenetic traits are physical characteristics of an individual, so this study provides a simple discriminations of one individual from the others by simple observation. Different studies are carried out in different countries, like China, India, Nigeria and others on the distribution and prevalence of morphogenetic traits and ABO blood groups. But in our study (Awi, Amhara and Negede) has no any previous documented data in our best of knowledge, so this study has its own contribution to asses and document the data for next studies as reference. There are no available study on the association of ABO phenotypes with simple traits of inheritance, (Handedness, Hairline, Freckles, Hitch-Hiker Thumb and Little figure) Therefore, the novelty of the current research is to decide is there association between the occurrence of ABO blood phenotypes with genetic traits (earlobe, hand clasping, facial dimple, mid digital hair, tongue rolling, etc..) and gender or not.

1.3 Significance of the study

This study gives a clue about the frequency of blood groups and morphogenetic traits of the study populations. The morphogenetic and physical genetic traits of simple inheritance indicate ethnic variation and have been widely employed in population variation studies. Some selected genetic traits of simple inheritance, ABO and Rh (D) blood phenotype is investigate to establish the inheritance pattern prevalence and to assess association between the traits and ABO rhesus phenotypes between unrelated families. It also help to make the illiterate public aware of the essential of knowing blood groupings. The distribution of blood groups among the population in specific areas is important for clinical studies.

This has relevance to the study of human diversity as well as population variation of these morphogenetic traits. The results from this kind of study has an important role in 'predictive human screening' for clinical purposes; for instance, the preliminary screening for emergency blood donation and transfusion. It can give additional information, regarding the morphogenetic variations, evolution and taxonomic investigation. The aspect of relating morphogenetic traits are of great important to many areas such as, forensic pathology, a base for further anthropological researches, clinical practice, emergency cases and other related measured disciplines; as such it will be useful to determine the frequency of these traits in different regions which could aid in the identification of human of different populations.

1.4 Objectives of the study

1.4.1 General objective

To determine the distribution pattern of human morphogenetic traits and blood groups in Amhara, Awi and negede ethnic groups.

1.4.2 Specific objective

- ✓ To investigate the prevalence of morphogenetic traits among three ethnic groups
- ✓ To examine the distribution pattern of blood groups among three ethnic groups
- ✓ To assess association of morphogenetic traits with blood groups among the three ethnic groups

2. LITERATURE REVIEW

2.1. Variation in Human

Human variability or human variation is the range of possible values for any characteristic, physical or mental, of human beings. Frequently debated areas of variability include cognitive ability, personality, physical appearance (body shape, skin color, etc.) and immunology. Variability is partly heritable and partly acquired (nature vs. nurture debate). As the human species exhibits sexual dimorphism, many traits show significant variation not just between populations but also between the sexes. Human variability is attributed to a combination of environmental and genetic sources. Phenotypic variation is a combination of one's genetics and their surrounding environment, with no interaction or mutual influence between the two. This means that a significant portion of human variability can be controlled either by interactions of environment and gene or individually (Hedrick, 2005).

Environmental sources includes; nutrition and malnutrition, quality of life and health care, pollution and toxin exposure and other stressors, education, culture, climate, family environment and upbringing (especially before age 5), accidents, industrial or intentional injury and mutilation, or change of the body. Nutrition and diet play a substantial role in determining phenotype because they are arguably the most controllable forms of environmental factors that create epigenetic changes. This is because they can be changed or altered relatively easily as opposed to other environmental factors like location. If people are reluctant to changing their diets, consuming harmful foods can have chronic negative effects on variability. One such instance of this occurs when eating certain chemicals through one's diet or consuming carcinogens, which can have adverse effects on individual phenotype (Hedrick, 2005).

Genetic sources are mutations, Sexual reproduction, recombination, blood types/immune types, Allelic differences, mate selection, reproductive capabilities. Many genetic differences (polymorphisms) have little effect on health or reproductive success but help to distinguish one population from another. It is helpful for researchers in the field of population genetics to study ancient migrations and relationships between population groups. Genetic variation in humans is any variance in phenotype which results from heritable allele expression and mutations. While

human phenotypes may seem diverse, individuals actually differ by only 1 in every 1,000 genes and is primarily the result of inherited genetic differences. Pure consideration of alleles is often referred to as Mendelian Genetics, or more properly Classical Genetics, and involves the assessment of whether a given trait is dominant or recessive and thus, at what rates it will be inherited. The color of one's eyes was long believed to occur with a pattern of brown-eye dominance, with blue eyes being a recessive characteristic resulting from a past mutation. However, it is now understood that eye color is controlled by various genes, and thus, may not follow as distinct a pattern as previously believed. The trait is still the result of variance in genetic sequence between individuals as a result of inheritance from their parents. Common traits which may be linked to genetic patterns are earlobe attachment, hair color, and hair growth and others (Frazer *et al.*, 2009).

The ability of genes to be expressed may also be a source of variation between individuals and result in changes to phenotype. This may the result of epigenetics, which are founded upon an organism's phenotypic plasticity, with such a plasticity even being heritable. Epigenetics may result from methylation of gene sequences leading to the blocking of expression or changes to histone protein structuring as a result of environmental or biological cues. Such alterations influence how genetic material is handled by the cell and to what extent certain DNA sections are expressed and compose the epigenome. The relative importance of genetic and non-genetic inheritance mechanisms is likely to vary among different phenotypic traits within a population (Frazer *et al.*, 2009)

In humans, some variable traits that are easy to observe include: ear lobe pattern, hand clasping types, and tongue folding and tongue rolling ability, dimple chin, mid digital hair, hair on the back of hand, hair in the era, freckles, hitch-hiker thumb, bent little finger and widow’s peak etc. most of the time those morphogenetic traits are highly visible and easy to understand in adult stage of human being. The study of genetic and non-genetic traits is relevant in biological anthropology especially in the study of population variation and human diversity as they are said to be caused by variable factors like genetic drift and gene flow addition to migration and selection (Dennis, 2017).

The existence of genetic variation in man is caused by many factors among which selection, migration, gene flow and genetic drift are the most important. Over years, blood groups have been projected as a useful marker in studying variations in family, linkage analysis and population study. Blood groups are inherited from both parents. The Rh and ABO antigens are still the clinically most significant and genetically most polymorphic of all human blood groups (Uphaday-Dhungel *et al.*, 2013). The ABO are carbohydrate antigens depending on the enzymatic activity and specificity of allelic glycosyltransferases, whereas Rh antigens are protein motifs whose surface expression entails an interaction of two genetic loci (Kooffreh *et al.*, 2015).

2.2. Morphogenetic Traits

Population variability gives a chance to investigate the morphogenetic variations in endogamous population facing different ecological circumstances. Morphogenetic traits are physical characters of an individual. Though the genetic mechanism to control the morphogenetic traits is still not clear as they are observed with variable frequency among different population (Munir *et al.*, 2015).

Population diversity provides a unique opportunity to study the morphogenetic variations amongst endogamous populations living in different geographical and ecological conditions (Nwaopara *et al.*, 2008).

2.2.1. Dimple

Dimples are small and natural visible indentations on the surface of the skin. They may appear on various parts of the body like the cheek. Dimples tend to accentuate a smile, thus increasing the perception of attractiveness, sociability and facial beauty. Dimples on females enhance facial beauty and expression. They occur with no particular preponderance, may express unilaterally or bilaterally and are genetically inherited as a dominant trait (Daponte *et al.*, 2004).

Dimples are highly heritable, meaning that people who have dimples tend to have children with dimples but not always. Because their inheritance isn't completely predictable, dimples are considered an “irregular” dominant trait. Dimples are considered mark of beauty and loveliness. The truth is that dimples are actually genetic defects that are caused by shortened facial muscles. Dimples are caused by a

fault in the subcutaneous connective tissue that develops in course of the embryonic development. A variation in the structure of the facial muscle may also cause dimples. It must be interesting to note that dimples are inherited facial traits that are passed from one generation to the next generation (Nwaopara *et al.*, 2008).

Cheek dimples appear as marked depressions of varying depth and size. They are situated at various distance laterally to the angles of the mouth. They may be unilaterally or bilaterally expressed. Transfer of dimples from parents to children occurs due to just one gene. The dimple creating genes are present in the sex cells prior to the process of reproduction. Each parent provides one of these genes to the child. So, if both the parents have dimples, the children have 50-100% chances of inheriting dimple genes. If, however, only one parent has dimple genes, the chances of the children inheriting the genes are 50%. If neither of the parents has the dimple genes, their children will not have dimples (Keyban, 2012).

2.2.2. Tongue rolling

Tongue rolling is the ability to roll the lateral edges of the tongue upwards into a tube. The intrinsic muscles allow some people to form their tongues into specific shapes. Popular belief holds that variation in this ability is the result of genetic inheritance. Rolling the tongue into a tube shape is often described as a dominant trait with simple Mendelian inheritance.

There is little laboratory evidence supporting the hypothesis that tongue rolling is inheritable and dominant. In 1940, Alfred Sturtevant observed that ~70% of people of European ancestry could roll their tongues and the remaining ~30% could not do it. A 1975 twin study found that identical twins were no more likely than fraternal twins to both have the same phenotype for tongue rolling. Cloverleaf tongue is the ability to fold the tongue in a certain configuration with multiple bends. To the extent to which it is genetic, it is probably a dominant trait distinct from tongue rolling. The frequency distribution of tongue rollers and tongue folders is lower than non-rollers and non-folders. The proportions of rollers and folders among males are much less than their female counterparts. These traits fail to establish statistically significant bisexual variation (Nwaopara *et al.*, 2008).

Other Studies of traits that have been carried out in different populations of Nigeria the ability to fold the anterior part of the tongue upward and backward or tongue folding and to roll the lateral edges of the tongue into a tube or tongue rolling is controlled by dominant gene, while the recessive gene for inability of these tongue movements; although contrary view abounds and environmental influence has also been suggested (Dennis, 2017).

2.2.3. Ear lobe attachment

The individuals having earlobes, hang freely have free earlobes and those having fused with the sides of head are termed as attached earlobes, the earlobes are further classified into three different types on the base of attachment or angle such as obtuse, acute and right, the single gene regulate this trait for which free earlobe is dominant and attached earlobe is recessive, however other factors such as sex and age also influence the length of earlobes. An earlobe is made up of connective tissues combined with a mixture of areola tissues and fat cells. Earlobes have a good blood supply which help in keeping them warm and maintaining balance. Majorly, there are two types of earlobes found in humans - free earlobes and attached earlobes (Onyije, 2012)

(1) **Free Earlobes:** Free earlobes are the most common form of lobes found. This type of earlobe is often large and hangs below the point of attachment to the head. This happens due to the influence of a dominant allele (Munir *et al.*, 2015). If the genes from the parents get expressed by the dominant allele, then the child will be born with free earlobes.

(2) **Attached Earlobes:** These types of earlobes are not rare, but are also not commonly found. Earlobes of such type are small in size and do not have hangs. They are attached directly to the side of the head. The structural formation of this kind of lobe is due to the absence of the dominant allele in the chromosomes. The recessive allele is expressed instead in the chromosomes to form an attached earlobe. It is not necessary that parents with attached earlobes should give birth only to the attached earlobe child (Singh *et al.*, 1979)

2.2.4. Hairline

Hairline is the line demarcating the hairs of scalp from the forehead. The shape of hairline may be curved or straight, the curved hairline shows a V shaped point descending from mid of head just above forehead also called as Widow's peak. Or anatomically, 'widow's peak' refers to the descending V-shaped point at the middle of the head's hairline just above the forehead of some individuals. The two alleles are responsible for controlling the shape of hairline. Widow's peak is dominant character while the straight one is recessive. This trait follows simple dominant- recessive inheritance pattern. The pattern of transmission follows the Mendel's law of inheritance, which assumes that (W) allele is for widow's peak which is dominant while (w) allele is for recessive straight hairline. If an individual expresses the widow's peak hairline shape, the possible genotype is (WW) homozygous or (Ww) heterozygous while one that expresses straight hairline possesses the genotype (ww) (Naz *et al.*, 2014).

2.2.5. Mid-digital hair

Mid-digital hair the hair located on the back of the middle segment of the fingers, excluding the thumb, as it does not have a middle segment. Other names for this trait include digital hair, mid-phalangeal hair (MPH), phalangeal hair, and phalanx/phalange 2 hair (p2 hair). Typically, researchers examined the presence and absence of hair in various populations, and described it in terms of age, ancestry, and sex. Recently MPH has been examined as a potential anthropometric indicator of androgen levels, androgen-related side effects in women, gene homozygosity, and disease resistance (Westlund *et al.*, 2015). The Finding suggests that ethnicity, sex, and age need to be controlled in any studies examining MPH and its relationship with other variables. Two measures of MPH (i.e., presence/absence of MPH and actual hair count) are both acceptable to use in MPH assessment; and the use of a hand lens to examine. MPH provides high reliability when MPH is assessed by expert raters (Westlund *et al.*, 2015).

Middle phalangeal hair (MPH) is a trait frequently examined in anthropological studies throughout the 20th century. Middle phalangeal hair has been a focus of study in different populations for the absence or presence of this trait. Clinically, this is

often perceived as a solely cosmetic feature. However, because of a series of patients questioning the presence of hair on this location. Anatomically, middle phalangeal hair is mostly on the fourth finger and more ulnar rather than central or symmetric in pattern of deviation. Its presence has been most associated with high prenatal androgen exposure, predisposing patients to suffer from adverse side effects from oral contraceptive (Pooja and Sandeep, 2013). Phalangeal hair may be helpful in tailoring treatment to certain patients from different ethnic backgrounds, and particularly in individuals with unknown ancestry (Westlund *et al.*, 2015).

Traditionally, MPH has been evaluated in terms of its presence or absence among various ethnic groups. The weighted average of the proportion of males and females without MPH is reported using percentages.

According to (Naz *et al.*, 2014), MPH is most common in individuals of European descent, with MPH− showing a weighted mean of 30.35%. Individuals of Arabian and Asian descent have moderate proportions of MPH, with MPH− having weighted means of 46.24% and 59.26%, respectively. Oceanic, South American, African, and Canadian Aboriginal groups have the least MPH, with weighted MPH means of 61.55%, 81.50%, 82.31%, and 85.51%, respectively.

2.2.6. Handedness

Handedness describes our preference for using either our left or right hand for activities such as writing and throwing a ball. Overall, about 10% of people are left-handed, but the number varies among cultures from 0.5% to 24%. Some have reported that handedness is controlled by just one or two genes (Petricevica and Cvjeticanin, 2011), but this is not the case. Multiple studies present evidence that handedness is controlled by many genes at least 30 and as many as 100, each with a small effect; many are linked to brain development (Levy and Nagylaki, 1972). Environment also plays an important role: some cultures actively discourage left-handedness (Henry and Yehoash, 1996).

2.2.7. Hitch-Hiker Thumb`

Hitchhiker’s Thumb is a trait actually known as “Distal Hyper extensibility of the Thumb”. This trait is distinguished by the ability to bend the distal joint of the thumb

back as far as possible. Some people can bend their thumb back as far as a 90 degree angle. It is believed this trait is caused by a recessive gene (h), meaning two copies are required to display this characteristic. According to (Glass and Kistler, 1953), they called all thumbs as Hitchhiker's thumb which could bent equal to or greater than 50 degree angle

2.2.8. Bent Little Finger

The malformation of the little finger was first described by (Kirner, 1972). It consists of radial bowing of the terminal phalanx. The tip of the little finger points towards the thenar eminence. This malformation is usually bilateral. A dominant gene causes the last joint of the little finger to bend inward toward the fourth finger(Munir *et al.*, 2015).The presence of bent little finger is due to the dominant allele (B) and straight little finger is due to recessive allele (b). Bent little finger is classified into three different types; Clinodactyly, Camptodactyly and Kiner's deformity involves the metacarpo-phalangeal (hand/finger junction) and proximal inter-phalangeal joints. Clinodactyly involves the proximal inter-phalangeal joint only and Kiner's affects the end joint, the distal inter-phalangeal joint. Clinodactyly term is used when little finger diverges away from axial point of finger and it is actually a physical trait which does not related with any deformity. Camptodactyly derived from Greek word; camptos mean bend and dactulos mean finger, which was described by (Landouzy, 1906), is defined as "an enduring contraction of single or both little fingers at the distal proximal interphalangeal (PIP) joints"(Munir *et al.*, 2015).

2.2.9. Freckles

Freckles are small, concentrated spots of a skin pigment called melanin. Most fair-skin-ned, red haired people have them. Freckles are controlled primarily by the MC1R (me-lanocortin1) gene (Wang *et al.*, 2007). Freckles show a dominant inheritance pattern: parents who have freckles tend to have children with freckles. Variations, also called alleles, of MC1R control freckle number. Other genes and the environment influence freckle size, color, and pattern. For example, sun exposure can temporarily cause more freckles to appear. Freckles are kind of macro channel segregation for its brown spots morphology in the transverse section. Freckles originate from the solute rich liquid co-nvection in the mushy zone. Rayleigh number accurately describes the

liquid convection in the mushy zone and was selected as the criterion for channel segregation (Wang *et al.*, 2007).

2.2.10. Hand clasping

Hand clasping is the superimposition of the fingers of one hand over those of the opposite hand. When hands are clasped, either the right thumb is on top (right thumb up) or the left thumb is on top (left thumb up).If the left thumb is on top you have the dominant trait (C), the right thumb is recessive (c). One study found that 55% of people place their left thumb on top, 45% place their right thumb on top, and 1% have no preference(Dennis, 2017). A study of identical twins concluded that hand clasping has a strong genetic basis (most twins share the trait), but it doesn't fit a predictable inheritance pattern. It is likely affected by multiple genes as well as environmental factors.

Variations in phenotypic traits occurring in humans have been described to be a result of several factors. Hand clasping patterns have previously been described as an inherited trait. Significant parent offspring correlations have suggested a polygenetic mode of inheritance. Though the genetic basis for inheritance of this trait is still debatable, it is however pertinent to note that these traits are of significant value in physical anthropology especially in studying human diversity. Most importantly, several studies involving Europeans, Asians and American populations have been investigated, but very little data exist amongst Africans (Odokuma *et al.*, 2011).

2.3. Blood Group Systems

The term "blood group" refers to the entire blood group system comprising red blood cell (RBC) antigens whose specificity is controlled by a series of genes which can be allelic or linked very closely on the same chromosome. In addition to the ABO and Rh system, at present, 300 blood group systems representing over 346 antigens are listed by the International Society of Blood Transfusion (Abdullah, 2010). Most of them have been cloned and sequenced. The genes of these blood group systems are autosomal, except XG and XK which are X-borne, and MIC2 which is present on both X and Y chromosomes. The antigens can be integral proteins where polymorphisms lie in the variation of amino acid sequence (e.g., rhesus [Rh], Kell), glycoproteins or glycolipids (e.g., ABO). The ABO system is the most important

blood group system in transfusion therapy and was the first blood group system to be discovered (Abdullah, 2010).

Some of the important groups are mentioned here;

MNS antigen system: is first described by Landsteiner and Levine in 1927. It can be characterized based on two genes: Glycophorin A and Glycophorin B. The blood group is under control of an autosomal locus on chromosome 4 and also under control of a pair of co-dominant alleles LM and LN. Anti-M and anti-N antibodies are usually IgM types and rarely, associated with transfusion reactions (Lögdberg *et al.*, 2005)

Lutheran system: Lutheran system comprised of four pairs of allelic antigens representing single amino acid substitution in the Lutheran glycoprotein at chromosome (Lögdberg *et al.*, 2005). Antibodies against this blood group are rare and generally not considered clinically significant.

Kell system: These erythrocyte antigens are the third most potent immunogenic antigen after ABO and Rh system, and are defined by an immune antibody, anti-K. It was first noticed in the serum of Mrs. Kellacher. She reacted to the erythrocytes of her newborn infant resulting in hemolytic reactions. Since then 25 Kell antigens have been discovered. Anti-K antibody causes severe hemolytic disease of the fetus and newborn (HDFN) and haemolytic transfusion reactions (Lögdberg *et al.*, 2005).

Duffy system: it was first isolated in a patient called Duffy who had haemophilia. It is also known as FY glycoprotein and is present in the surface of RBCs. It is a nonspecific receptor for several chemokines and acts as a receptor for human malarial parasite, Plasmodium vivax. Antigens Fya and Fyb on the Duffy glycoprotein can result in four possible phenotypes, namely Fy(a+b−), Fy(a+b+), Fy(a−b+), and Fy(a−b−). The antibodies are IgG subtypes.

Kidd system: it known as Jk antigen is a glycoprotein, present on the membrane of RBCs and acts as a urea transporter in RBCs and renal endothelial cells. Kidd antibodies are rare but can cause severe transfusion reactions. These antigens are defined by reactions to an antibody designated as anti-Jka. Jka was the first antigen to be discovered by Kidd blood group system, subsequently, two other antigens Jkb and Jk3 were found (Lögdberg *et al.*, 2005).

2.3.1. ABO Blood System

In 1900 Karl Landsteiner reported a series of tests, which identified the ABO Blood Group System. In 1910 he won Nobel Prize for medicine for this discovery. He mixed the serum and cells of all the researchers in his lab and found four different patterns of agglutination. From those studies he developed Landsteiner's rules for the ABO Blood Group**:** A person does not have antibody to his own antigens and each person has antibody to the antigen he lacks (only in the ABO system). The ABO blood group distribution varies in different geographical and ethnic groups. ABO blood group genes are mapped at 9q34.2.There are four principal types: A, B, AB, and There are two antigens and two antibodies that are mostly responsible for the ABO types (Krishna *et al.*, 2014).

The genes of ABO & Rh (D) are located on chromosome 9 & 1 respectively. There are differences in the distributions of ABO, & Rh (D) blood groups amongst different populations. The study of blood grouping is important as it plays an important role in various genetic studies, in clinical studies for reliable geographical information and in blood transfusion practice as it will help a lot in reducing the morbidity and mortality rate. Knowledge of distribution of ABO & Rh blood group is also essential for effective management of blood bank inventory (Rajshree and Raj, 2013).

Different ethnic groups also have different frequency of the main blood types in their populations. For example, approximately 45 percent of Caucasians are type O, but 51 percent of African-Americans and 57 percent of Hispanics are type O. Type O is routinely in short supply and in high demand by hospitals , because it is the most common blood type and because type O negative blood, in particular, is the universal type needed for emergency transfusions. Minority and diverse populations, therefore, play a critical role in meeting the constant need for blood. Blood group O is the most common blood type throughout the world, particularly among peoples of South and Central America. Type B is prevalent in Asia, especially in northern India. Type A also is common all over the world; the highest frequency is among Australian Aboriginal people (Abdullah, 2010).

According to (Mortazavi *et al.*, 2014) in Iran the frequency of ABO blood groups in different Iranian ethnic groups was released. The frequency of blood groups, serum

proteins and red cells enzymes in various Iranian populations were reported. Furthermore, a collection of valuable and extensive cooperation with Iran Blood Transfusion Organization, different types of blood groups in various population of Iran, was reported.

The ABO blood types are controlled by a single gene located on the long arm of the ninth chromosome with 3 alleles: i, IA, and IB. IA and IB alleles are dominant over i, expressing a special dominance relationship (co-dominance), which means that type A and type B parents can have an AB-type child and O-type child if they are both heterozygous (IBi, IAi).ABO blood groups are the most investigated blood group system, and owing to ease of identifying their phenotypes, they have been used as genetic markers of populations. It is well established that differences in ABO blood groups exist, both within and among ethnic groups and by geographical area. Some variations may even occur in different areas within one small country (Rajshree and Raj, 2013)

ABO antibodies

Antibodies are immunoglobulin proteins secreted by B-lymphocytes after stimulation by a specific antigen. The antibody formed binds to the specific antigen in order to mark the antigen for destruction. The type of antigenic exposure occurring in the body determines if the antibody is a naturally occurring or immune antibody. The term ‘naturally occurring’ is used for blood group antibodies produced in individuals who have never been transfused with red cells carrying the relevant antigen or been pregnant with a fetus carrying the relevant antigen. Naturally occurring antibodies can be formed after exposure to environmental agents that are similar to red cell antigens, such as bacteria, dust or pollen (Yamamoto *et al.*, 1993).

Table 2-1 ABO blood group antibodies and their genotype

ABO blood group	antibodies present on the plasma	Antigen on the RBC	Genotype
Blood type A	Anti B	Anti A	AA & AO
Blood type B	Anti A	Anti B	BB & BO
Blood type AB	Neither anti A nor B	Both anti A and Anti B	AB
Blood type O	Anti A and Anti B	Neither anti A nor B	OO

Antibodies are produced by the immune system against foreign substance. Anti-A and Anti-B are produced soon after birth by everyone who does not have A or B. Group O people make both anti-A and anti-B as they lack both A and B blood group factors. In contrast, people who are group AB cannot make anti-A or anti-Bas the A and B blood group factors are a normal part of their blood cells (Yamamoto et al., 1993).

2.3.2. Rh (Rhesus) blood group system

It is the most important blood group system after ABO system. At present, the Rh blood group system consists of 50 defined blood antigens, among which the five antigens D, C, c, E and e are the most important. The commonly used terms Rh factor, Rh positive and Rh negative refers to D antigens only. This antigen is used to determine the risk of hemolytic disease of the newborn (erythroblastosisfetalis). If the Rh antigen is lacking, the blood is called Rh negative and is present called Rh positive. When the mother is Rh negative and the father is Rh positive, the fetus can inherit the Rh factor from the father. This makes the fetus Rh positive too. Problems can arise when the fetus's blood has the Rh factor and the mother's blood does not. A mother who is Rh negative may develop antibodies to an Rh positive baby (Connie, 2007).

When the rate of Rh positive is considered, varying percentages were reported in various races and populations: Caucasians (85%),7 African blacks (94%),14 Asians (99%),7 Arabians (91%),15 and Europeans with their descents (84%) (Jaff, 2010).

Rh system antigens

The human red cells that carry antigen D are referred to as rhesus positive (Rh+) while those without it are rhesus negative (Rh-).The proteins which carry the Rh antigens are trans- membrane proteins. The main antigens are D, C, E c and e, which are encoded by two adjacent gene loci, the RHD gene which encode the RhD proteins with the D antigens and the RHCE gene which encode the RhCE protein with the C, E, c and e antigens (Connie, 2007).

This antigen is immunogenic, inducing an immune response in 80% of D negative individuals when transfused with D. It is also the major cause of hemolytic disease of newborns. Generally only a few percentages of humans are rhesus negative. This condition has been reported to be 5.5% in South India, 5% in Nairobi, 4.8% in Nigeria and 7.7% in Rawalpindi (Anibor *et al*., 2014).Rh phenotypes are readily identified by the presence and absence of Rh surface antigens or D antigens. Most of the Rh phenotypes can be produced by several different genotypes. The exact genotype of any individual can only be identified by DNA analysis (Connie, 2007).

Rh system antibodies

Rh antibodies are IgG antibodies which are acquired through exposure to Rh positive blood (generally either through pregnancy or transfusion of blood products). The D antigen is the most immunogenic of all the non ABO antigens. Approximately 80% of individuals who are D negative and exposed to a single D positive up to the productions of anti-D antibody. Rh antibodies are capable of causing hemolytic transfusion reactions with extra-vascular hemolytic disease (Gruswitz *et al.*, 2010).

3. MATERIALS AND METHODS

3.1 Study Site

The study was conducted in Amhara Region at Bahir Dar city (Ghion secondary and preparatory school and Alem children support organization) and Injibara town (Agew Midir secondary and preparatory school). Bahir Dar is situated on the southern shore of Lake Tana, the source of the Blue Nile (*Abay*), in what was previously the Gojjam province. Bahir Dar city is located approximately 578km north-northwest of Addis Ababa, having a latitude and longitude of11°36′N and 37°23′E respectively and an elevation of about 1,800 meters (5,906 feet) above sea level. According to 2009 Population and Housing Census of Ethiopia Bahir Dar has 17 districts or Kebeles and having 133,368 of a total population (M=66458 &F=66910) (Census, 2009).

Injibara is the administrative centre of Agew Awi zone, which is one of the 10 Zones of the Amhara region. Agew Awi Zone is bordered on the west by Benishangul-Gumuz Region, on the north by Semien Gondar Zone and on the east by Mirab Gojjam Zone. Injibara is located approximately 447 km north-west of Addis Ababa, having a latitude and longitude of 10°56'59.99" N and 36°55'59.99" S respectively. According to 2009 Population and Housing Census of Ethiopia there is 33015 of total population (M=17178 & F=15837) (Census, 2009).

3.2 Data Collection

A cross-sectional study was conducted from Nov, 2007-Apr, 2018. That means the data were collected ones a time and the variable was not change through a time. Purposive sampling technique was used to select the ethnic groups and semi-structured questionnaires for different demographic questions. Data was collected randomly from 270 individuals of three ethnic groups (Agew, Amhara and Negede) between the ages of 18 to 45 years. Of the subjects, 100 were the Amhara ethnic group students from Ghion secondary and preparatory school, 70 were the Negede Weyto ethnic group students from Alem children support organization, and 100 were the Agew ethnic group students from Agew Midir secondary and preparatory school due to time, money and man power. Half of the study subjects were females and the remaining half were males. The three study site were prefer for simplification and to get unalloyed individuals.

3.2.1. Morphogenetic Data Collection

Different standard techniques were employed to record and analyze morphogenetic traits. For tongue rolling, each individual was asked to perform the activity and a person was classified tongue roller or non- tongue roller depending upon their ability (Sturtevant, 1940). In the cases of earlobe attachment, dimples, mid digital hair, hairline, freckles, hand clasping and the others were recorded by physical observation and by taking photographs to check for the presence or absence of those phenotype and then the result was recorded accordingly.

3.2.2. ABO and Rh Blood Group determination

Blood samples were collected by finger-prick method in the side of the thumbs from 270 unrelated individuals of both sexes belonging to Agew-Awi, Negede and Amhara populations of Bahir Dar and Injibara. The portion was wiped vigorously with cotton wool, which was washed in methylated spirit to sterilize and stimulate blood flow. The clean surface was pricked with a fresh sterile blood lancet and the thumb was pressed gently to allow blood flow.

Then three drops of blood sample were placed on three different slide on the tile and the different anti-sera were dropped accordingly on the blood and with one end of a glass pistol, the blood samples and the anti-sera were mixed by wooden stick rocker properly. After the tile is rocked for some seconds, it was incubated for 2 min at room temperature for agglutination to take place. Then blood groups were determined on the basis of agglutination reaction or blood clumps. That means agglutination with anti-sera-A show A blood group, with anti-sera-B show B blood group and with both A and B show AB and with neither of these show O blood group. Agglutination of blood with D show positive test for D antigen (Kooffreh *et al.*, 2015).

3.3 Variables

Dependent variables: ABO blood groups, Rh factor and morphogenetic traits
Independent variables: Age, sex and ethnicity

3.4 Data Analysis

The data were analyzed with the aid of SPSS version 21. The distribution of ABO and RH blood group data was expressed in percentages. Chi-square test, contingency table (7x2) were applied to test the statistical significant of associations between traits and ethnicity, traits and ABO blood group as well as gender at $p<0.05$.

3.5 Ethical Consideration

Ethical clearance was soughed and obtained from the Ethical Clearance Committee of Science College, Bahir Dar University before initiation of the study. The informed consent was obtained from each participant during data collection based on their willing to know their blood groups and phenotypes.

4. RESULT

Table 4.1 the socio-demographic data of the study population

Variable	Options	Frequency	Percentage
sex	M	135	50%
	F	135	50%
Age	18-45	135	100
Ethnicity	Amhara	100	37.04%
	Awi	100	37.04%
	Negede	70	25.93%
Genetic traits	Morphogenetic traits, ABO and Rh blood group	-	-
Mother tongue language	Amharic and Agewgna	-	-

4.1. Distribution pattern of morphogenetic traits

Table 4.1 shows the prevalence and distribution of traits studied in males and females in each ethnic group. Right hand clasper was more frequent in all the ethnic groups than left hand clasper 113 (41.85%) and 157 (58.15%) respectively. All the population under study showed high frequency of right handed. The highest incidence of strait hair line was observed than windows peak 140 (51.85%) and 130 (48.15%) respectively. Individuals with the absence of cheek dimples was predominant compared to individuals with dimples in all ethnic groups 36 (13.33%), 234 (86.67%) respectively. In all ethnic group there was no freckles people. The ability of tongue rolling was predominant compared to inability to tongue rolling in all the ethnic groups 144 (53.33%), 126 (46.67%) respectively. After analyzing the frequency and distribution of mid digital hairs among Awi, Amhara and Negede, the absence of mid digital hair was highly recorded 185 (68.52%). In case of Hitchhiker's Thumb, strait thumb was more prevalent (56.67%), than bent thumb (43.33%). The result showed

that the prevalence of strait little finger was highly observed in all ethnic groups 252 (93.33%). In the pattern of the ear lobe attachment free or unattached ear lobes were most common than the attached 265 (61.11%) and 105 (38.89%) respectively but in Negede ethnic groups attached ear lobe were most prevalent 43 (61.93%).Hand clasping, handedness, cheek dimple, mid digital hair, hitchhiker's Thumb, little finger and ear lobe attachment were significantly associated with ethnicity ($p<0.05$), but others were not.

In the prevalence and distributions of morphogenetic traits in gender, the result showed that most males were right hand clasper than females (31%) and (27%) respectively. All most there was higher frequency of right handedness in both sex. Strait hair line shape was highly observed in female (37%) than male (15%). The distribution of cheek dimple among female and male were in par. The ability of tongue rolling was highly prevalent in male than female (30%) and (27%) respectively. Most females had no mid digital hair 124 (45.93%) but 74 (27.4%) of male had mid digital hair. Thumb strait were most prevalent in female than male (29%) and (28%) respectively. The distribution of little finger among female and male were in par. The prevalence of free ear lobe attachment were most prevalence in male than female (31%) and (30%) respectively. There was significant association between hair line shape, tongue rolling and mid digital hair with gender ($p<0.05$), others were not associated.

Table 4-1 Prevalence and distribution of morphogenetic traits in relation to ethnicity and gender

Trait	Phenotype	Agew		Amhara		Negede			Within sex		Within ethnicity	
		F (%)	M (%)	F (%)	M (%)	F (%)	M (%)	Total (%)	x2	p	x2	P
HC	LOR	29	21	21	22	11(11.71)	9(12.86)	113(41.85)	1.23	0.27	7.86	.020*
	ROL	21	29	29	28	24(34.23)	26(37.14)	157(58.15)				
HN	RH	50	50	50	50	34(48.57)	32(45.71)	266(98.52)	1.012	.314	12	.003*,
	LH	0	0	0	0	1(1.43)	3(4.286)	4(1.48)				
HL	S	39	12	36	15	25(35.71)	13(18.56)	140(51.85)	53.45	.000	0.22	0.89
	V	11	38	14	35	10(14.29)	22(31.43)	130(48.15)				
CD	D	7	10	11	6	0(0)	2(2.86)	36(13.33)	0	1	8.98	.011*
	ND	43	40	39	44	35(50)	33(47.14)	234(86.67)				
FR	FR	0	0	0	0	0(0)	0(0)	0(0)	-	-	-	-
	NF	50	50	50	50	35(50)	35(50)	270(100)				
TR	TR	23	30	23	28	16(22.86)	24(34.29)	144(53.33)	5.95	.015	0.63	0.73
	NTR	27	20	27	22	19(27.14)	11(15.71)	126(46.67)				
MDH	MDH	0	31	11	32	0(0)	11(15.71)	85(31.48)	68.15	.000	14.23	.001*
	NMDH	50	19	39	18	35(500	24(34.29)	185(68.52)				
HHT	TS	24	30	27	23	26(37.14)	23(32.88)	153(56.67)	0.015	0.90	7.17	.028*
	TB	26	20	23	27	9(12.86)	12(17.14)	117(43.33)				
LF	S	43	45	50	47	33(47.14)	34(48.57)	252(93.33)	0	1	7.37	.025*
	B	7	5	0	3	2(2.86)	1(1.43)	18(6.67)				
ELA	FEL	35	38	36	29	11(15.71)	16(22.86)	165(61.11)	0.015	0.90	21.54	.000*
	AEL	15	12	14	21	24(34.19)	19(27.14)	105(38.89)				

M=male; F=female; HC=hand clasping; LOR=Left over right ; ROL= right over left; TR=tongue rolling; TR=tongue rollers; NTR=non-tongue rollers; HN=Handedness; RH=Right handed ;LH=Left handed; HL=Hair line ; S=Strait; V=Widow's peak; CD=Cheek dimple; D=Dimpled; ND =Non dimpled ; FR=Freckles; NF =non freckles; MDH=Mid digital hair; MDH=mid digital hair; NMDH=Non mid digital hair; HHT =Hitchhiker's Thumb; TS=Thumb strait; TB=Thumb bent; LF=Little Finger; S=Strait; B=Bent; ELA= ear lobe attachment; AEL= attached ear lobe; FEL= free ear lobe

4.2. Prevalence of blood groups

The prevalence of A, B, AB, O blood group were shown in Table 4.2. The most common blood group was O, 41.1% (n=111) followed by blood groups B, 26.7 % (n=72), A, 25.2% (n=68) and AB 7.0% (n=19) have the least percentage distribution. Blood group O was highly recorded (57%) in Awi, blood group A (31%) in Amhara and blood group B (54.28 %) in Negede ethnic groups. Chi-square analysis revealed a significant association between ethnicity and the distribution of ABO blood groups. (x^2= 54.039, df = 6, p=0.000).

The difference in the pattern of blood groups O, A, B, and AB in male and female was inconsequential and there was no significant association between gender and ABO blood group distribution (x^2 =3.714, df=3, p=0.29).

Table 4-2 Prevalence and distribution of ABO blood group in relation to ethnicity and gender

Blood groups	Awi		Amhara		Negede		
	F	M	F	M	F	M	Total (%)
A	13	7	17	14	10	7	68(21.19)
B	8	12	7	7	20	18	72(26.67)
AB	1	2	4	6	2	4	19(73).
O	28	29	22	23	3	6	111(41.11)
Total	50	50	50	50	35	35	270(100)

4.3 Association of morphogenetic traits with blood groups

Table 4.3 shows prevalence and distribution of morphogenetic traits in relation to blood group in the study populations. The percentage distributions of hand clasping with blood groups A, B, AB and O, were, 30% of O blood group in Awi was left hand clasper, 14% A in Awi, 24% O and 19% A in Amhara as well as 41.43%B and 15.71%A in Negede were right hand claspers. In our study 2.86% of B blood group in Negede was left handed while greater than 35% of blood group O in Awi and Amhara were right handed.30% O and 14% A in Awi, 25%O in Amhara and 30% B blood group in Negede were strait hair line shape while 16%A in Amhara and 12.86% A in Negede had v-shaped or widow' peak hair line shape. 48% O & 18%A, 37% O & 26% A and 52.85%B %& 24.29%O blood group had no cheek dimple in Awi, Amhara and Negede respectively. In this study there was no freckle people in all study populations. In this study 34% and 37% of blood group O and 31.43% blood group B were the ability to tongue roll in Awi, Amhara and Negede respectively while 12%B and 12.86% A was inability to tongue roll in Awi and Negede respectively. 39%O & 14%A in Awi, 25% O&20%A in Amhara and 44.29% B& 22.86% A Negede had no mid digital hair. 34% O, 24%O&38.57%B were thumb strait in Awi, Amhara and Negede respectively while 11% and 12.86% of blood group A was thumb bent in Awi and Negede respectively. The distribution of little finger with ABO blood group phenotype was, 51%O &19%A, 44%O&30%A and 54.29%B &21.43% A were strait little finger in respective ethnic groups. In case of ear lobe attachment, 44%O&15%A and 28%O &22%A had free or unattached ear lobe in Awi and Amhara ethnic groups while 35.71%B and 14.29%A had attached ear lobe in Negede ethnic groups. The statistical analysis showed that, Handedness, hair

line shape, the presence or absence of cheek dimple, the ability of tongue rolling, the presence or absence of mid digital hair, little finger and Hitchhiker's Thumb had no significant associations with ABO blood group phenotypes ($p>0.05$). After analyzing the chi-square contingency table, hand clasping and ear lobe attachment were significantly associated with ABO blood group ($x^2=12.00$; df =3; $p=0.007$; and $x^2= 9.14$; df =3; $p=0.027$) respectively. For each morphogenetic traits Rh positive blood groups were highly prevalent than Rh negative blood group phenotypes.

Table 4-3 Frequency and distribution of morphogenetic traits in relation to blood group in study population

Trait	Phenotype	Awi								Amhara								Negede							
		A	B	AB	O	Sig.	X2	Rh+	Rh-	A	B	AB	O	Sig.	X2	Rh+	Rh-	A	B	AB	O	Sig.	X2	Rh+	Rh-
HC	LOR	13	6	1	30	0.139	5.491	41	9	12	5	5	21	0.805	0.983	37	6	6	9	1	4	0.503	2.349	18	2
	ROL	7	14	2	27			42	8	19	9	5	24			51	6	11	29	5	5			40	10
HN	RH	20	20	3	57	-	-	83	17	31	14	10	45	-	-	88	12	16	36	5	9	0.594	1.897	55	11
	LH	0	0	0	0			0	0	0	0	0	0			0	0	1	2	1	0			3	1
HL	S	14	6	1	30	0.077	6.854	42	9	15	8	3	25	0.487	2.435	44	7	8	21	4	5	0.862	0.749	33	5
	V	6	14	2	27			41	8	16	6	7	20			44	5	9	17	2	4			25	7
CD	D	2	6	0	9	0.288	3.764	17	0	5	2	2	8	0.982	0.173	14	3	0	1	1	0	0.18	4.894	2	0
	ND	18	14	3	48			66	17	26	12	8	37			74	9	17	37	5	9			56	12
TR	TR	11	8	0	34	0.123	5.784	45	8	15	9	3	24	0.402	2.936	47	4	8	22	4	6	0.736	1.27	34	6
	NTR	9	12	3	23			38	9	16	5	7	21			41	8	9	16	2	3			24	6
MDH	MDH	6	7	0	18	0.679	1.516	24	7	11	7	5	20	0.745	1.233	38	5	1	7	2	1	0.391	3.001	9	2
	NMDH	14	13	3	39			59	10	20	7	5	25			50	7	16	31	4	8			49	10
HHT	TS	10	9	1	34	0.566	2.029	42	12	16	7	3	24	.608a	1.832	46	4	8	27	5	9	0.034	8.646	38	11
	TB	10	11	2	23			41	5	15	7	7	21			42	8	9	11	1	0			20	1
LF	S	19	15	3	51	0.199	4.655	73	15	30	13	10	44	0.745	1.234	85	12	15	38	5	9	0.083	6.665	55	12
	B	1	5	0	6			10	2	1	1	0	1			3	0	2	0	1	0			3	0
ELA	FEL	15	12	2	44	0.508	2.325	61	12	22	7	8	28	0.39	3.012	60	5	7	13	2	5	0.678	1.519	21	6
	AEL	5	8	1	13			22	5	9	7	2	17			28	7	10	25	4	4			37	6

5. DISCUSSION

5.1 Distribution pattern of morphogenetic traits

The present study assessed the relative distribution of hand clasping, handedness, hair line shape ,cheek dimple , freckle , tongue rolling ability, the presence or absence of mid digital hair ,hitch's hiker thumb, little finger and ear lobe attachment among the Awi, Amhara and Negede peoples and their association with ABO blood groups. The finding in the present study regarding hand clasping with the right thumb on top was the dominant type (58.15%) with the highest frequency among the Amhara as well as Negede. This finding was similar to previous findings Pooja and Sandeep, (2013) in the study of African Negro also found high frequency of right hand clasper .Some Awi females were left hand clasper. Left hand clasper was relatively higher in females than in males. In the converse, unlike previous reports, Dennis (2017) and Odokuma *et al*. (2011) in Nigeria reports Left hand clasper was relatively higher in males than in their counter parts. There was no significant association between hand clasping pattern and gender which is similar to the studies done by Dennis (2017) in South Nigerian and Odokuma *et al*. (2011). But hand clasping pattern were significantly associated with ethnicity.

All the population in the present study showed high frequency distribution of right handedness in all ethnic groups which is similar to the studies done by Pooja and Sandeep, (2013) there was high frequency distribution of right type handedness and the overall inter caste frequency distribution of the trait was found to be heterogeneous. But other finding done by Petricevica and Cvjeticanin, (2011) in Montenegro and Serbia, the higher percentage of left handedness was found, due to higher number of recessive character in left handed persons Cvjeticanin and Marinkovic, (2005) points out that in patients with congenital hip dislocation left handed patients have on average the highest number of homozygous recessive traits. Few number of male was left handed in Negede. There was association with ethnicity.

The current studies showed higher frequency of straight hair line shape than widow's peak hair line shape individuals which is similar to the study conducted by Naz *et al.* (2014) revealed higher prevalence of straight hairline than widow's peak and Nwaopara *et al.* (2008) who observed higher frequency of straight hairline shape.

Straight hairline shape were highly prevalence in females than males which is similarity with the finding done by Ordu and Agi, (2014) in Nigeria also indicated that straight hairline was most common in females than males .The study conducted by Naz *et al.* (2014) revealed higher prevalence of straight hairline than widow's peak and Nwaopara *et al.*, (2008) who observed large number of population possessing straight hairline shape but Nusbaum and Fuentefria, (2009) claimed dissimilarity with present study; they reported 81 % widow's peak during their study in women. There was a significant association between gender and hair line shape.

The result showed that individuals with the absence of cheek dimples was predominant compare to individuals with dimples 234 (86.67%) and 36 (13.335) respectively in all ethnic group, which is similar to the findings of Omotoso *et al*. (2010) and Abayomi, (2014). The distribution of this trait among female and male were in par but other studies done by Kooffreh *et al,(* 2015) in Calabarhad a different report that facial dimples were found to be more in the females than in the males. The result showed there was no significance association between gender and cheek dimple but other finding by Kooffreh *et al.* (2015) observe sex and facial dimples were associated.

With respect to tongue rolling pattern, the ability of tongue rolling was predominant compared to inability to tongue rolling in all the ethnic groups which is similar to the studies of Onyije *et al.* (2012) there was higher prevalence of an individual that belonging to can roll there tongue as against cannot roll there tongue. Other studies done by Kooffreh *et al.*(2015) which is dissimilar to our result, the frequency distribution of tongue rolling showed a lower percentage of tongue rollers in the population and a higher percentage of non-rollers of tongue. The ability of tongue rolling were higher in male than females, similarity with studies done by Dennis (2017) the percentage of tongue rollers was higher compared to non-rollers, with male dominance that compared to females. but at variance with the study by Odokuma *et al.* (2011) and Anibor *et al.*(2014)because they reported female dominance .There was significant association between tongue roll ability and gender. This is in tandem with the results of the studies conducted among the Odokuma *et al.(*2011) in Urhobo, Nwaopara *et al.*(2008) in residents of Ekpoma and Onyije, (2012) in Southern Nigerians.

After analyzing the frequency and distribution of mid digital hairs among Awi, Amhara and Negede, the absence of mid digital hair was highly recorded than the presence of mid digital hair. The result were dissimilar to the finding of Kooffreh *et al.*, (2015) showed higher incidence of the presence of mid phalangeal hair and Pooja and Sandeep, (2013) mid-digital hair was present on 92% of the studied population while 8% lacked it. In female there was higher prevalence of absence of mid digital hair than males. It was significantly associated with gender, which is the inverse of the studies done by Kooffreh et al., (2015) mid-digital hair had no associations with sex.

The result illustrated the prevalence of thumb bent lower than straight thumb 117(43.33%), 153(56.67%), respectively, except 26% of Awi female and 27% of Amhara male was thumb bent, which is similar to the studies done by Munir *et al.* (2015) and Onyije *et al.* (2012).The results showed there was higher frequency of strait thumb in female than male which is similarities with the study conducted in Pakistan done by Munir *et al.* (2015) and Onyije *et al.* (2012).The chi-square test showed no significant association between Hitchhiker's thumb and gender.

The prevalence of strait little finger was highly observed than bent little finger in all ethnic groups, which is showed similarity with Munir *et al.* (2015) the percentage of straight little finger was higher. The frequency of strait and bent little finger in females and males was the same. Our result was different from the result obtained in South-South Nigeria by Onyije *et al.* (2012) and Munir *et al.* (2015) in Pakistan the frequency of bent little finger in females was higher than males. The prevalence of bent little finger according to our research and few other researches in the world shows a low prevalence. There was no association between little finger and gender which is dissimilar result with the finding by Munir *et al.* (2015).

In all the ethnic groups, free or unattached ear lobes were most common than attached ear lobe, which is similar to the finding done by Onyije *et al.* (2012) the total prevalence for attached ear lobe was lowest than unattached ear lobes. While in Negede ethnic group the frequency of attached ear lobe were higher than unattached ear lobe which is similarity with the studies of Munir *et al.* (2015). The finding in the present study regarding ear lobe attachment is in tandem with the results of some studies carried out among residents of Ekpoma Nwaopara *et al.* (2008), Bini people

Anibor *et al.* (2014), some Nigerians Ordu K.S *et al.* (2014), and Assamese Sikh in India Jaswant and Sarthak (2004), in which higher percentage of unattached ear lobes compared to attach ear lobes occurred. Different studies claimed dissimilarity with present study which is done by Munir *et al.* (2015) they reported it was observed that the frequency of free earlobe was lower than attached earlobe.

The prevalence of unattached ear lobe were higher in males than females which is dissimilar with the studies of Munir *et al.* (2015) there was higher percentage of unattached ear lobe females than males in line with Negede ethnic groups. Data analyzed by Chi-Square test revealed no association between gender and attached/free earlobes, which is similar to the finding done by Dennis (2017).

5.2. Prevalence of blood groups

Frequency and distribution of blood groups play a vital role in transfusion medicine, genetic research, human evolution, forensic pathology and it is also associated with varied number of diseases. The phenotype and genotype frequencies of ABO and Rhesus groups vary widely across different study population and geographical areas. The present study was the first to document the frequencies of the ABO and Rh blood groups in Awi, Amhara and Negede ethnic groups. Distribution of the ABO and Rh blood groups phenotype frequencies were studied in 270 three ethnic groups. Blood group O was found to be the most prevalent, followed by group B, group A and group AB that followed the pattern seen in previous studies of Southern part of India done by Periyavan *et al.* (2010)at Bangalore, Das *et al.* (2001) at Vellore, and at Davanagere by Mallikarjuna, (2012) found that the commonest blood group was O followed by B, A and AB. While in Negede ethnic groups, blood group B was the most prevalent followed by group A in line with the findings done by Rajshree and Raj, (2013) at western Rajasthan, the most common being blood group B.

Outside India, in Pakistan the study done by Gadwalkar and Kumar, (2013) in Bellary the commonest blood group is B which is same as in our study in negede. AB blood group was rare in our subject as similar to other all studies. Other Studies done by Rajshree and Raj, (2013) the geographical distribution of Blood Groups in India shows that in Northern & Western part of India; B is the commonest blood group, that similar to my study of Negede peoples where as in Eastern, Southern and Central part, O is the most frequently occurring blood group similarly with my study of Awi and

Amhara ethnic groups. The advantage of the high prevalence of blood group O in this study since the previous studies revealed that blood group O had less sever malaria compare to group A, B and AB Tadesse and Tadesse, (2013). This could suggest that individuals within Awi and Amhara have high resistance to malaria. Also, there are reports that individuals with blood group A, B and AB are more susceptible to oral, pancreatic, ovarian, gastric, leukemia, rectal and cervical cancers Wolpin *et al.* (2009); Mortazavi *et al.* (2014) and Jaleel and Nagarajappa, (2012) thus, the decrease in the prevalence of blood group A, B and AB suggest that the prevalence of these disease conditions in Awi and Amhara could be low. Chi-square analysis revealed a significant association between ethnicity and the distribution of ABO blood groups. The difference in the pattern of blood groups O, A, B, and AB in male and female was inconsequential and there was no significant association between gender and ABO blood group distribution.

5.3 Association of morphogenetic traits with blood groups

Association existed between hand clasping and ABO blood group, blood group O having more prevalent of left hand clasper individuals in Awi female subjects while other blood group were most prevalent of right hand clasper in Amhara and Negede groups. There was an associations between ABO blood group and hand clasping pattern .The result showed similarity with the findings of Calabar done by Kooffreh *et al.* (2015). Greater than 35% of blood group O in Awi and Amhara were right handed while in Negede blood group B were highly prevalent. Blood group O (30% and 25%) in Awi & in Amhara as well as 30% B blood group in Negede were strait hair line shape while 16%A in Amhara and 12.86% A in Negede had v-shaped or widow' peak hair line shape. Blood group O in Awi and Amhara were had no cheek dimple which is similar to the finding of Nwaopara *et al.* (2008) in Ekpoma and Nigeria while of blood group B were in Negede ethnic groups. Similar analysis of the influence of blood group phenotypes on facial dimples showed a non-significant value which is similar to the studies done by Kooffreh *et al.* (2015) Blood group O and B were the ability to tongue roll in Amhara and Negede respectively. The same analysis showed that blood group phenotypes was not significantly associated with tongue rolling ability which is similar result were observed in Calabar by Kooffreh *et al.* (2015). Higher percentage of blood group O in Awi & blood group B in Negede were thumb strait while lower number of blood group A were thumb bent in Amhara and

Negede ethnic groups. Most blood group O & A had free or unattached ear lobe in Awi and Amhara ethnic groups while an individual with blood group B had attached ear lobe in Negede ethnic groups. There was a significant association with ABO blood group. There was no significant association between little finger, Hitchhiker's thumb, mid digital hair, strait hair line, handedness and ABO blood group phenotypes. There is no previous researches done by the combination pattern of ABO blood group and those morphogenetic traits for comparison.

The Rh distribution also varies within any group of human population. In this study, there was higher prevalence of Rh positive than Rh negative blood groups in all ethnic groups which is similar to the finding of some neighboring Arabian countries, Saudi Arabia Al-Himaidi and Umar, (2002) Arians Boskabady *et al.* (2005) and Iran Ali *et al.* (2005).The incidence of Rh blood group in most of the part of India varies from 94 to 98 % were Rh+ve and 2 to 6% were Rh-ve whereas in our study 84.81% were Rh+ve and Rh-ve were 15.19%. Other studies done by Rajshree and Raj, (2013) which is dissimilar to our result, there was higher prevalence of Rh-ve than Rh+ in Western Rajasthan. Other studies by Mollison *et al.* (2005) in USA which is similar to our study 85% were Rh+ve and 15% were Rh-ve.

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusion

The result showed that the Right Hand clasper , right handedness, straight hair line shape, non-freckles, absence of cheek dimple, the ability to tongue rolling, the absence of mid digital hair, straight thumb and straight little finger were highly frequent traits in the three groups. Right Hand clasper, the ability to tongue rolling and free ear lobe attachment were high in male than female while straight thumb, straight hair line shape and absence of mid digital hair were high in female. Hand clasping, handedness, cheek dimple, mid digital hair, hitchhiker's Thumb, little finger and ear lobe attachment were significantly associated with ethnicity while others were not associated. There was a significant association between gender and tongue rolling, mid digital hair as well as hair line shape, the others were not associated. From the findings of this study, that people within in Awi and Amhara have high prevalent of blood group O and blood group B in Negede while AB blood group was lowest in all ethnic groups. Most prevalent morphogenetic trait (Right Hand clasper , right handedness, straight hair line shape, non-freckles, absence of cheek dimple, the ability to tongue rolling, the absence of mid digital hair, straight thumb and straight little finger) were associated with blood group O in Awi and Amhara while blood group B in Negede respectively. There was a significant association between hand clasping and ear lobe attachment with ABO blood groups phenotype while other traits were not significantly associated with ABO blood group phenotypes. Rhesus positive phenotype individuals were more prevalent than rhesus negative in all ethnic groups.

6.2. Recommendation

This study forms the basis for genetic counseling in relating to Hemolytic Disease of newborn babies that make create awareness for female respondents about the consequence of Rh negative phenotypes. It may use as genetic marker, that means if an individual with more frequented one traits with one blood groups and also for forensic pathology, anthropological or cultural researches, clinical practice, and other related measured disciplines. Further studies with large sample size at different places are more recommended to get an accurate result.

References

Abayomi, A. (2014). Genetic and morphological traits among the Binis *International Journal of Current Research, 6*(11), 10222-10227.

Abdullah, S.M. (2010). Frequency of ABO and Rh blood groups in the Jazan region of Saudi Arabia. *Pak J Med Sci, 26*(4), 818-821.

Al-Himaidi, A.R. and Umar, m. (2002). ABO blood group distribution among Saudi citizens related to their regional and original tribal location. *Kuwait JSc Eng, 11*, 75–81.

Ali, N., Anwar, M., Bhatti, F.A., Nadeem, M., Nadeem, A. and Ali, A.M. (2005). Frequency of ABO and Rh blood groups in major ethnic groups and casts of Pakistan. *Pakistan journal of medical sciences*, 26-29.

Anibor, E., Edjomariegwe, O. and Ajayi, A. (2014). Genetic and Morphological Traits among the Binis. *International Journal of Current Research.*, *6*(11), 10222-10227.

Boskabady, M.H., Shademan, A., Ghamami, G. and Mazloom, R. (2005). Distribution of blood groups among population of the city of Mashhad (North East of Iran). *Pak J Med Sci Q*, *21*(2), 194–198.

Census. (2009). *Population and Housing Census of Ethiopia: Results for Amhara Region*.

Connie, W.M. (2007). *The structure and function of the Rh antigen complex.* Paper presented at the Seminars in hematology.

Cvjeticanin, S. and Marinkovic, D. (2005). Genetic Variability in the Group of Patients with Congenital Hip Dislocation. *Russ. J. Genet, 41*(8), 936–940.

Daponte, A.P., Vienna, A., Brant, L. and Hauser, G. (2004). Cheek dimples in Greek children and adolescents. *International Journal of Anthropology*, *19*(4), 289-295.

Das, P. K., Nair, S. C., Harris, V.K., Rose, D., Mammen, J.J., Bose, Y.N. and Sudarsanam, A. (2001). Distribution of ABO and Rh-D blood groups among blood donors in a tertiary care center in South India. *Trop Doct*, *31*(1), 47-48.

Dennis, E.O. (2017). Morphogenetic Traits in Eight South Nigerian Ethnic Groups.

Farhud, D., Yeganeh, D. and Zarif, M. (2013). A brief history of human blood groups. *Iranian journal of public health, 42*(1), 1.

Frazer, K.A., Murray, S.S., Schork, N.J. and Topol, E.J. (2009). Human genetic variation and its contribution to complex traits. *Nature Reviews Genetics, 10*(10), 241–251.

Gadwalkar, S.R. and Kumar, N.S. (2013). Distribution of blood groups in and around Bellary, Karnataka. *Ind. Jour. Clin. Prac, 24*(3), 247–250.

Glass, B. and Kistler, J.C. (1953). Distal hyperextensibility of the thumb. *Acta Geneticaet Statisca Medica, 4*, 192-206.

Gruswitz, F., Chaudhary, S., Schlessinger, A., westhoff, C.M. and Stroud, R.M. (2010). Function of human Rh baed on structure of antibodies. *Proceedings of the national academy of science*.

Hedrick, W.P. (2005). *Genetics of Populations* (3rd ed.). ed.): Jones and Bartlett Publishers.

Henry, A. and Yehoash, J.R. (1996). New hair cells arise from supporting cell conversion in the acoustically damaged chick inner ear. *Neuroscience letters, 205*(1), 17-20.

Jaff, M.S. (2010). ABO and rhesus blood group distribution in Kurds. *Journal of blood medicine, 1*, 143.

Jaleel, B.F. and Nagarajappa, R. (2012). Relationship between ABO blood groups and oral cancer. *Indian J. Dent, 23*, 7-10.

Jaswant, S. and Sarthak, S. (2004). Some morpho-genetic and behavioural traits among the Assamese Sikhs. *The Anthropologist, 6*(4), 253-255.

Keyban, Seid Omid. (2012). Dimple Creation Surgery Technique: A Review of the Literature and Technique Note. e403–e407.

Kirner, J. (1972). Doppelseitige Verkrummungen 19. des Klein fingerendgliedes als selb standiges Krankheitsbild. *Fortschr Geb Rontgenstr, 36*(804).

Klein, H.G. and Anstee, D.A. (2005). Mollison's Blood Transfusion in Clinical Medicine. *Blackwell Publishing, London, 13*, 912.

Kooffreh, M.E., Ikpeme, E.V. and Ekerette, E.E. (2015). Evaluating the Prevalence of Five Genetic Traits of Simple Inheritance in Association with the Distribution Pattern of ABO and Rhesus Phenotypes among Families in Calabar, Nigeria. *Journal of Medical Sciences, 15*(4), 185.

Krishna, M.C., Sharadha, M.S., Hulinaykar, R.M. and Harish, S.G. (2014). Frequency and distribution of ABO and Rhesus (D) blood groups in and around Tumkur,

Karnataka, Study from Teritiary Care Teaching Hospital. *International Journal of Healthcare Sciences, 2*(1), 135-139.

Landouzy, L. (1906). Camptodactylie Stigmateorganiqueprécoce du neuro-arthritisme. *La Presse Medicale, 14*, 251-253.

Levy, J. and Nagylaki, T. (1972). A model for the genetics of handedness. *Genetics, 72*(1), 117-128.

Lögdberg, L., Reid, M.E., Lamont, R.E. and Zelinski, T. (2005). Chromosomal locations and cloning strategies. *Human blood group gene, 19*, 45–57.

Mallikarjuna, S. (2012). Prevalence of ABO and Rhesus blood group among blood donors. *Indian J. Pub. Health, Research and Development, 3*(2), 106-109.

Mollison, P.L., Engelfriet, C.P. and Contreras, M. (2005). ABO, Lewis and P groups and Ii antigens. *Transfusion in Clinical Medicin*, 114-125.

Mortazavi, H.S., Hajian, E., Fadavi, V., Baharvand, M.S. and Bakhtiari, S. (2014). ABO blood groups in oral cancer: A first case-control study in a defined group of Iranian patients. *Asian Pac. J. Cancer Prev, 15*, 1415-1418.

Munir, S., Sadeeqa, A., Nergis, B., Tariq, N. and Sajjad, N. (2015). Assessment of Morphogenetic Inherited Traits; Earlobe Attachment, Bent Little Finger and Hitchhiker's Thumb in Quetta, Pakistan. *World Journal of Zoology, 10*(4), 252-255.

Naz, G., Hameed, F., Bibi, Z., Khatoon, D. and Sajjad, N. (2014). Hairline shapes: study of a morphogenetic inheritance trait. *Pak. J. Biochem. Mol. Biol, 47*(1-2), 118-120.

Nusbaum, B.P. and Fuentefria, S. (2009). Naturally occurring female hairline patterns. . *Dermatol Surg, 35*, 907-913.

Nwaopara, A.O., Anibeze, C.I.P., Apkuaka, F.C. and Agbontaen, O.F. (2008). Morphogenetic traits combination pattern amongst the population of Ekpoma, Nigeria: Focus on tongue rolling, ear lobe attachment, blood groups and genotypes. *African Journal of Biotechnology, 7*(20).

Odokuma, E.I., Otuaga, P.O., Obaseki, D.E. and Ejebe, D. (2011). A study on hand clasping traits in an African population. *Scientific Research and Essays, 6*(7), 1692-1693.

Onyije, F.M. (2012). Assessment of Morphogenetic Trait of AEL and CRT in Relation to Hb Genotype. *World Applied Sciences Journal, 20*(9), 1213-1215.

Onyije, F.M., Oyinbo, C.A. and Waritimi, E.G. (2012). The prevalence and comparison of bent little finger and hitchhiker's thumb in South-South Nigeria. *Eur J. Appl. Sc, 4*(4), 157-159.

Ordu K.S., Didia B.C. and Egbunefu, N. (2014). Inheritance Pattern of Ear lobe Attachment amongst Nigerians. . *Greener Journal of Human Physiology and Anatomy, 2*(1), 001-007.

Özyurt, K., Öztürk, P., Gül, M., Benderli, Y.C., Çölgeçen, E. and Inci, R. (2013). ABO blood groups, Rhesus factor, and Behçet's disease. *Alpina, Pannonica et Adriatica, 22*(10), 63-64.

Periyavan, A., SangeethaS, K., Marimuthu, P., B, K Manjunath. and Seema. (2010). Distribnution of ABO and Rhesus-D, groups in and around Bangalore. *Asian J Transfus Sci, 4*(1), 41.

Petricevica, B. and Cvjeticanin, S. (2011). Morphogenetic Variability and Handedness in Montenegro and Serbia. *Russian Journal of Genetics,, 47*(3).

Pooja, C. and Sandeep, K.S. (2013). A study on distribution of morphological, behavioral and serological traits in three endogamous groups of scheduled castes in jammu and kashmir. *2*(1), 47-50.

Rajshree, B. and Raj, J.Y. (2013). Distribution of ABO blood group and RH (D) factor in Western Rajasthan. *Natl J Med Res, 3*(1), 73-75.

Singh, L., Goel, K.V. and Mahendru, P. (1979). Tongue-folding and rolling, arm-folding and ear lobe among Khatris and Baniyas of Patiala. *Indian Anthropologist, 9*(2), 135-138.

Sturtevant, A.H. (1940). A new inherited characters in man. *Proceed. Natl. Acad. Sci. V.S., 26*, 100-102.

Tadesse, H. and Tadesse, K. (2013). Assessing the association of severe malaria infection and ABO blood groups in northwestern Ethopia. *Vector Borne Dis, 50*, 292-296.

Uphaday-Dhungel, K., Banskota, G.N., Das, P.K. and Sohal, A. (2013). Distribution of ABO and Rh blood groups in Nepalese medical students. *Janaki Medical College Journal of Medical Science, 1*(2), 17-20.

Vinutha, B., Shashikala, P. and Kavita, G.U. (2018). Frequency and Distribution of ABO and Rhesus Blood Groups in Women of a Degree College. *RGUHS Journal of Medical Sciences, 8*(1), 21-24.

Wang, L., Dong, J., Yang, C. and Xi-Shan, X. (2007). Mechanisms for macro segregation freckles and their criteria. *Zhuzao Jishu(Foundry Technology), 28*(5), 585-589.

Westlund, N., Oinonen, K.A., Mazmanian, D. and Bird, J.L. (2015). The value of middle phalangeal hair as an anthropometric marker: A review of the literature. *HOMO-Journal of Comparative Human Biology, 66*(4), 316-331.

Wolpin, B.M., Chan, A.T., Hartge, P. and Chanock, S.J.K. (2009). ABO blood group and the risk of pancreatic cancer. J. Natl. *Cancer Inst, 101*, 424-431.

Yamamoto, F., Patricia, M.D., Yamamoto, M., Hakomori, S., Harris, T., Judd, J.W. and Davenport, R.D. (1993). Molecular genetic analysis of the ABO blood group system: 1. Weak subgroups: A^ 3 and B^ 3 alleles. *Vox sanguinis, 64*, 116-119.

Appendix 1:- Data Collection Sheet

Date: ……

Sample Code: …….....

A. General Information

1) School ……
2) Birth Place: Town/Village ……..…Zone: …….Region: ……
3) Age ……
4) Sex: Male ☐ Female ☐
5) Ethnicity:
   I. Agew-Awi ☐
   II. Negede ☐
   III. Amhara ☐
   IV. Other (Please specify): _____
6) Mother tongue language
   I. Amharic ☐
   II. Awigna or Agewgna ☐,
   III. Other ----------

B. Data Sheet for Blood Groups

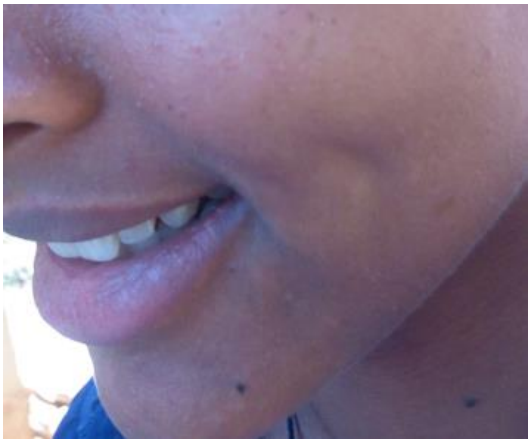
1) ABO blood group system:
   i. Group O
   ii. Group A
   iii. Group B
   iv. Group AB
2) Rh blood group system
   i. Rh positive
   ii. Rh negative

C. Morphogenetic Trait

No	**Morphogenetic Trait**	**Your Phenotype**	
1	Hand Clasping	Left over Right (D)	Right over Left (R)
2	Handedness	Right- handed (D)	Left-handed (R)
3	Hairline	Widow's Peak (D)	Straight (R)
4	Cheek dimple	Dimpled (D)	Non dimpled (R)
5	Freckles	Freckles (D)	No freckles (R)
6	Tongue Rolling	Tongue Roller (D)	Non Tongue Roller (R)
7	Mid-Digital Hair	Mid-Digital Hair (D)	No Mid-Digital Hair (R)
8	Hitch-Hiker Thumb	Thumb – Straight (R)	Thumb – Bent (D)
9	Little Finger	Bent (D)	Straight (R)
10	Ear lobe attachment	Free Ear Lobes (D)	Attached Ear Lobes(R)

D=Dominant; R=Recessive

Appendix 2:- Photos showing morphogenetic traits, A, B: cheek Dimple pattern, C, D: hair line shape; E, F: hand clasping type; G, H: tongue rolling; I, J: hitch-hiker thumb; K, L: little finger pattern; M, N: Ear lobe pattern

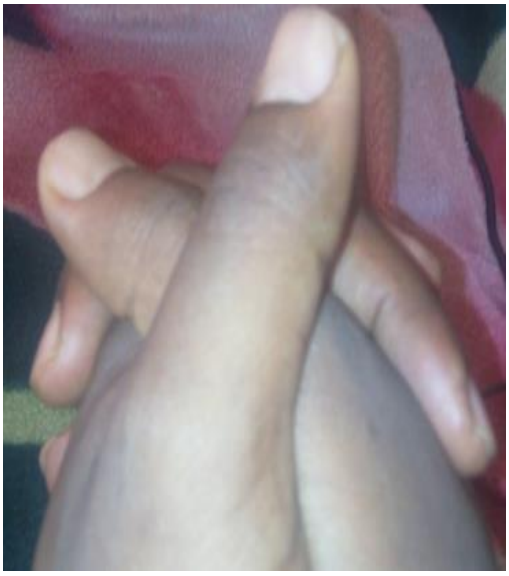


(A)Cheek dimpled

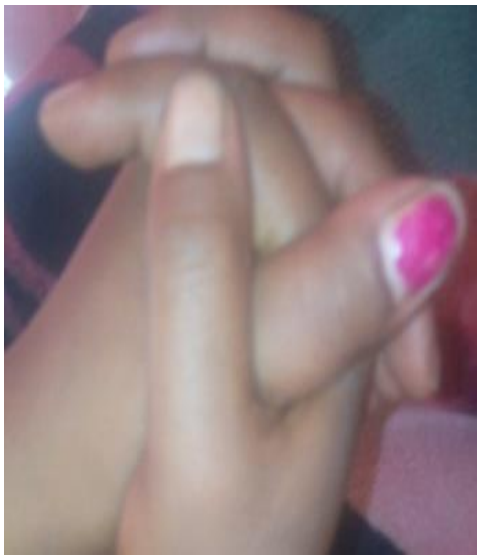
(B) non cheek dimpled

(C) Straight

(D) widow's peak

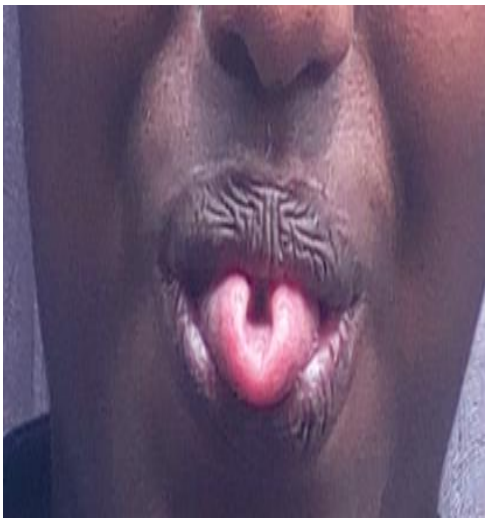


(E) Left over right

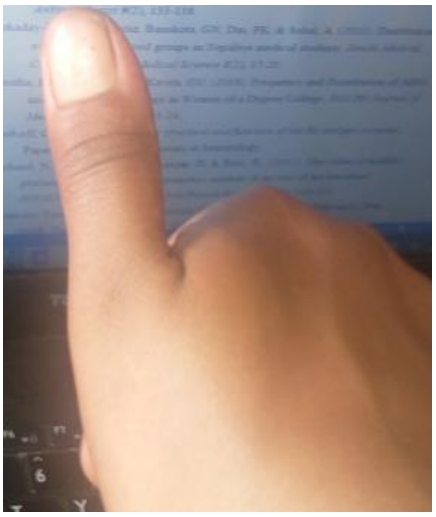


(F) Right over left

(G) Not tongue rolling



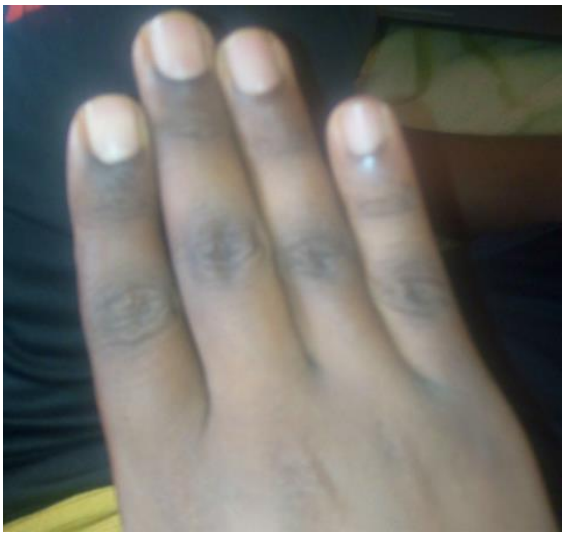
(H) Tongue roller



(I) Thumb straight

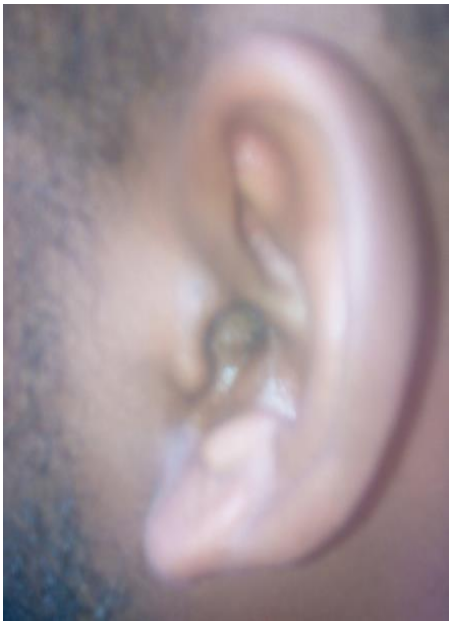
(J) Thumb bent

(K) Bent little finger



(L) Straight little finger

(M) Attached ear lobe



(N) free or unattached ear lobe