



Saint Paul's Hospital Millennium Medical College Department of Forensic
Medicine and Toxicology

Evaluation of pattern of skeletal maturity of pelvic girdle bone among 8-19
years children and adolescent with known chronological age using X-ray

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Evaluation of the pattern of skeletal maturity of pelvic bone among 8 to 19 years old children and sub adults from schools with known chronological age using X-rays,
Addis Ababa, Ethiopia, 2022 G.C

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Abstract

Background: Age, Sex and Stature constitutes the three primary characteristics of identification .Age -refers to the length of time that a person has lived or thing has existed. It is a very important task assigned to forensic experts particularly in legal matters where criminal responsibility has to be considered to impose punishment or to grant privileges of civil rights according to the age group of the claimant. Bones constantly undergo changes and those changes that occur in the skeleton would follow a chronological pattern .The pelvic girdle has different ossification centers. From these centers, ossification progresses till the bone is completely formed. Radiological study was carried out with the objective to assess the general skeletal maturity around pelvic girdle age group of 8-19 years were selected , subjects in Addis Ababa, Ethiopia. The cases were selected after ruling out the nutritional, developmental, and endocrinal abnormality which affects the skeletal growth.

Objective

To establish standards based on pattern of skeletal maturity pelvic girdle bones by using X- ray among 8-19 years old children and adolescent Addis Ababa, Ethiopia.

Methods and materials

The study was conducted from September 1, 2023; to November30, 2023 in the department of FMT, SPHMMC A.A Ethiopia 150 subjects were selected by non-probability convenience sampling from various A.A schools. Data was collected and coded by using SPSS23 software for analysis. Descriptive statistics demonstrating the percentiles, means and standard deviations were calculated according to stage of fusion among age and sex of study participants. Chi-square test of independence was used to see association between categorical variables. Independent sample t-test was used to see difference in skeletal maturity of pelvic girdle between Male and Female study participants. Data will be presented by using graphs, charts and tables.

Result:

A total of 150 study participants (94 Male and 56 Female) were included to study appearance and fusion of iliac crest, femoral head, ischia tuberosity, and ischia-pubic ramus, greater and lesser trochanter. The study was conducted by department of Forensic Medicine and Toxicology, SPHMMC, Addis Ababa, Ethiopia. The study participants were taken from two schools, date of birth was confirmed from their birth certificate.

Iliac crest: All cases in the age range 8-11 years ossification center for iliac crest did not appear. Majority of cases ossification center for iliac crest appear age group of 15 – 16 years for male and age group of 14 – 15 years for female. Complete fusion started to seen at age range of 17-18 years in female and 18-19 years males respectively.

Ischia tuberosity: Ossification center for ischia-tuberosity appearance in age group of 16–17 years in male and in age group of 14 –15 years respectively. Majority of the male study participants complete fusion in the age range of 18-19 years. Majority of female cases are in complete fusion in the age of 18-19 years.

Femoral head: In age range of 11-12 years all cases of female showed partial fusion. All male subjects at age range of 9-14 years showed partial fusion. All cases showed complete fusion in age range of 17-18 years.

Tri-radiate cartilage: Majority of the female cases in age group of 8-11 years tri-radiate cartilage partial fusion. In majority of female cases complete fusion in age range of 12-13 years. In majority of male cases complete fusion in age range of 15-16 years. All cases in the age of 16-17 years complete fusion.

Greater trochanter: In majority of males complete fusion seen in the age group of 16-17 years. All males showed complete fusion at age range of 17-18 years. Complete fusion started to seen age range of 14-15 years for female cases. All females showed complete fusion at age group of 16-18 years. All cases complete fused age range of 17-18 years.

Lesser trochanter: In all male cases age group of 12-13 years ossification center for lesser trochanter appeared. In female cases age group of 11-12 years ossification center for lesser trochanter appeared. All male cases complete fusion in age group of 17-18 years. All female cases complete fusion in age group of 16-18 years. All cases complete fusion at age group of 18-19 years.

Ischia-pubic ramus: Majority of male cases in age group of 9-16 years complete fusion. Complete fusion in majority of female cases in the age group of 8-15 years. All female cases complete fusion age of 16-17 years. All cases complete fused at age range of 16-17 years.

Conclusion: From the present study we can conclude that the earliest appearance of epiphyseal iliac crest observed in both sex between 12–13 years. Latest appearance of epiphyseal iliac crest observed at age range of 16--17 year and age range of 14-15years in male and female respectively. Complete fusion started to seen at age range of 17-18years in both sexes. The ossification center for ischia-tuberosity observed at age range of 12–13 years in males and at age range of 14-15 years in females whereas complete fusion seen in age range of 14-15 years for females and 17-18 years for males. The complete fusion of femoral head occurs in the age of 15 to 16 years in females and 16 to 17 years in males. The complete fusion of greater trochanter occurs in the age of 14 to 15 years in females and 16 to 17 years in males. The ossification center for lesser trochanter appear in age range of 11-12 years in females and age range of 12-13 years in males whereas complete fusion at age range 12-13years in females and at age range of 16-17years in males. In observation from present study all ossification and fusion in cases of female early than male cases.

Key Words: Age estimation, Fusion, pelvis girdle bone, Radiographs.

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List of acronyms and abbreviations

AA	Addis Ababa
CI	Confidence Interval
AE	Age estimation
FMT	Forensic Medicine and Toxicology
IRB	Institutional Review Board
ML	Medicolegal
OR	Odds Ratio
OC	Ossification Center
SPHMMC	Saint Paul's Hospital Millennium Medical College
SPSS	Statistical Package for Social Science

Introduction

Background

Age, Sex and Stature constitutes the three primary characteristics of identification. Age is one of the identification parameter in the determination of the individuality of a person living or dead (3, 6). Physical, sexual, skeletal, and dental maturity indicators are frequently used for age estimation (4). Age refers to the length of time that a person has lived or thing has exist. Chronologic age is the time elapsed since birth, which calculated using the date of birth of an individual. Biologic age is a degree of maturation of a person's bones (14).

Pelvic girdle is bony structure that connects the spine and lower limbs while supporting and balancing the torso (4). The bones of human skeleton develop from separate ossification centers. The appearance and fusion of various epiphyses occurs at a definite order and period of time in life with minor variations and the correlation between age and timing of epiphyseal Centre can be used to establish age. Determination of the age of an individual from the appearance and the fusion of the ossification centers is a well-accepted fact in the field of medical and legal professions (1, 3).

Estimation of reasonably accurate age, plays an important role in civil and criminal cases like personal identification, fixing of criminal responsibility, judicial punishment i.e. in cases of rape, kidnapping, criminal abortion, attempted or evident murder, theft, burglary, dacoity and employment, attainment of majority, marriage contract. In most countries, the 14th, 16th, and 18th years of life are relevant age thresholds for legal assessment. Radiological examination of the bones helps in analyzing these changes (2, 5, and 13). Therefore, it is possible to estimate the approximate age of an individual by using X-ray, CT scan and MRI examination of the

bones till ossification process is complete. These changes can be studied by means of X-rays and considered as most easily available and affordable methods.

The seven ossification centers investigated in present study are femoral head, greater trochanter, lesser trochanter, iliac crest, ischial tuberosity, tri-radiate cartilage and ischio-pubic ramus bones in the pelvic girdle bones (15). This study involves radiological examination of Pelvic girdle (AP view) of age skeletal maturity of pelvic girdle bones in the individuals age group of 8-19 years.

Statement of the problem

Age determination in live individual with no valid proof of date of birth; make age assessment an important and vital tool to undertake for accurate estimation of age. It is a very important task assigned to forensic experts particularly in legal matters where criminal responsibility has to be considered to impose punishment or to grant privileges of civil rights according to the age group of the claimant (2).

It has generally been accepted that bone maturity is affected by racial, socio-economic and nutritional factors (Crawley et al., 2007). Current age estimation using skeletal maturity is based on the standards developed by Asians and westerns.

Thus, applicability of the available standards to populations which differ from their reference population is often questioned. Hence, the main purpose of conducting the present study is to establish reliable standards by using pelvic girdle radiograph suitable for our region.

Significance of the study

Age determination is the most important issue to the court. In developing countries, age estimation becomes problematic due to the ignorance of the public towards the importance of registration of births. In Ethiopia, so far, no single published research was done on determination of age using X-ray studies of pelvic girdle maturity

Age estimation required in criminal and civil law suits, childhood marriages and competitive sports. In law the crime and punishment are partly based on criminal responsibility and this is in turn dependent on the age of the person (1).

In the modern society, crimes committed against children and by children are increasing. It is essential to establish the identity of a person at the time of admission to schools, colleges, institutes, or while competing in sports tournaments at regional, state or national levels(5).It is also important while taking consent or in cases relating to juvenile offenders, rape, kidnapping, employment in government competency as a witness, attainment of majority, marriage, fixation of criminal responsibility, etc. (Bokariya et al., 2010).

In Ethiopia civil and family Code, Art. 198 a minor is a person of either sex who has not attained the full age of eighteen years. Art. 272under sub art-3. Work of minor, from the age of fifteen years onwards, the minor himself shall receive the income deriving from his work. Article- 7, age neither a man nor a woman who has not attained the full age of eighteen years shall conclude marriage and (art. 89) children between 14 and 18 years of age are categorized as young workers and the Proclamation provides that this category of children can work under strict conditions. In Ethiopia criminal codes Article 56-Criminals Over Fifteen but Under Eighteen Years of Ages are criminal minority (15 years) to legal majority (18 years).Therefore, this study is aimed at establishing a reliable age reference standards for the proposed age groups (8-18 years) and population which will enable health professionals who are mandated to do age

determination by using this reference so that their estimation/determination will be more reliable than before which was determined using European or Asian reference standards.

Hence, the main purpose of conducting the present study is to establish reliable standards by using pelvic girdle x ray suitable for our country.

Literature review

Study done in grants medical college, J.J hospital Mumbai, India. 99 males' age group of 9-25 years old and 76 female's age group of 3-24 years old were selected. Uses Dr. Sangma et al, Mckern and Stewart's method for crest ilium and ischia tuberosity appearance (A) and non -appearance (NA) and different phases of fusion. These are Stage1, Non- union, Stage 2, (1/4th unite), Stage 3(Incomplete union 1/2 united), Stage 4(Complete union 3/4 united) and Stage5 (Complete union) with absence of epiphyseal scar. The obtained result show epiphysis of crest of ilium appears at 15–16 years old and fused at 21–22 years old in majority's cases in males and appears 14-15 years and fused, 20-21 years in females respectively. Epiphysis of ischial tuberosity appears at 16-17 years old and fused at 21–22 years in males. Appears at 15-17 years and fused at 20-21 years in females respectively. These findings are close to study carried out by Galstaun, and Parikh because both studies are done in India and for ischia tuberosity complete union was seen at 21 to 22 years for both males and females (1).

Study conducted in Southern Punjab Population from January 2019 to May 2020. A series of 100 patients having chronological age of 13— 15 years (50 males and 50 females) were included in this study. Obtained results show that in male children epiphysis of iliac crest have appeared in, 12 children at the age between 13—14 years and in 11 children up to the age of 15 years. In case of female children epiphysis of iliac crest has appeared in 13 children at the age between 13—14 years and in 05 children up to the age of 15 years. Ischial Tuberosity has appeared in male children at the age between 13—14 years and female children epiphysis has appeared in 18 children at the age between 13—14 years (14)

Another study done demonstrated that earliest appearance of epiphysis center of ischeal tuberosity occurred a 12—13 years in male and 10—11 years in females, while the latest appearance was observed at the age of 21—22 years in females and 22—23 years in male. The complete union of center of ossification was observed earliest at the age of 19—20 years in females and 16—17 years in males (6).

In another study done demonstrated that epiphysis of crest of ilium appeared at 15—16 years in males and 14—16 years in females and epiphysis of ischeal tuberosity appeared at 16—17 years in males and 15—17 years in females. Epiphysis of crest of ilium fused in most of the cases at 21—22 years for males and at 20—21 years for females and ischeal tuberosity fuses at 21—22 years in both sexes (2).

Study done at Bahawalpur Victoria Hospital, a tertiary referral center, in Pakistani, 47 females and 121 males between 10 to 24 years of age, attending the outpatient were selected to study variation in age of fusion of ischial tuberosity. The study was done using standard radiographic technique for pelvis in anteroposterior view with supine position. Ischial tuberosity on radiographs was studied for different stages of union.

Stage	Status of epiphyseal centres and fusion	Grade
I	Epiphyseal centre not appeared	A
II	Epiphyseal centre appeared	+
III	Partial union with visible gap/line	++
IV	Complete fusion with no visible line	+++

In this study, In present study in males' majority of cases show epiphyseal Ischial tuberosity appearance in between 16–17 years age group and in females in between 15 –17 years age group (1).

Age estimation among adolescent individuals from fusion of tri-radiate cartilage study was carried out in 120 healthy subjects (60 males and 60 females) aging from 12 to 18 years individuals from Nagpur city in Central India. X-rays of tri-radiate cartilage, AP & lateral views were taken & five different stages of union were graded. In males, Triradiate cartilage shows: commencement of fusion in 12 (20%) cases in age group of 12-14 years, Incomplete fusion in 9 (15%) cases in age group of 13-15 years, complete fusion with epiphyseal scar in 14 (23.33%) cases in age group of 13-16 years & complete fusion without epiphyseal scar in 25 (41.66%) cases in age group of 15-18 years. Complete fusion is seen in all the subjects in age group of 16-18 years. In females, tri-radiate cartilage shows: non fusion in 3 (5%) cases in age group of 12-14 years, commencement of fusion in 19 (31.66%) cases in age group of 12-15 years, Incomplete fusion in 6 (10%) cases in age group of 14-15 years, complete fusion with epiphyseal scar in 5 (8.33%) cases in age group of 14-16 years & complete fusion without epiphyseal scar in 27 (45%) cases in age group of 15-18 years. Complete fusion is seen in all the in age group of 16-18 years. The union at tri-radiate cartilage in both males & females is completed in all instances (100%) at the age of 16-17 years (7).

Study conducted in Adapazari Turkey, August 4, 2021 to March 24, 2022 age group of age 8–16 years and data collected retrospectively and radiologists retrospectively reviewed the images evaluated as follows: 0: open, 1: semi-closed, and 2: closed . Total of 118 girls and 145 boys were included in study age estimation performed by examining ischia-pubic, computed tomography images. Result shows the ischia-pubic generally open in girls who are 8–9 years old and all closed at the ages of 14–16 years old. In all the children aged from 15–16, there were closed ischia-pubic- there was no closed ischia-pubic for children age 11 and below (16).

Study conducted in Shridevi Institute of Medical Sciences and Research Centre, Tumkur, Karnataka , Indian Age assessment and comparative analysis of age assessment method in children age 12-14 years by dental and radiologic examination, in assess the age of 100 school going children based on radiological examination of Hip Joint and second molar eruption age between 12 – 14 years prospectively selected The lesser trochanter was also appeared in all the study subjects and about 64% and 36% of females in age group 13 – 14 years and 12 – 13 years showed reduction in epiphyseal –diaphyseal space (Grade -2) in comparison to 12% males in both the age groups. Thus one can conclude from the above table that appearance and fusion of the epiphyses occur early in females

compared to males(17)

Variation in the age of fusion of ischa-tuberosity a radiological , study done by H. Siddiqi, S.Nisar*, N,W, ahawalpur Victoria Hospital, Bahawalpur –Pakistan, cross sectional study used, age between 10 to 24 years of age were elected total 47 females and 121 males. Ossification center for ischia-tuberosity appearance of in males occurred at 12-13 years and in females at 10-11 years. Complete union was seen at the age of 19–20 years in females and 16–17 years in males. All cases in age group of 23–24 years showed complete union(4)

Radiological Study of Appearance and Fusion of Iliac Crest in hip bone in Bikaner Region in 14-22 Years Age Group, this study involves radiological examination of Pelvis (AP view) of 169 individuals for the study of age related appearance and fusion of ossification center of Iliac Crest in the individuals of age group of 14-22years of both male and female in S P Medical college, Bikaner, Rajasthan in males, the appearance of the ossification centre of iliac crest was observed in 100% of cases in age group 15-16 years and in female age group of 14-15 years of age. Complete fusion of iliac crest was observed in 100% of cases in age group of 20-21 years in males and In our study we observed the average age of fusion of the ossification centre of iliac crest in females at 19- 20 years (13).

Study conducted in Anantapuram, Andhra Pradesh, India, age estimation among 12-18 Years Children by the Ossification Centers of Hip Joint and Pelvis, total of 72 patients were selected from various schools and colleges at Radiology department, X-ray of hip joint and pelvis of studied population was taken to study. Result Triradiate cartilage ossification appeared in the age group of 12-13 years in most of the children, recent union observed mostly in the age group of 14-15 years. Ischial tuberosity appears by 15-16 years and fusion of epiphyseal center shown by 17-18 years. Iliac crest appeared in males and females by 13-14 years and completes its appearance by 15-16 years in females and 16-17 years in males. Pubis appeared by 13-14 years and completed by 16-17 years in both males and females(5)

Ossification center for femoral head, greater and lesser trochanter appears 1 year, 4 year and 12-14 years respectively and fused with respective shaft at age of the 17-18 years. Ossification center for iliac crest appears at age of 14 years and fused with respective shaft at 18-20 years. Ossification center for ischial tuberosity appears at age of 15-17 years and fused with respective shaft at age of 19-21 years (Krishan V, 2011, P-61).

Ossification center for femoral head, greater and lesser trochanter appears 1 year, 4 year and 12-14 years respectively and fused with respective shaft at age of the 17-18 years. Ossification center for iliac crest appears at age of 14 years and fused with respective shaft at 20-21 years. Ossification center for ischial tuberosity appears at age of 16 years and fused with respective shaft at age of 20-21 years (Dr. K.S. Narayan R, 2014, P-81)

Objective

General objective.

To establish age reference standards by evaluating patterns of skeletal maturity of pelvic girdle bones by using X- ray among 8-19 years old children and adolescent, Addis Ababa, Ethiopia

Specific objectives

- To determine time of appearance and degree of fusion of the bones constituting the pelvic girdle
- To compare skeletal maturity of bones constituting pelvic girdle in boys and girls.
- To compare final result with some of the standard textbook that have being used as references for age estimation in the department.

Methods and materials

Study design and study period

The study was carried out involving children and adolescent of school students of age group 8 to 19 years at A.A Schools nearest to the SPHMMC Dept. of Forensic Medicine, Addis Ababa, Ethiopia over a period of 3 months from September 1, 2023 to November 30, 2023.

Description of study area

Ethiopia, officially the Federal Democratic Republic of Ethiopia, is a landlocked country in East Africa. It shares borders with Eritrea to the north, Djibouti to the northeast, Somalia to the east, Kenya to the south, South Sudan to the west and Sudan to the northwest. With over 109 million inhabitants as of 2019, Ethiopia is the 12th most populous country in the world and the second most populous nation on the African continent (after Nigeria).

Its capital and largest city is Addis Ababa, which lies several kilometers west of the East African Rift valley with an estimated population of 7.1 million people in 2019 and located on 9°1'48"N38°44'24"E coordinates.

Located in the capital city is the Saint Paul's Hospital and Millennium Medical College which is a tertiary referral and teaching hospital directly under the ministry of health. The hospital gives service to an average of 300,000 people annually with a catchment population of more than 5 million. There are over 13 departments which include FMT and the hospital gives service under different clinical disciplines which include age estimation conducting about 600 age estimations per year.

Target or reference population

All children and adolescent age group 8-19 years old in A.A, Ethiopia.

Source population

All children and adolescent age group 8-19 years old and who are in particular schools in A.A during the period of the study.

Study population

All children and adolescent who was voluntary and fulfill inclusion criteria ages group of 8-19 years during the study period in A.A schools.

Eligibility criteria

Inclusion criteria

- All voluntary children and adolescent who provided documentary evidence of their chronologic age those were found in Addis Ababa schools age between 8-19 years during the study period

Exclusion criteria

- All children and adolescent subjects suffering from any chronic illness, congenital bony deformities, foreign nationals and children of foreign nationals.
- Chronic drug intake that may interfere with bone growth directly or indirectly, fractures of Pelvic bone and recent or old and pregnant women.

Sampling technique and sample size

The schools were selected by non-probability convenience which is in Gulele sub-city or near St. Paul's hospital. After that stratified random sampling method was used; the samples were stratified into genders and specific age groups. The minimum required sample size was calculated using single population proportion formula.

$$n = (Z_{\alpha/2})^2 * p * (1-p) / (MOE)^2$$

Where=desired sample size $Z_{\alpha/2}$ =critical value at 95% confidence level of certainty=1.96

P=the proportion of radiography mean value measurement=50%

MOE=margin of error=5% Thus $(1.96 \times 1.96)0.5(1-0.5)/0.05 \times 0.05 = 0.9604/0.00025 = 384$.and contingency of 10% which is 38 will be kept, making the total sample size 422.

Data collection method and Study instrument

Chronological ages of the children were taken from birth certificate and immunization notification. The subjects were subjected to the X-ray examination of the pelvic girdle at the Department of Radio diagnosis and Imaging. The X-rays of the pelvic girdle was taken in anterior- posterior (AP) view. From the digital x- ray machine the images were automatically saved and taken via phone. The radiograph films were collected from the technicians and were viewed.

Study variables

Dependent variables

Skeletal maturity of the pelvic girdle bones.

Independent variables

Age, sex, address

Data processing and data quality

Data entry was done by using Statistical Package for Social Sciences (SPSS) version 23. Data was cleaned with consistence checks and analyzed using the same SPSS package. Any errors identified at this time were corrected after revision of the original data using the code numbers. In order to maintain the quality of the data, i was work along with at least 2 Forensic medicine and toxicology seniors for reading of the X-rays that are taken by radiology technicians because these seniors are used to reading such data and are well aware of the short comings in determination of age. The data analysis using the same SPSS package was carried out after appropriate data entry task was completed.

Data analysis

Data analysis was performed using the SPSS statistical software (version 23) to evaluate overall skeletal maturity. The results of all the analyses were summarized and then were compared. Significance will be set at $\alpha = 0.05$. Finally, the finding was presented by using tables and graphs as appropriate.

Ethical consideration

The study was started after approval from Saint Paul's hospital and Millennium Medical College Institutional Review board (IRB). Information used in this study was anonymized. AE numbers were assigned to individual cases, and the information was kept confidential from other parties excepting the investigating authorities.

Dissemination and utilization of results .After finalizing the research, the result will be presented as part of final year dissertation paper for SPHMMC's post graduate committee. Additionally, the study result will be disseminated to forensic experts who serve in the other departments which carry out medico legal age estimations and academic partners working on this area, further attempt will be made to publish it on national and international scientific journals.

RESULTS

5.1 Characterization of study participants

A total of 150 study participants (94 Male and 56 Female) were included to study appearance and fusion of iliac crest, femoral head, tri-radiate cartilage, ischial tuberosity, ischia-pubic ramus ,greater and lesser trochanter in age group 8-19 years. The mean age of study participants was 13.65 years old (min= 8, max= 19, SD= 3.135).

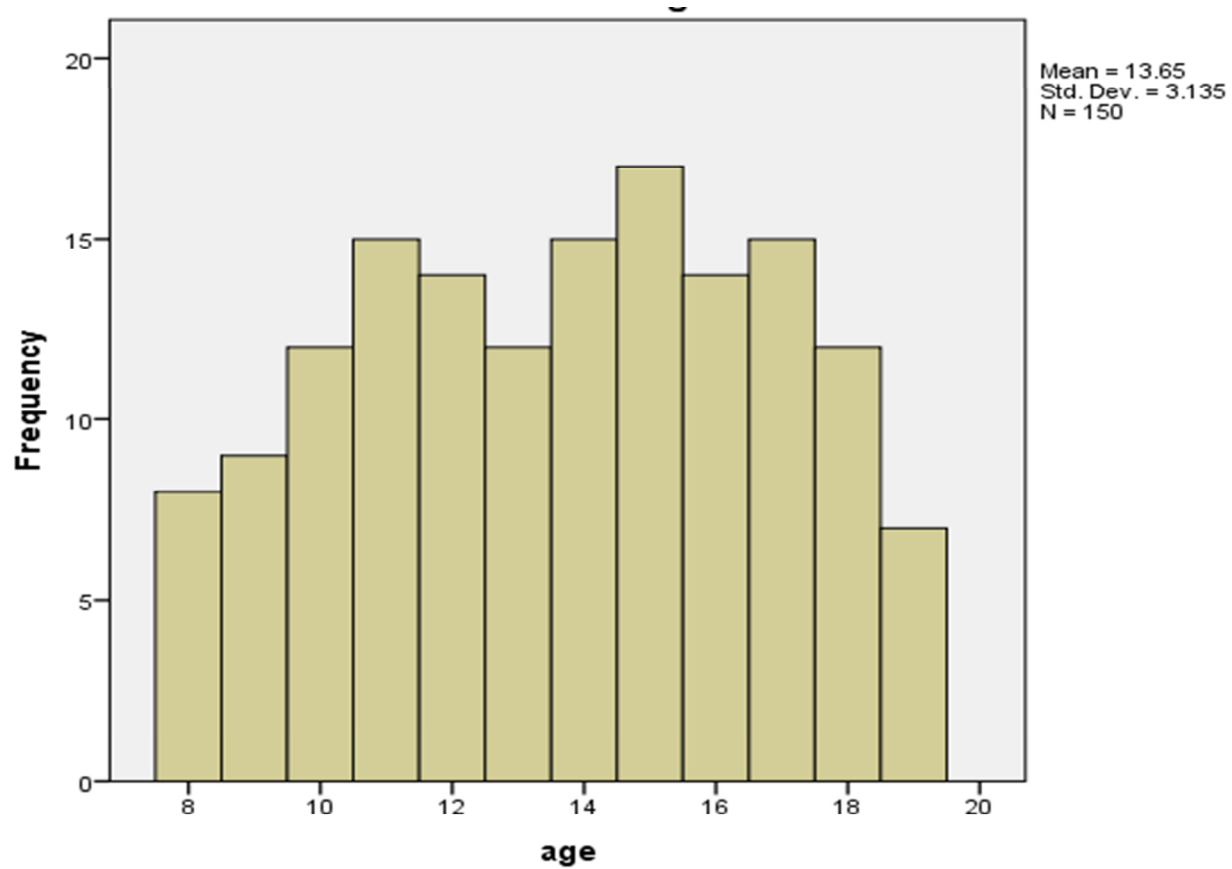
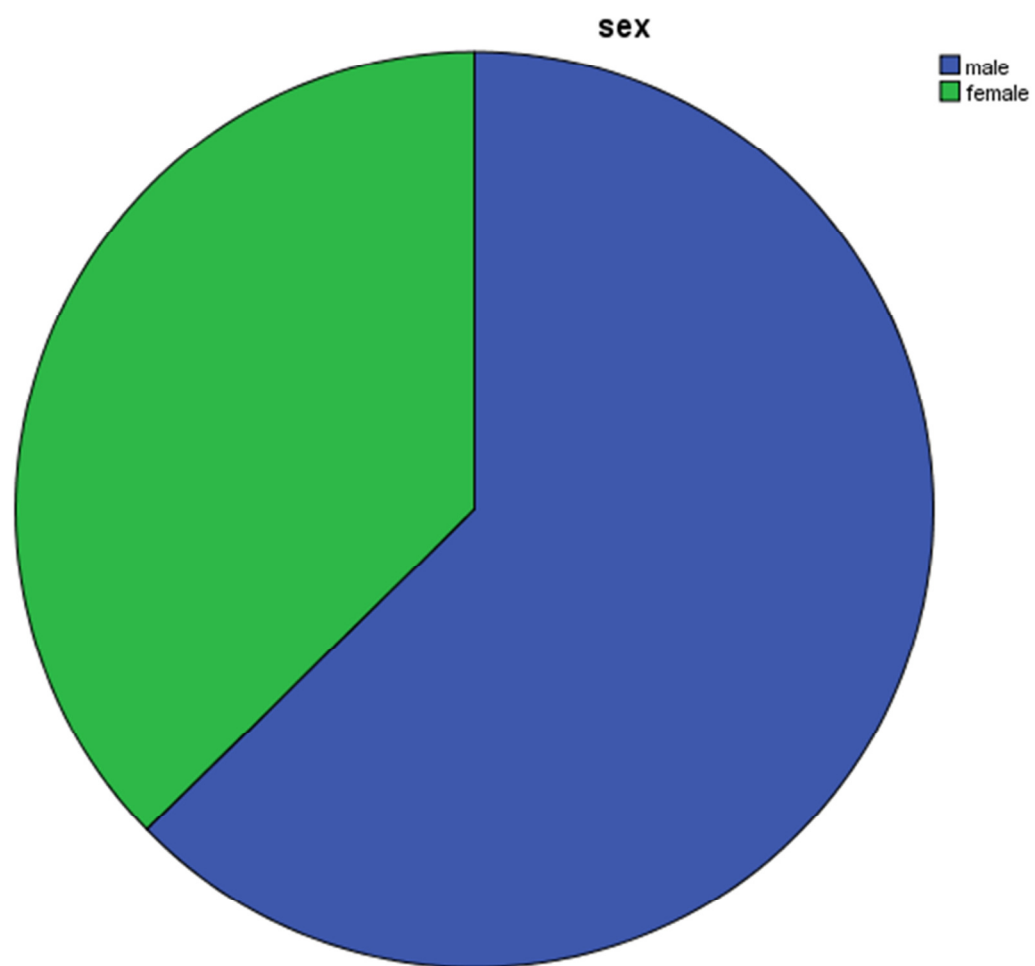


Figure 1: Frequency of Age of study participants, SPHMMC, Addis Ababa, 2023



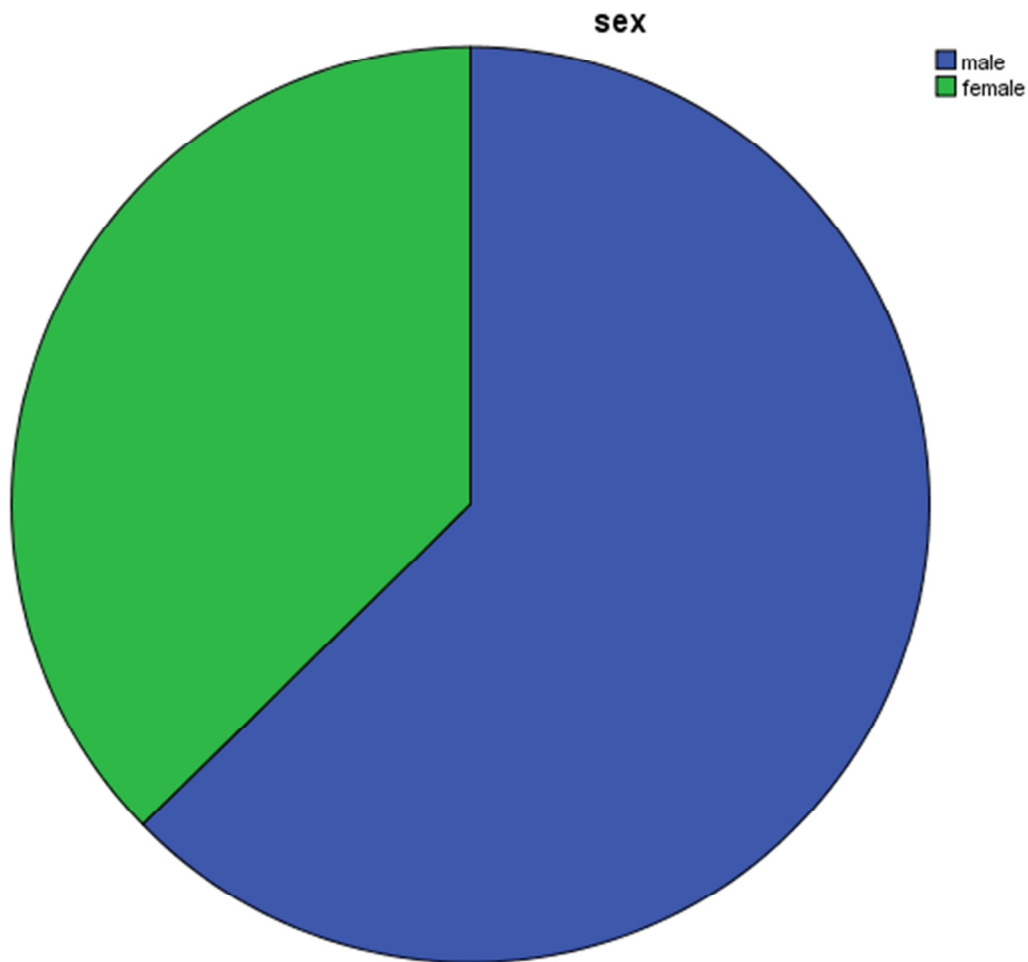


Figure 2: Sex status of the study participants, SPHMMC, Addis Ababa, 2023

Age	Sex		Total
	Male	Female	
8	5	3	8
9	5	4	9
10	8	4	12
11	11	4	15

12	11	3	14
13	5	7	12
14	9	6	15
15	11	6	17
16	8	6	14
17	10	5	15
18	8	4	12
19	3	4	7
Total	94	56	150
Percentage	62.66%	37.33%	100%

Table1: Age distribution among sex of Study participants, SPHMMC, Addis Ababa, 2023.

Age category	Sex		Total
	Male	Female	
8-----9	5	3	8
9-----10	5	4	9
10----11	8	4	12
11----12	11	4	15
12----13	11	3	14
13----14	5	7	12
14----15	9	6	15
15----16	11	6	17
16----17	8	6	14
17----18	10	5	15
18----19	8	4	12
>=19	3	4	7

Table 2: Age Category among sex of study participants, SPHMMC; Addis Ababa, 2023

	Dr. William Sangma et al and Mckern and Stewart staging
1. Not appeared.: Stage 0 – Ossification center not appeared	
2.Appeared	
Stage 1	Stage 1 – No Union (Ossification center appeared but no union)
Stage 2	Stage 2 – Partial Fusion (Fusion started but incomplete)
Stage 3	Stage 3 – Complete Fusion

Table 3: Fusion stages (Dr. William Sangma et al and Mckern and Stewart staging.

Operational definitions

- 1. Appearance:** If the ossification center has appeared and visible on plain radiography.
- 2. Non-appearance:** If the ossification center of interest doesn't appear or exist on viewing plain radiography.
- 3. Non fusion:** Includes all ossification centers where the epiphysis has appeared but does

not yet start fusing or fused completely. It includes stage 1 to stage 2 of epiphyseal union.

4. Partial fusion: Where the epiphysis of the bone has started fusion but not into phase of completed fusion. Epiphyseal scar can be present and includes stage 3 and 4 of epiphyseal union.

5. Completed fusion: where the epiphysis of the bone has completely fused, and no epiphyseal scar is visible, and it includes stage 5.

Appearance and Fusion (three Stages) in each age
ory.

Age	No of cases	Sex	iliac crest				Total
			not appeared	Stage1	Stage2	Stage3	
8—9	8	Male	5(100%)				5(100%)
		Female	3(100.0%)				3(100%)
9—10	9	Male	5 (100%)				5(100%)
		Female	4(100%)				4(100%)
10—11	12	Male	8(100%)				8(100%)
		Female	4(100%)				4(100%)
11—12	15	Male	11(100%)				11(100%)
		Female	4(100%)				4(100%)
12—13	14	Male	10(90.9%)	1(9.1%)			11(100%)
		Female	2(66.7%)	1(33.3%)			3(100%)
13—14	12	Male	5(100%)				5(100%)
		Female	4(57.1%)	1(14.3%)	2(28.6%)		7 (100%)
14---15	15	Male	5(55.6%)	3(33.3%)	1(11.1%)		9(100%)
		Female		3(50%)	3(50%)		6(100%)
15—16	17	Male	5(45.5%)	4(36.4%)	2(18.2%)		11(100%)

		Female			6 (100%)		6(100%)
16—17	14	Male		3(37.5%)	5(62.5%)		8(100%)
		Female			6 (100%)		6(100%)
17—18	15	Male			8(80.0%)	2(20.0%)	10(100%)
		Female			1(20%)	4(80%)	5(100%)
18—19	12	Male			7(87.5%)	1(12.5%)	8(100%)
		Female			2(50%)	2(50%)	4(100%)
>=19	7	Male			1(33.33%)	2(66.66%)	3(100%)
		Female				4(100%)	4(100%)

**Table 4; Appearance and Stages of Fusion (3 Stages) of iliac crest, SPHMMC,
Addis Ababa, 2023**

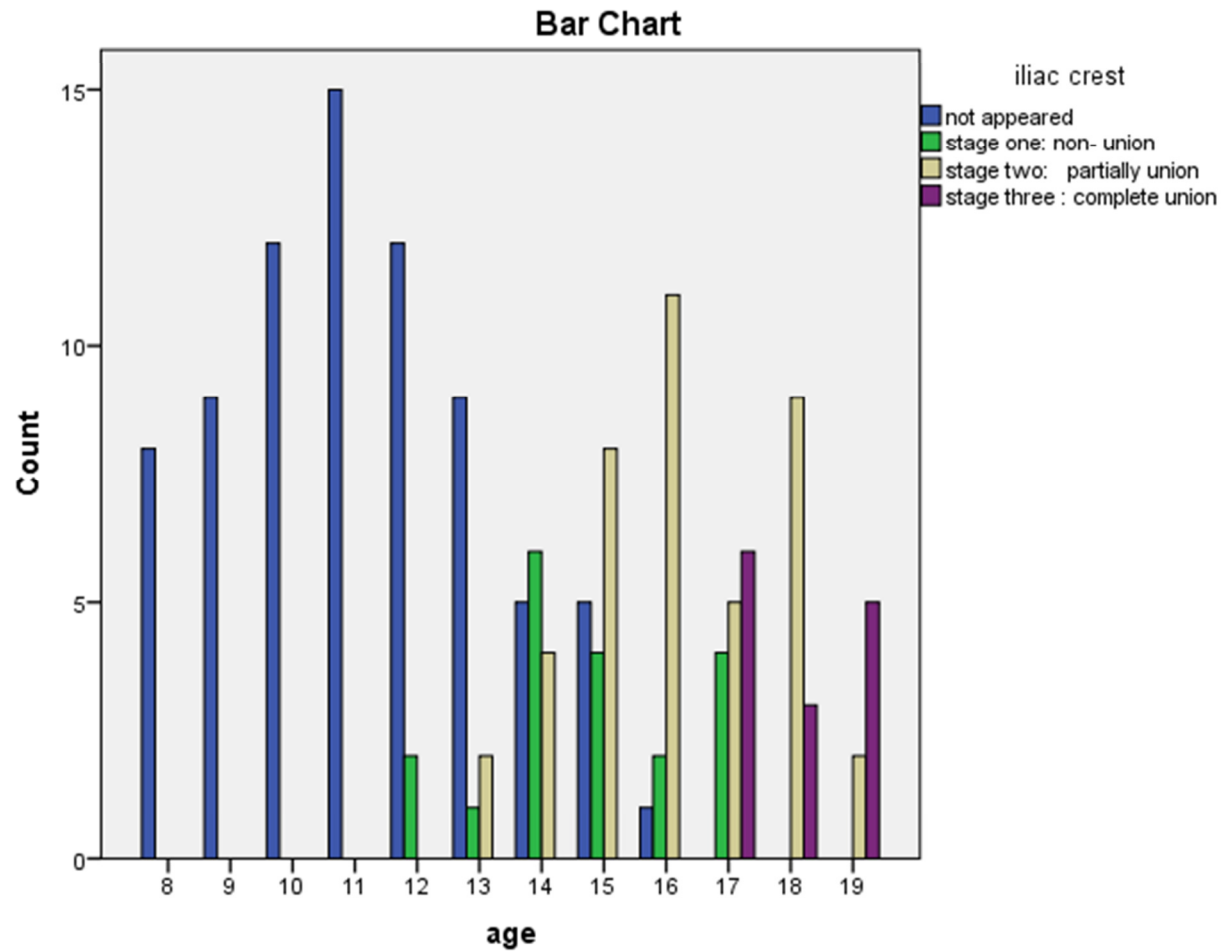


Fig.3: Distribution of Stage of Fusion of iliac crests among age of study participants

As shown above table 4 and figure 3, at age range of 8-12 years 29(100%) ossification center for iliac crest did not appear in males but it extended as long as age of 12-15 years in 20(80%) cases. The ossification center for iliac crest appears at age range of 15-16 years but appearance as earlier as 12-15 years in 05(20%). In age group of 16-17 years 05(62.5%) showed partial fusion in males. In males case complete fusion started to seen in age of 19 years. Ossification center for iliac crest did not appear in females 15(100%) at age range of 8-12 years. Ossification center for iliac crest appeared 06(100%) cases in female in age range of 14-15 years. All female case complete fusion started to seen age group of 17-18 years.

Age	No of cases	SEX	Ischial tuberosity				Total
			not appeared	stage 1	stage 2	stage 3	
8—9	8	Male	5(100.0%)				5(100.0%)
		Female	3(100.0%)				3(100.0%)
9—10	9	Male	5(100.0%)				5(100.0%)
		Female	4(100.0%)				4(100.0%)
10—11	12	Male	8(100.0%)				8(100.0%)
		Female	4(100.0%)				4(100.0%)
11—12	15	Male	11(100.0%)				11(100.0%)
		Female	4(100.0%)				4(100.0%)
12---13	14	Male	11(100.0%)				11(100.0%)
		Female	2(66.7%)	1(33.3%)			3(100.0%)
13—14	12	Male	5(100.0%)				5(100.0%)

		Female	5(71.4%)	2(28.6%)			7(100.0%)
14—15	15	Male	6(66.7%)	3(33.3%)			9(100.0%)
		Female	2(33.3%)	2(33.3%)	2(33.3%)		6(100.0%)
15—16	17	Male	10(90.9%)		1(9.1%)		11(100.0%)
		Female			6(100.0%)		6(100.0%)
16—17	14	Male	3(37.5%)		5(62.5%)		8(100.0%)
		Female	1(16.7%)		5(83.3%)		6(100.0%)
17—18	15	Male	1(10%)	4(40.0%)	3(30.0%)	2(20.0)	10(100.0%)
		Female			4(80.0%)	1(20.0%)	5(100.0%)
18—19	12	Male			7(87.5%)	1(12.5%)	8(100.0%)
		Female			2(50%)	2(50%)	4(100.0%)
>=19	7	Male			1(33.3%)	2(66.7%)	3(100.0%)
		Female			1(25%)	3(75%)	4(100.0%)

Table5; Appearance and Stages of Fusion (3 Stages) of ischia tuberosity, SPHMMC, Addis Ababa, 2023.

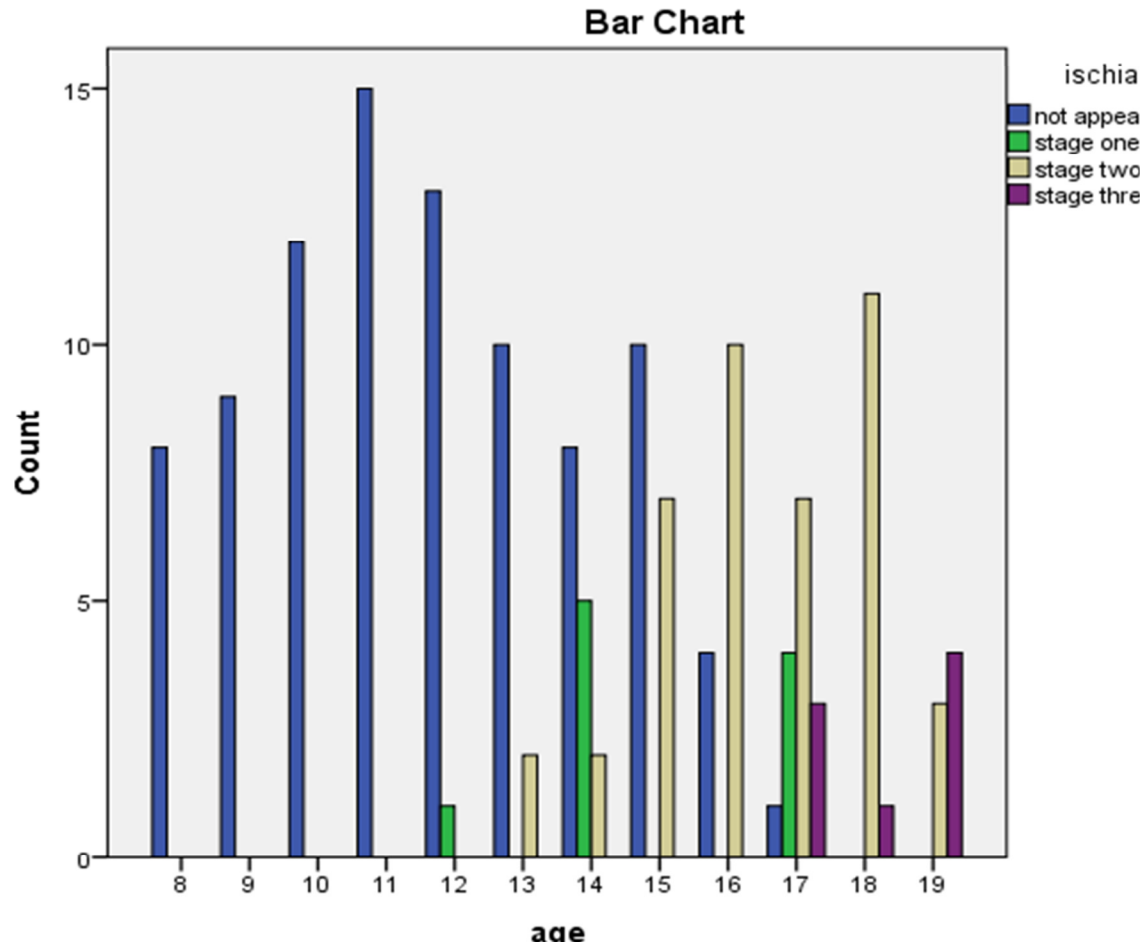


Fig.4: Distribution of Stage of Fusion of ischia tuberosity among age of study participants

As shown above table 5 and figure 4; for male cases at age range of 8-15 years ossification center for ischia-tuberosity 51(94.4%) did not appear. ossification center for ischia-tuberosity started to appear in age range of 16-17 years 05(62.5%) in males but 03(5.6) cases at age range of 14-15 years showed appearance. males at age range of 16-18years in 05(62.5%) cases in partial fusion. Complete fusion at age of 19 year but as earlier as 17-18years in 02cases. Female at age range of 8-12 years 15(100%) cases ossification center for iliac crest did not appear. Ossification center for ischia tuberosity appeared

at age range of 14-15 years 04(66.66%) cases. 06 (100%) cases in female at age range of 15-16 years in partial fusion. Complete fusion in female case at age of 19 years but 01(20%) complete fusion seen at range of 17-18 years.

Age category	No cases	Sex	tri-radiate cartilage			Total
			Stage1	Stage2	stage 3	
8---9	8	Male	4(80.0%)	1(20.0%)		5(100.0%)
		Female		3(100.0%)		3(100.0%)
9---10	9	Male	3(60.0%)	2(40.0%)		5(100.0%)
		Female		4(100%)		4(100.0%)
10---11	12	Male	4(50.0%)	4(50.0%)		8(100.0%)
		female		4(100.0%)		4(100.0%)
11---12	15	Male	6 (54.5%)	5(45.5%)		11(100.0%)
		female		4(100.0%)		4(100.0%)
12---13	14	Male	1(9.1%)	9(81.8%)	1(9.1%)	11(100.0%)
		female		1(33.3%)	2(66.7%)	3(100.0%)
13---14	12	Male	2(40.0%)	3(60.0%)		5(100.0%)
		female		1(14.3%)	6 (85.7%)	7(100.0%)
14---15	15	Male		3(33.3%)	6(66.7%)	9(100.0%)
		female			6 (100.0%)	6(100.0%)
15---16	17	male		5(45.5%)	6(54.5%)	11(100.0%)
		female			6(100.0%)	6(100.0%)

16—17	14	male			8(100%)	8(100.0%)
		female			6(100.0%)	6(100.0%)
17—18	15	male			10(100.0%)	10(100.0%)
		female			5(100.0%)	5(100.0%)
18—19	12	male			8(100.0%)	8(100.0%)
		female			4(100.0%)	4(100.0%)
>=19	7	male			3(100.0%)	3(100.0%)
		female			4(100.0%)	4(100.0%)

Table 6; Appearance and Stages of Fusion (3 Stages) of tri-radiate cartilage, SPHMMC, Addis Ababa, 2023.

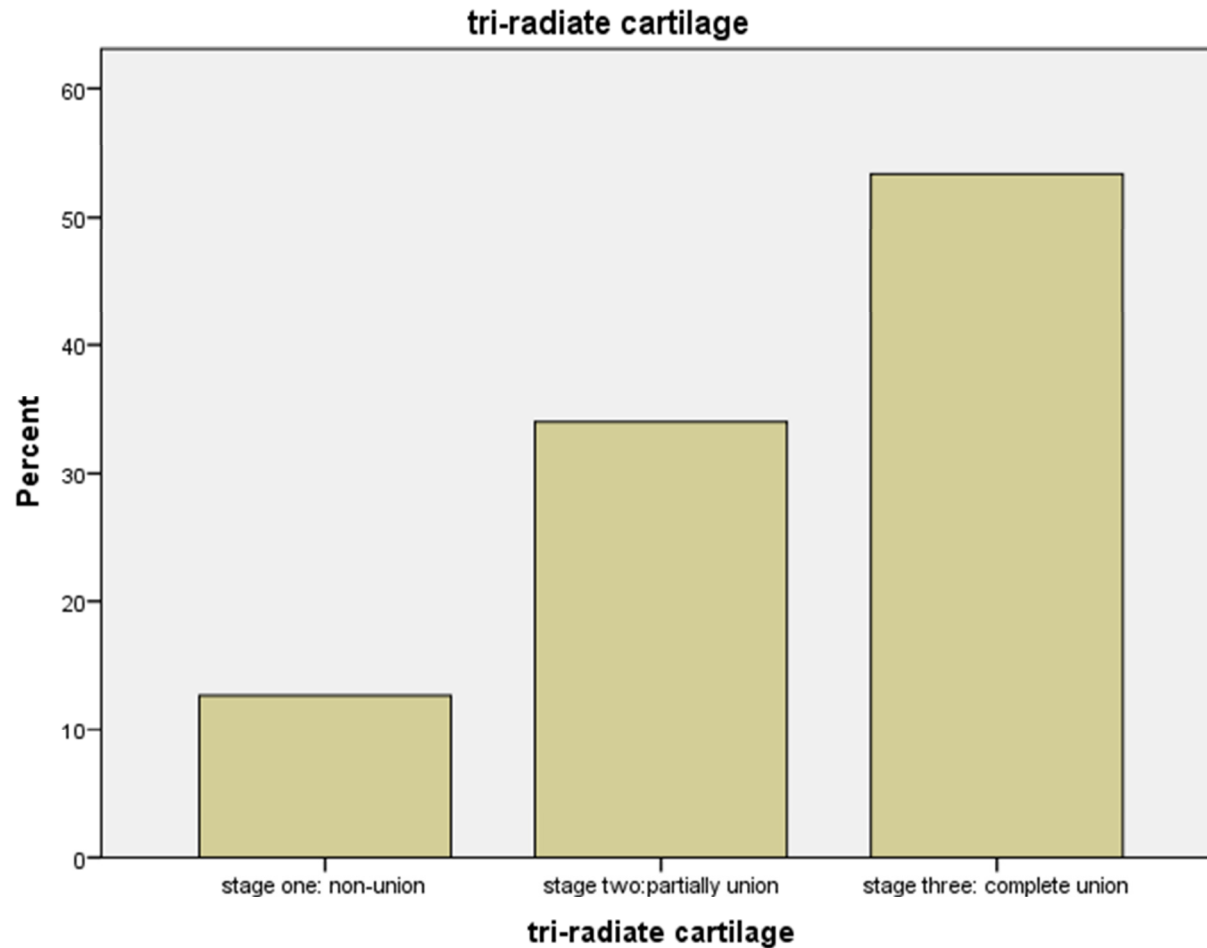


Fig.5: Distribution of Stage of Fusion of tri-radiate cartilage among age.

As shown above table 6 and figure 5, in this study, the earliest partial fusion of tri-radiate was observed in age range of 8–11 years in (100%) cases while latest at age range of 12-13 years in 02(22.2%) in female subjects. Complete fusion started to be seen in age range of 12-13 years in females. In male subjects, earliest non fusion was seen in age range 8-11 years in

17(61.9%) while latest age range of 15-16 years in 03 cases. Complete fusion in male started to seen in age range of 15-16 years but 01(9.1%) complete fusion seen in age range of 12-13 years.

Age category	no Cases	Sex	Femora			
			Stage1	stage 2	stage 3	Total
8---9	8	Male	2(40%)	3(60%)		5(100.0%)
		Female		3(100.0%)		3(100.0%)
9—10	9	Male		5(100.0%)		5(100.0%)
		Female		4(100.0%)		4(100.0%)
10---11	12	Male		8(100%)		8(100%)
		Female		4(100.0%)		4(100%)
11---12	15	Male		11(100%)		11(100.0%)
		Female		4(100.0%)		4(100.0%)
12---13	14	Male		11(100.0%)		11(100.0%)
		Female		2(66.7%)	1(33.3%)	3(100.0%)
13---14	12	Male		5(100.0%)		5(100.0%)
		Female		4(57.1%)	3(42.9%)	7(100.0%)
14—15	15	Male		8(88.9%)	1(11.1)	9(100.0%)

		Female			6(100.0%)	6(100.0%)
15—16	17	Male		9(81.8%)	2(18.2%)	11(100.0%)
		Female			6(100.0%)	6(100.0%)
16—17	14	Male		2(25.0%)	6(75.0%)	8(100.0%)
		Female			6(100.0%)	6(100.0%)
17—18	15	Male			10(100%)	10(100.0%)
		Female			5(100.0%)	5(100.0%)
18—19	12	Male			8(100.0%)	8(100.0%)
		Female			4(100.0%)	4(100.0%)
>=19	7	Male			3(100.0%)	3(100.0%)
		Female			4(100.0%)	4(100.0%)

Table 7; Appearance and Stages of Fusion (3 Stages) of femoral head , SPHMMC, Addis Ababa, 2023.

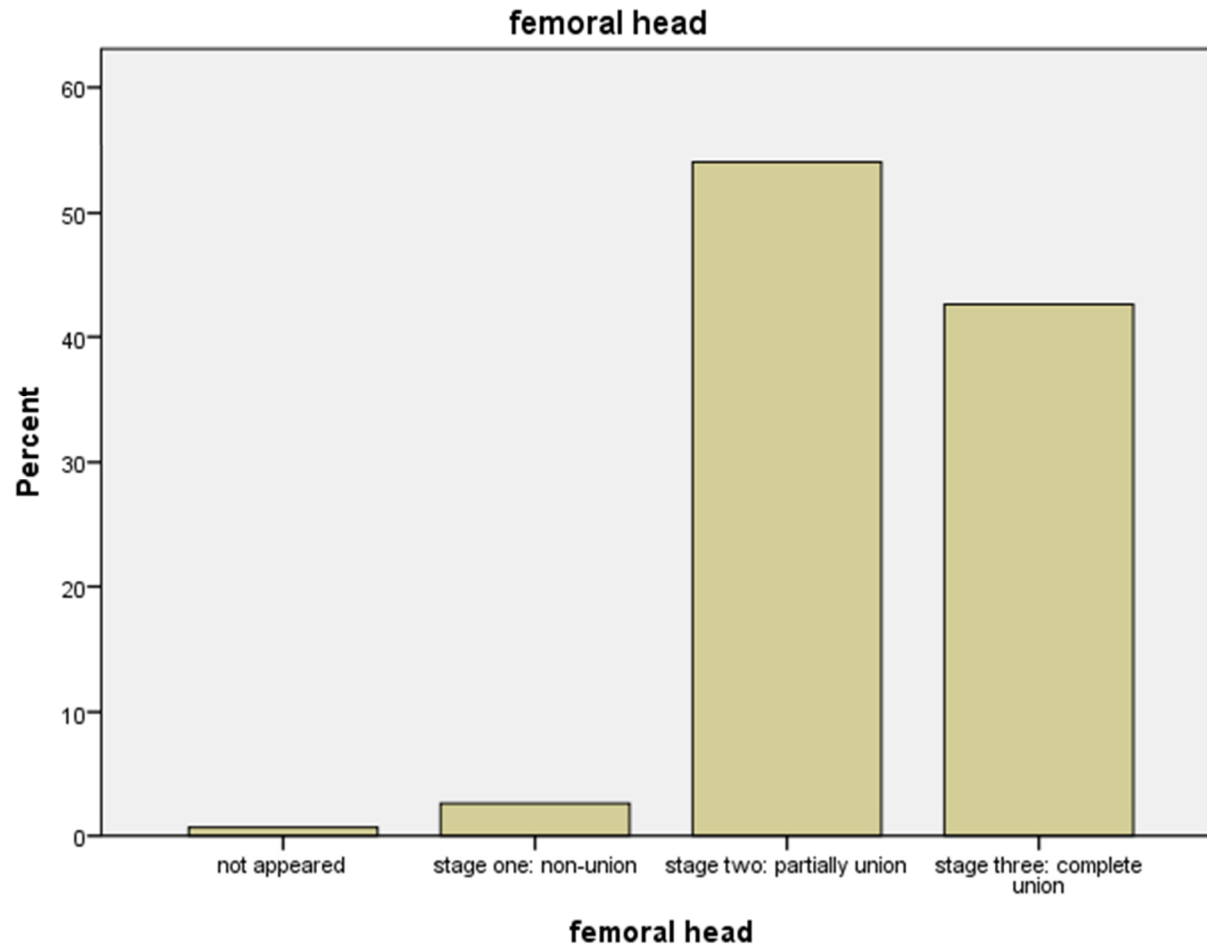


Fig.6: Distribution of Stage of Fusion of femoral head among age.

It clearly seen above table7 and figure 6, in age range of 8-12 years 15(100%) showed partial fusion female subjects. All female subjects' showed complete fusion at age range of 14-19 years but 04 cases as earlier as age range of 12-14years. All male subjects at age range of 9-14 years 45(100%) showed partial fusion. In age range of

8-9 years 02(40%) in non –fusion and 03(60%) partial fusion in male subjects. Complete fusion started to seen in age range of 16-17 years in males ‘subjects. All cases showed complete fusion in age range of 17-19 years

Age category	No cases		greater trochanter			Total
			Stage1	Stage2	Stage3	
8---9	8	Male	3(60.0%)	2(40.0%)		5(100.0%)
		female		3(100.0%)		3(100.0%)
9—10	9	Male	3(60.0%)	2(40.0%)		5(100.0%)
		female		4(100.0%)		4(100.0%)
10---11	12	Male	5(62.5%)	3(37.5%)		8(100.0%)
		female		4(100.0%)		4(100.0%)
11---12	15	Male	7(63.6%)	4(36.4%)		11(100.0%)
		female		4(100.0%)		4(100.0%)
12---13	14	Male	4(36.4%)	7(63.6%)		11(100.0%)
		female		3(100%)		3(100.0%)
13---14	12	Male	3(60.0%)	2(40.0%)		5(100.0%)
		female		7(100%)		7(100.0%)
14—15	15	Male		9(100.0%)		9(100.0%)
		female		2(33.33%)	4(66.6%)	6(100.0%)
15—16	17	Male		11(100.0%)		11(100.0%)
		female		1(16.7%)	5(83.3%)	6(100.0%)

16—17	14	Male		3(37.5%)	5(62.5%)	8(100.0%)
		female			6(100.0%)	6(100.0%)
17—18	15	Male			10(100%)	10(100.0%)
		female			5(100.0%)	5(100.0%)
18—19	12	Male			8(100.0%)	8(100.0%)
		female			4(100.0%)	4(100.0%)
>=19	7	Male			3(100.0%)	3(100.0%)
		female			4(100.0%)	4(100.0%)

Table 8; Appearance and Stages of Fusion (3 Stages) of greater trochanter, SPHMMC, Addis Ababa, 2023.

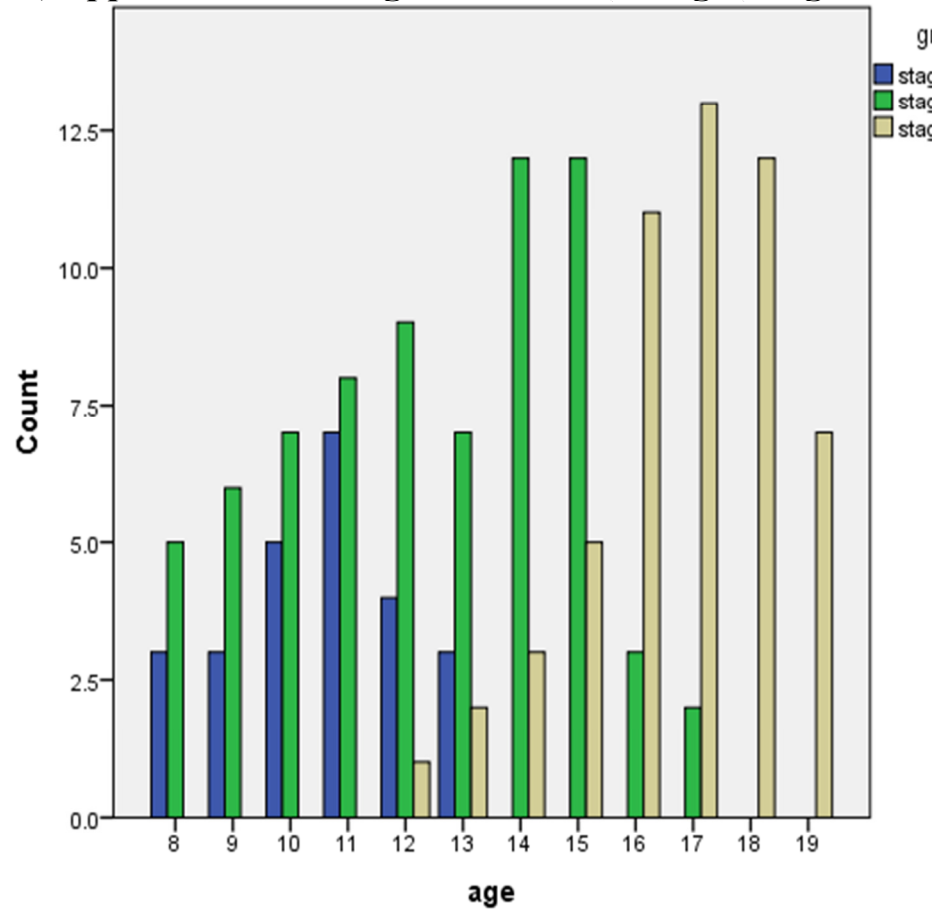


Fig.7: Distribution of Stage of Fusion of greater trochanter among age of study participants

As shown above table 8 and figure7, for age group 8-11 years 18(62%) showed non fusion and 11(32%) showed partial fusion in males respectively. In majority of males complete fusion started to seen in age group of 16-17 years. All males showed complete fusion at age range of 18-19 years. In females age group of 8-13 years

25(100%) showed partial fusion. Complete fusion started to seen age range of 14-15 years 04 (66.66%) in females. All females showed complete fusion at age group of 16-18 years. All cases showed complete fused age range of 17-18 years.

Age category	No of cases		lesser trochanter				Total
			not appeared	stage 1	stage 2	stage 3	
8---9	8	Male	5(100.0%)				5(100.0%)
		Female	3(100%)				3(100.0%)
9—10	9	Male	5(100.0%)				5(100.0%)
		Female	4(100%)				4(100%)
10---11	12	Male	8(100%)				8(100%)
		Female	4(100%)				4(100%)
11---12	15	Male	11(100%)				11(100%)
		Female	2(50.0%)	2(50.0%)			4(100.0%)
12---13	14	Male	5(45.5%)	2(18.2%)	4(36.4%)		11(100%)
		Female		1(33.3%)	2(66.7%)		3(100%)
13---14	12	Male		2(40.0%)	3(60.0%)		5(100%)
		Female		2(28.6%)	5(71.4%)		7(100%)
14—15	15	Male		3(33.33%)	6(66.7%)		9(100%)
		Female		1(20%)	5(80.0%)		6(100%)
15—16	17	Male		2(18.2%)	9(81.8%)		11(100%)
		Female			6(100.%)		6(100%)

16—17	14	Male			3(37.5%)	5(62.5%)	8(100%)
		Female				6(100%)	6(100%)
17—18	15	Male			2(20.0%)	8(80%)	10(100%)
		Female				5(100%)	5(100%)
18—19	12	Male				8(100%)	8(100%)
		Female				4(100%)	4(100%)
>=19	7	Male				3(100%)	3(100%)
		Female				4(100%)	4(100%)

Table 9; Appearance and Stages of Fusion (3 Stages) of lesser trochanter, SPHMMC, Addis Ababa, 2023.

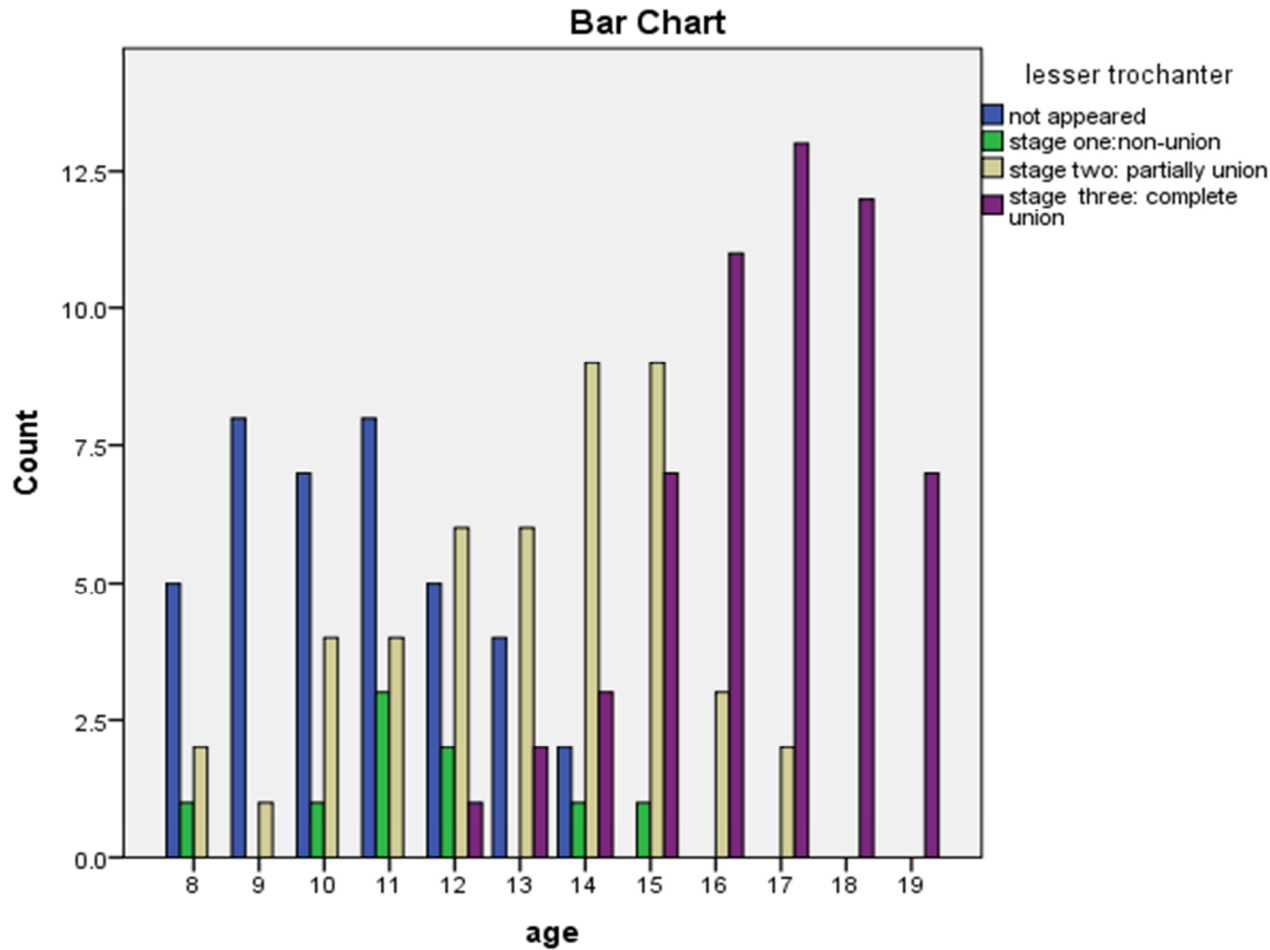


Fig8: Distribution of Stage of Fusion of lesser trochanter among age of study participants.

As shown above table 9 and figure 8 , In males subjects age group of 8-12 years 29(100%) did not appeared. The ossification center started to appear in age range of 12-13 years 06(54.6%) in males. In age range of 13 -16 years majority of males are in partial fusion. Complete fusion started to seen in age range of 16-17 years in 05(62.5%) in males. All male cases complete fusion in age group of 17-18 years. In females subjects age group of 8-11 years

11(100%) did not appeared. The ossification center started to appear in age range of 11-12 years 02(50%) in females. In age range of 12 -16 years majority of females are in partial fusion. Complete fusion started to seen in age range of 16-17 years 06(100%) in females. All female cases complete fusion in age group of 16-18 years.

Age			Ischiopubic ramus		Total
			stage 2	stage 3	
8---9	8	male	3(60.0%)	2(40.0%)	5(100%)
		female	1(33.3%)	2(66.7%)	3(100%)
9—10	9	male	1(20.0%)	4(80.0%)	5(100%)
		female	1(25.0%)	3(75.0%)	4(100%)
10---11	12	male	4(50.0%)	4(50.0%)	8(100%)
		female	2(50.0%)	2(50.0%)	4(100%)
11---12	15	male	4(36.4%)	7(63.6%)	11(100%)
		female	1(25.0%)	3(75.0%)	4(100%)
12---13	14	male	2(18.2%)	9(81.8%)	11(100%)
		female	1(33.3%)	2(66.7%)	3(100%)
13---14	12	male		5(100.0%)	5(100%)
		female	1(14.3%)	6(85.7%)	7(100.0%)
14—15	15	male	1(11.1%)	8(88.9%)	9(100.0%)
		female	1(16.7%)	5(83.3%)	6(100.0%)
15—16	17	male	1(9.1%)	10(90.9%)	11(100.0%)
		female	1(16.7%)	5(83.3%)	6(100.0%)

16—17	14	male		8(100.0%)	8(100.0%)
		female		6(100.0%)	6(100.0%)
17—18	15	male		10(100.0%)	10(100.0%)
		female		5(100.0%)	5(100.0%)
18—19	12	male		8(100.0%)	8(100.0%)
		female		4(100.0%)	4(100.0%)
>=19	7	male		3(100.0%)	3(100.0%)
		female		4(100.0%)	4(100.0%)

Table 10; Appearance and Stages of Fusion (3 Stages) of ischia-pubic ramus, SPHMMC, Addis Ababa, 2023.

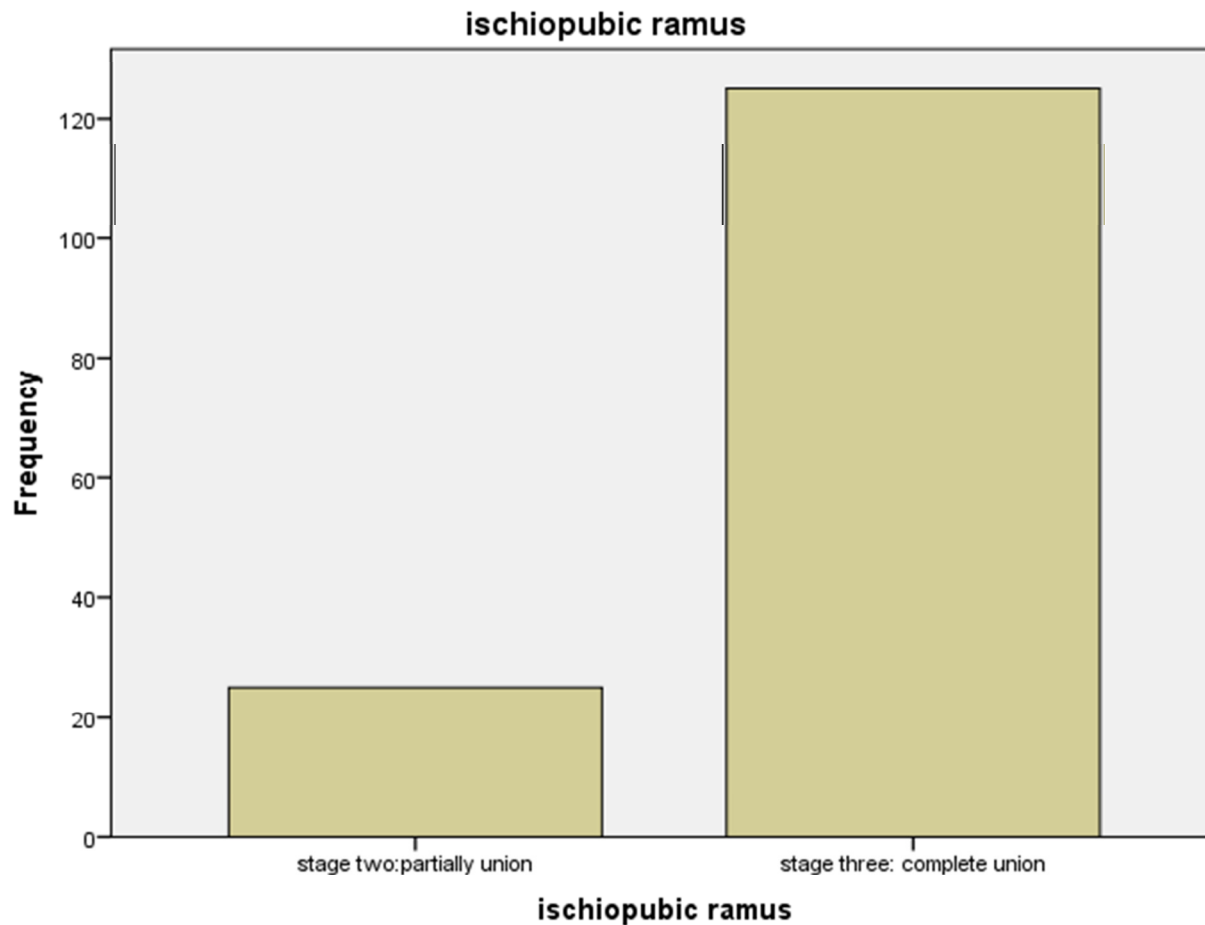
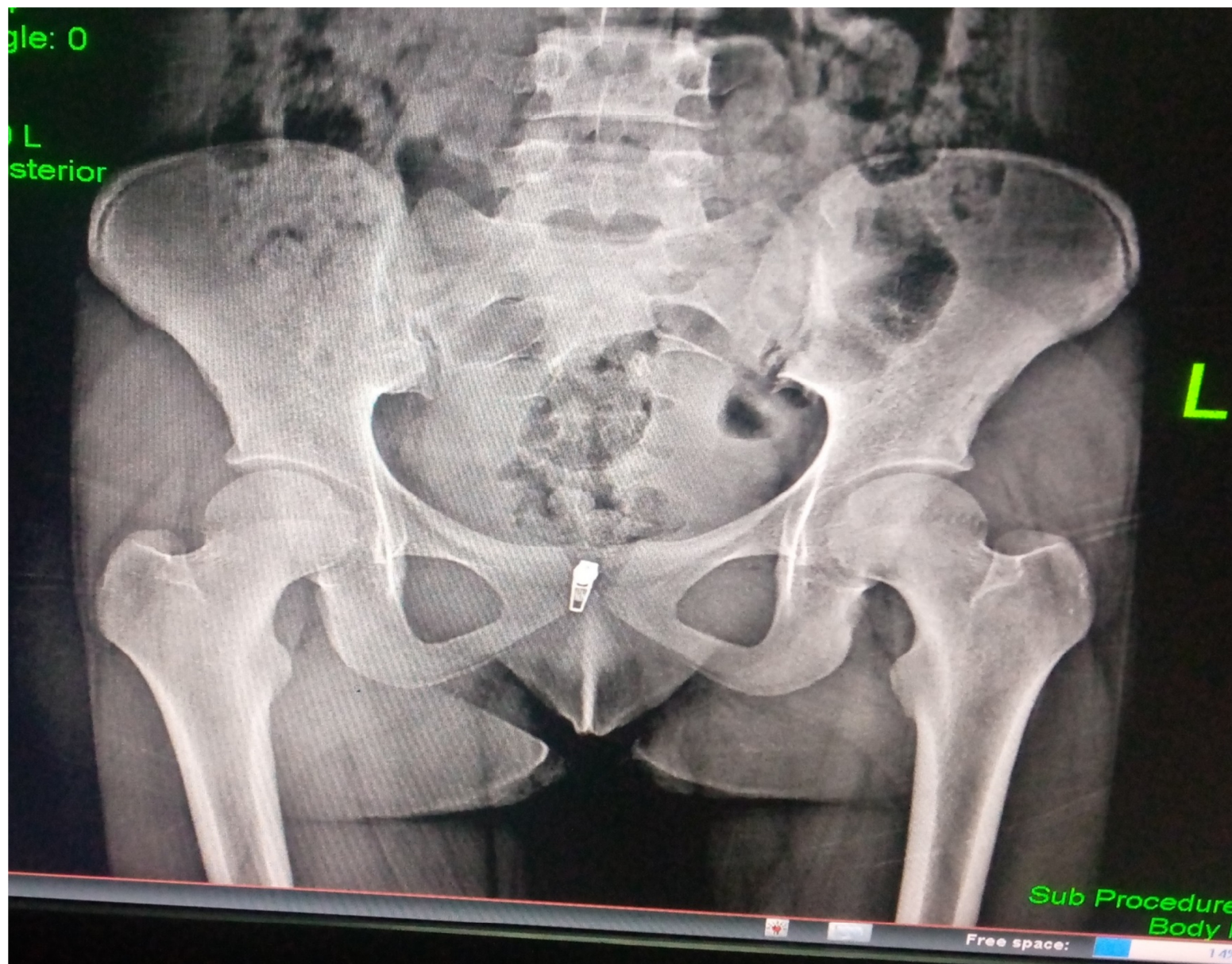


Fig 9: Distribution of Stage of Fusion of As shown above table 10 and figure 9;

In age group of 8-9 years 03(60%) showed partial fusion, 02(40%) showed complete fusion in males. In age group of 9-16 years 43(78%) showed complete fusion. All male cases complete fusion age of 16-18 years but 05(100%) cases at age range of 13-14 years complete fused. In age group of 8-16 years 27(78%) showed complete fusion, 08(22%) showed partial fusion in females. All female cases complete fusion age of 16-18 years. All cases complete fused at age range of 16-18 years.



DELL



Pseudo R-Square

Cox and Snell	.665
Nagelkerke	.734
McFadden	.463

Link function: Logit.

Parameter Estimates of Iliac crest

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[crest = 0]	-5.776	1.037	31.043	1	.000	-7.807	-3.744
	[crest = 1]	-4.357	.996	19.131	1	.000	-6.309	-2.404
	[crest = 2]	-.934	.838	1.243	1	.265	-2.576	.708
Location	[age=8]	-26.730	.000	.	1	.	-26.730	-26.730
	[age=9]	-26.730	.000	.	1	.	-26.730	-26.730
	[age=10]	-26.730	.000	.	1	.	-26.730	-26.730
	[age=11]	-26.730	9165.624	.000	1	.998	-17991.023	17937.563
	[age=12]	-7.611	1.291	34.758	1	.000	-10.142	-5.081
	[age=13]	-6.749	1.211	31.061	1	.000	-9.122	-4.375
	[age=14]	-5.222	1.110	22.146	1	.000	-7.397	-3.047
	[age=15]	-4.673	1.087	18.487	1	.000	-6.804	-2.543
	[age=16]	-3.399	1.084	9.840	1	.002	-5.523	-1.275
	[age=17]	-1.983	1.002	3.918	1	.048	-3.946	-.019
	[age=18]	-1.770	1.027	2.966	1	.085	-3.783	.244
	[age=19]	0 ^a	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Pseudo R-Square

Cox and Snell	.579
Nagelkerke	.669
McFadden	.432

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[tuberosity = 0]	-4.938	1.009	23.953	1	.000	-6.916	-2.961
	[tuberosity = 1]	-4.260	.992	18.432	1	.000	-6.205	-2.315
	[tuberosity = 2]	-.312	.762	.168	1	.682	-1.805	1.181
Location	[age=8]	-26.086	.000	.	1	.	-26.086	-26.086
	[age=9]	-26.086	.000	.	1	.	-26.086	-26.086
	[age=10]	-26.086	.000	.	1	.	-26.086	-26.086
	[age=11]	-26.086	.000	.	1	.	-26.086	-26.086
	[age=12]	-7.543	1.459	26.739	1	.000	-10.402	-4.684
	[age=13]	-6.458	1.253	26.571	1	.000	-8.913	-4.002
	[age=14]	-5.340	1.120	22.720	1	.000	-7.536	-3.144
	[age=15]	-5.042	1.097	21.143	1	.000	-7.191	-2.893
	[age=16]	-3.637	1.096	11.018	1	.001	-5.785	-1.490
	[age=17]	-2.858	1.059	7.279	1	.007	-4.934	-.782
	[age=18]	-1.934	1.028	3.542	1	.060	-3.949	.080
	[age=19]	0 ^a	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Discussion

The present study has been conducted in 150 study participants who are taken from two schools; date of birth was confirmed from their birth certificate.

Iliac crest: All cases in the age range 8-11 years ossification center for iliac crest did not appear. In present study majority of cases ossification center for iliac crest appear age group of 15 – 16 years for male and age group of 14 – 15 years for female. In present study, ossification center for iliac crest is consistent with the observation of the study done by M, Indubala, S, Hussai, B, Bhavesh, S, Yogesh, and A Anjali(13) and another study done by S.S. Bhise and S. D. Nanandkar(1). In this study majority of the male cases complete fusion in the age group of 18-19 years. In this study majority of the female cases complete fusion in the age group of 17-18 years. In this study regarding to fusion of iliac crest, males 3-4 years and females 2-3 years earlier than that of study done by M, Indubala¹, S Hussai, B, Bhavesh³, Sharma Yogesh⁴, and Agrawal Anjali(13). Again, this study inconsistency with study done by S.S. Bhise and S. D. Nanandkar(1) in Mumbai Region.

Ischia tuberosity: In present study majority of cases ossification center for ischia-tuberosity appearance in age group of 16–17 years in male and in age group of 14–15 years. This observation is similar in case of males subjects (in their study appearance in between 16–17 years) while different in females subject (between 15–17 years) in the studies conducted by S.S. Bhise and S. D(1) in Mumbai Region. Again, This observation different in both sexes, study done by H Siddiqi, S Nisar, N, Waheed in Bahawalpur – Pakistan(4), appearance of ischia-tuberosity in males occurred at 12-13 years and in females at 10-11 years.

Majority of the male study participants complete fusion in the age range of 18-19 years. The present study is inconsistency with studies done by Galatian, and Parikh in India shows comparatively late fusion of epiphysis in males by 2-3 years. Majority of female

cases are in complete fusion in the age of 18-19 years. In female cases the observation of present study fused 1 years earlier than that of study done by S.S.Bhise and S. D(1) in Mumbai Region.

Again fusion of ischia-tuberosity is 1-2 years earlier than H Siddiqi, S Nisar,N,Waheed(4) (Complete union was seen at the age of 19–20 years in females and 16–17 years in males) in Bahawalpur –Pakistan.

Femoral head: In age range of 11-12 years all cases of female showed partial fusion. All male subjects at age range of 9-14 years showed partial fusion. Similar finding was observed with regards to partial fusion of femoral head in all cases with study done by Y.Singi ,H Shreekrishna(17),Tumkur, Karnataka, India. All females showed complete fusion at age range of 14-15 years. All cases showed complete fusion in age range of 17-18 years. Regarding to complete fusion of femoral head with shaft observation of present study is similar with standard textbook in both sexes.

Greater trochanter: In majority of males complete fusion in the age group of 16-17 years. All males showed complete fusion at age range of 17-18 years. Complete fusion started to seen age range of 14-15 years for female cases. All females showed complete fusion at age group of 16-18 years. All cases complete fused age range of 17-18 years. Regarding to complete fusion of greater trochanter, in male cases match with study done by Y.Singi ,H Shreekrishna(17),Tumkur, Karnataka, India but different in female cases fused 1-2 years earlier.

Lesser trochanter: In all male cases age group of 12-13 years ossification center for lesser trochanter appeared. In female cases age group of 11-12 years ossification center for lesser trochanter appeared. In female cases the observation of present study ossification center for lesser trochanter appeared 1 years earlier than that of study done Y. Sing, HK Shreekrishna

All male cases complete fusion in age group of 17-18 years. All female cases complete fusion in age group of 16-18 years. All cases complete fusion at age group of 18-19 years.

Ischio-pubic ramus: Majority of male cases in age group of 9-16 years complete fusion. Complete fusion in majority of female cases in the age group of 8-15 years. All female cases complete fusion age of 16-17 years. All cases complete fused at age range of

16-17 years. The observation of present study matches with work of Srinivasa Naik M1, Brahmaji P (5) Anantapuram, Andhra Pradesh, India.

Tri-radiate cartilage: Majority of the female cases in age group of 8-11 years tri-radiate cartilage partial fusion. In the present study majority of female cases complete fusion in age range of 12-13 years. In this study majority of male cases complete fusion in age range of 15-16 years. All cases in the age of 16-17 years complete fusion. The observation of present study matches with work of Ninad N, Swapnil P, Ranjit A (8) central Indian population. In contrary, studies done by Srinivasa Naik M1, Brahmaji Master P(5) complete fusion 1-2 years earlier than current study.

Strength

- The study used primary data to study skeletal maturity of bone around pelvic bone.
- Age and sex distribution is good.

Limitation

- The study participants are limited in a single sub-city which makes difficult to generalize.
- The sample size is limited.

Conclusion

From the present study we can conclude that the complete fusion of iliac crest occurs in the age of 18 to 19 years in males and 17 to 18 years in females. For ischia-tuberosity age of appearance of ossification center is 16-17 years for males and 14-15 years for females whereas complete fusion are seen in age of 19 years for both sexes.

For femoral head complete fusion are seen in the age group of 14 to 15 years in females and 16 to 17 years in males. In the present study sex difference is noted in the age of fusion of pelvic bone by 1 to 2 years. Females show earlier appearance and onset of fusion than males which is similar with previous studies from India and other countries. There is statistically significant relationship between sex and skeletal maturity of pelvic bone. There is a significant difference in skeletal maturity of spelvic bone between Male and Female study participants.

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3.APPENDIX

1. INFORMATION SHEET AND INFORMED CONSENT.

This information sheet and informed consent will be translated to Amharic language before collecting data.

Dear respondent:

Hello, my name is Dr. Aklilu Mente, I am one of the participants who is working on a radiological study of pelvic girdle bone for the purpose of evaluation of pattern of maturity. Today I am here to collect data to assess the age using shoulder x-ray in SPHMMC. I am asking you for a few minutes of your time to participate in this study. The Name and Address of the participant will not be recorded. You have the right not to answer for any questions which might be inconvenient for you. However, your information is very important for the study. And we would like to confirm to you that all your data are confidential and used for research purpose only.

Purpose of the study: To assess the pattern of skeletal maturity using bone ossification centers of pelvic girdle bone by using X-ray.

Risk and benefits – The effective radiation received during each exposure will be between 0.3 to 1.4 mSV. Adequate precautions will be taken to avoid unnecessary X-ray exposure of study participants by covering the non-study body regions with a protective shield. You will be benefited from participating in this study by having you a screening result given by a radiologist expert for any of bone diseases like tumors, infections and joint abnormalities. Finally this study will benefit the society when the information deduced finally shades light in providing justice for the victims. The transportations and other costs that could be expended during the study will be covered by me. I only need a few moments of your precious time to take part in this study.

Payments for participating – You will not receive any payment for participating in this study.

Confidentiality – The information collected from this study will be kept confidential and it will only be used for research purposes. The information will be stored in a file without any personal identifiers but a code number will be assigned to it.

Right to refusal or withdrawal – You have a full right to refuse and/or withdraw from the study at any time. Are you willing to participate in this study?

Consent Form

I am willing and/or allow my child (for parents/legal guardians) to participate in the study after it has been explained to me thoroughly in a language that I understand.

Signature: _____

Name of investigator: _____ Signature: _____ Date: _____

Identifiers: - Code of study participants. _____

ግንዛቤ ጠቋሚ መረጃ በቅድሚያ ሰላምታዬ ይድረስ፡ ስሜ ይባላል።

የተሟላ የአጥንት አድገት ላይ መድረሳቸውን በምርመራ ለማረጋገጥ ከአዲስ አበባ ትምህርት ቤቶች እንዲሁም ወደ ቅ/ጳ/ሚሊኒየም ሜዲካል ኮሌጅ ሆስፒታል ለሚመጡ ደንበኞች የክርን አጥንት ላይ የራጅ ምርመራ ከሚወስዱ የጥናቱ አድራጊ አካል አንዱ አባል ነኝ።

የጥናቱ አላማ፡- ቅደም ተከተሉን የጠበቀ የእድሜ እድገት ደረጃን ለማወቅ እና በየትኛው የእድሜ ደረጃ ላይ መጋጠሚያ የክርን አጥንት የእድገት ጉጠቶች ታይተው እንደሚጋጠሙ ሂደቱን

ለመረዳት የታቀደው ጥናት ወደ ቅ/ጳ/ሚ/ሜ/ኮሌጅ ሆስፒታል ለምርመራ የሚቀርቡ ደንበኞች እና ከአዲስ አበባ ት/ቤቶች በሚደረግ ድንገተኛ መረጣ ላይ የሚካሄድ ይሆናል። በጥናቱ ሊደርስ የሚችል ጉዳት እና ሊገኝ የሚችል ጠቀሜታ፡- በእያንዳንዱ የራጅ ምርመራ አንድ ተመርማሪ ለጨረረ ሞገድ ሊጋለጥ የሚችለው ከ0.3 — 1.4 mv ይሆናል። አስፈላጊ ከሆነ የጨረረ ሞገድ መጋለጥ

እንዳያስከትል በቂ የሆነ የመከላከያ መንገዶች ተግባራዊ ይሆናል። ከዚህ በተጨማሪም ለጥናቱ በማያስፈልጉ የተመረመረው አካል ክፍል ላይ ባለሙያዎች የጨረረ መከላከያ ጭንብል እንዲሸፈን ይደረጋል። ከዚህ በላይ በዋናነት ለአግልግሎት የማንጠቀምበትን የደሴ አጥንት ነው። በዚህ ጥናት ተሳታፊ በመሆን የሚገኝ ጥቅም፡- በራጅ ባለሙያ በኩል የአጥንት በሽታ ማለትም አንድ ካንሰር፣ የአጥንት በሽታ መዛመት፣ የመገጣጠሚያ የጤና እንከን መከሰታቸውን አስመልክቶ የምርመራ ውጤት የሚሰጥ ሲሆን ከዚህ ይበልጥ በዋናነት ተጨምቆ የሚገኘው የጥናት መረጃ አንድ ተጎጂ ክፍትህ ረገድ ሊያገኘው የሚችለውን አገልግሎት በማግኘቱ ህብረተሰቡ የጥናቱ ውጤት ተጠቃሚ መሆኑ ነው። ለዚህ ጥናት ተብሎ የሚከፈል የመጓጓዣ ወጪ እና ሌሎች ተያያዥነት ያላቸው ወጪዎች በእኔ በኩል የሚሸፈን ይሆናል።

ለማበረታቻነት ሲባል የሞባይል ካርድ ክፍያ የሚሸፈን ይሆናል። ከውድ ጊዜያችሁ ጥቂቱን ብቻ መስዋዕት በማድረግ በዚህ ጥናት እንድትሳተፉ ጥያቄዬን በማክበር አቀርባለሁ። ስለተሳታፊነት የሚደረግ ክፍያ፡- በዚህ ጥናት ተሳታፊ በመሆንዎ የሚደረግ ክፍያ አይኖርም። የሚስጥራዊነትን ስለመጠበቅ፡- ለዚህ ጥናት ተብሎ የሚሰበሰብ መረጃ ሚስጥራዊነቱ የሚጠበቅ ይሆናል። መረጃውም የሚውለውም ለጥናታዊ አላማ ብቻ ይሆናል። መረጃው ማንነትን በማይጠቁም መልኩ ኮድ ተሰጥቶት የሚቀመጥ ይሆናል። የጥናቱ ተሳታፊ ለመሆን ፍቃደኝነትን ወይም ተቃውሞን የመግለጽ መብት፡- በጥናቱ ላለመቀጠል ወይም ለማቋረጥ ከፈለጉ ሙሉ መብትዎን ተጠቅመው በማናቸውም ሰዓት ማቋረጥ ይችላሉ።

ጥያቄ ካለዎት? እንድጀምር ፈቅደዋል?

የፍቃደኝነት ስምምነት

በወላጆች/በህጋዊ አሳዳጊ በኩል የሚሞላ ልረዳው በምችል ቋንቋ ስለሚደረገው ጥናት በበቂ ሁኔታ የተብራራልኝ ስለሆነ ልጄ በጥናቱ ተሳታፊ እንዲሆን ፍቃደኝነቴን ከስር በሚገኘው ፊርማዬ አረጋግጣለሁ።

ስም-----ፊርማ-----

የመረመረው ስም ፊርማ ቀን-----

Subject's preliminary particulars(to be collected from the subject, family members or friends)	
AE number	
Age/Sex	
Address	
Marital status	
Any chronic illness	
Family income	
Birth certificate	

Immunization certificate	
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AE No/Sex	Age	Ossification center	Not appeared	Appeared		
				Non -union	Partial union	Complete union
		Femoral head				
		Iliac crest				
		lesser trochanter				
		Greater trochanter				
		Tri radiate cartilage				
		Ischipubic ramus				

		Ischial Tuberosity				
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Assurance of the Principal Investigator

I, the undersigned, agree to accept all responsibilities for the scientific and ethical conduct of the research project. I will provide timely progress report to my advisors and seek the necessary advice and approval from my primary advisors in the course of the research. I will communicate timely to my advisors all stakeholders involved in the study including any source of funding for this research.

Name: Dr Aklilu Mente

Signature _____

Date _____

Approval of Advisors

1. Name: **Dr. Ferid Hamza (Assistant Professor of FMT)**

Signature: _____

Date: _____

2. Name:

Signature: _____

Date: _____