

ORIGINAL ARTICLE

ESTIMATION OF AGE BY RADIOLOGICAL EXAMINATION OF THE ILIAC CREST: A STUDY ON YOUNG ADULTS

Varma N, Harsh, Srivastava JV, Dode P*

Department of Forensic Medicine, Teerthanker Mahavir Medical College & Research Center, Moradabad, Uttar Pradesh, India

ABSTRACT

Objective: This study aimed to estimate the age of young adults within the age group of 18-25 years using radiological examination of the iliac crest of the iliac bone. It also aimed to determine the age range with the mean within this study group. The sample size consisted of 200 participants, with equal representation of males and females.

Methods: This cross-sectional study was conducted using radiological examination of the iliac crests of the iliac bones. The study participants were aged between 18 and 25 years, with no history of significant trauma or skeletal abnormalities.

Results: The mean age of the study population was calculated. The minimum and maximum ages were determined as well. Data were analyzed separately for males and females to assess any gender-specific variations. The mean age of fusion of the iliac crest was calculated to be 22.25 ± 1.36 years, with a median age of 22.41 years for males whereas for females, the mean age was 21.96 ± 1.5 years, with a median age of 22.04 years. The fusion started at the earliest 19-<20 years in males and 18-<19 years in females.

Conclusion: Radiological examination of the iliac bone is a reliable method for estimating the age of young adults within the age group of 18-25 years. This study provides valuable information on the mean age, minimum age, and maximum age within this age group, which can contribute to forensic investigations, medical assessments, and population studies. Further research should focus on expanding the age range and including larger sample sizes to enhance the accuracy and generalizability of age estimation techniques.

Keywords: Age estimation; iliac bone; radiological age

Corresponding author: Dode P

dodepramod@gmail.com

ORCID ID: <https://orcid.org/0009-0006-5768-5559>

ARTICLE HISTORY

Received: 16.09.2024

Received in revised form: 18.11.2024

Accepted: 26.11.2024

Available online: 20.12.2024



This article is licensed under the terms of the Creative Commons Attribution-Non Commercial 4.0 International License.

INTRODUCTION

Determining the age of an individual, whether they are alive or deceased, at various stages of decomposition poses a challenge for medical experts in both civil and criminal cases¹. It is a crucial aspect of forensic examinations in medicolegal practice. Numerous researchers have studied this process, aiming to comprehend its origins, development, consequences, and potential countermeasures². The fusion of the iliac crest, which typically occurs around 18-21 years of age, plays a significant role in determining

several factors such as the appropriate age for marriage, attaining legal adulthood, voting rights, eligibility to contest elections, judicial sentencing, cases of kidnapping (as defined by section 361 of the Indian Penal Code)³, consent for participating in hazardous sports (as outlined under section 87 of the Indian Penal Code)⁴, and establishing personal identification in India. The present study aims to investigate the fusion of the epiphysis of the iliac crest to provide an estimated age range.

METHODS

This cross-sectional, observational study was conducted at the University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi, India, from Nov 2019 to April 2021. This institute caters to the north Indian population from Himachal Pradesh, Uttarakhand, Punjab, Haryana, Uttar Pradesh & Rajasthan, and Union territory of Chandigarh, Ladakh. The study participants were aged between 18 and 25 years. A total of 200 participants, with the age and sex known, were selected using random sampling (100 male and 100 female). Official documents like Aadhar Cards, voter identity cards (IDs), and school certificates were used to verify their age and native residence. Individuals without a documented age, having metabolic diseases that could affect bone age, history of fractures of the pelvis and clavicle, those with systemic diseases or drug use affecting skeletal development, non-natives of North India, pregnant women, and individuals of sexes other than male or female were excluded from this study. Ethical clearance was obtained from the Institutional Ethics Committee of the institute before the start of the study via the letter no HR/2019/41/36 dated 16/10/2019. Informed written consent was obtained from the participants. Digital radiographs of the antero-posterior (AP) view of the pelvis were taken and examined by the principal investigator to assess the degree of ossification of the iliac crest. The positioning for the AP view involved the subject lying supine, with adjustments made to align the median sagittal plane with the couch's central longitudinal axis. The anterior superior iliac spines were ensured to be equidistant from the top of the couch using non-opaque pads. Foam

pads were placed under the knees for comfort, and the heels were separated while rotating the limbs inward. Sandbags were used to maintain limb position. The X-ray beam was centered in the midline between the anterior superior iliac spines and the superior border of the symphysis pubis, with the central ray perpendicular to the film. The X-ray was performed with a General Electric X-ray machine. The estimated ages were presented as a range with a mean $\pm$ standard deviation and median also calculated.

RESULTS

A total of 200 radiographs, with 100 male and 100 female subjects, depicting the AP view of the pelvis were analysed. The subjects were within the age range of 18 to 25 years. To further analyse the data, the entire population was divided into specific age groups: 18 to less than 19 (group 1), 19 to less than 20 (group 2), 20 to less than 21 (group 3), 21 to less than 22 (group 4), 22 to less than 23 (group 5), 23 to less than 24 (group 6), and 24 to less than 25 years (group 7). The statistical analysis was performed using SPSS 20.0 software.

The findings of the study revealed that among the 17 male candidates in group (1), the epiphysis of the AP view of the iliac crest was unfused in all cases. In the group (2), only 3 out of the 16 male candidates (18.75%) demonstrated complete epiphyseal fusion. In the group (3), 12 out of the 15 male candidates (80%) showed complete epiphyseal fusion. In the group (4), 10 out of the 12 male candidates (83.34%) exhibited complete epiphyseal fusion. Among the subjects of the group (5), 17 out of the 18 male subjects (94.44%) demonstrated complete epiphyseal fusion. Above the age of 23 years, all 39 male candidates in groups (6) and (7) displayed complete epiphyseal fusion.

In males, the fusion of the epiphysis of the iliac crest' commenced at the age of 19 years and was completed by the age of 24 years. The mean age of fusion was calculated to be 22.25 ± 1.36 years, with a median age of 22.41 years (Table 1).

Table 1: Epiphyseal fusion of the iliac crest in males

Age group (years)	Cases showed complete fusion	Total cases
18-<19 (Group 1)	0	17
19-<20 (Group 2)	3	16
20-<21 (Group 3)	12	15
21-<22 (Group 4)	10	12
22-<23 (Group 5)	17	18
23-<24 (Group 6)	17	17
24-<25 (Group 7)	5	5

We observed that among the 23 female participants in group (1), only one individual (4.3%) showed fused epiphysis of the iliac crest. In group (2), 8 out of the 16 female participants (50%) displayed complete epiphyseal fusion. In group (3), 10 out of the 11 female participants (90.9%) exhibited complete epiphyseal fusion. Remarkably, in group (4), all 15 female participants (100%) showed complete epiphyseal fusion. Above the age of 22 years, all 35 female participants in groups (5), (6), and (7) demonstrated complete epiphyseal fusion of the iliac crest.

In females, the fusion of the epiphysis of the iliac crest began at the age of 18 years and was completed by the age of 23 years. The mean age of fusion was calculated to be 21.96 ± 1.5 years, with a median age of 22.04 years (Table 2).

Table 2: Epiphyseal fusion of iliac crest in females

Age group (years)	Cases showed complete fusion	Total cases
18-<19 (Group 1)	1	23
19-<20 (Group 2)	8	16
20-<21 (Group 3)	10	11
21-<22 (Group 4)	15	15
22-<23 (Group 5)	11	11
23-<24 (Group 6)	22	22
24-<25 (Group 7)	2	2

Figure 1 depicts an X-ray of the pelvis of a subject from the group (5), demonstrating an unfused epiphysis of the iliac crest. Figure 2 illustrates an X-ray of the pelvis of a subject from the group (6), showing a fused epiphysis of the iliac crest.



Figure 1: X-ray of the pelvis of a subject from the group (5) showing unfused epiphysis of the iliac crest.



Figure 2: X-ray of the pelvis of a subject from the group (6) showing fused epiphysis of the iliac crest.

DISCUSSION

According to this study, the complete fusion of the epiphysis of the iliac crest occurred at an average age of 22.25 ± 1.35 years in males and 21.96 ± 1.5 years in females. Importantly, there was no statistically significant difference observed in the age of fusion between males and females, indicating a similarity in the timing of this developmental milestone.

According to other studies conducted in India and the rest of the world, regional variations in the age of iliac crest fusion were observed. Therefore, it is crucial to consider the most up-

to-date data specific to a given for a more accurate estimation of age.

These findings are consistent with the findings of other Indian researchers, such as Singh P *et al.* (Punjab), Parikh *et al.* (Delhi), and Sankhyn *et al.* (Himachal Pradesh). All of these studies were performed in the Indian subcontinent, which has a similar nutritional status and environment.

Table 3: Comparison of the age of complete fusion of iliac crest with other studies conducted in India.

Author	Place of study	Age of males (years)	Age of females (years)
Singh P <i>et al.</i> ⁵	Punjab	23-24	22-23
Parikh <i>et al.</i> ⁶	Delhi	20-21	20-21
Sankhya S <i>et al.</i> ⁷	Himachal Pradesh	21.5	21.5
Present study	Delhi	23-24 (Mean age 22.25±1.35)	21-22 (Mean age 21.96±1.50)

To further explore the global perspective, we compared our findings with studies conducted outside India. The results were similar to studies conducted in the Eastern region of the Indian subcontinent as well as in Europe. Similar researches were conducted by Bartolini *et al.*⁸ in Germany, Wittschieber D *et al.*⁹ in Europe, and Ekizoglu O *et al.* in Turkey. All three studies reported the age at which fusion was complete as 21.74 years, 20.8 years, and 23.11 years in males, and 21.59 years, 20.8 years, and 22.88 years in females, respectively.

Table 4: Comparison of the age at which fusion of the epiphysis of the iliac crest was complete with other studies conducted in the world.

Author	Place of study	Age of males (years)	Age of females (years)
Bartolini V <i>et al.</i> ⁸	Germany	21.74	21.59
Wittschieber D <i>et al.</i> ⁹	Europe	20.8	20.8
Ekizoglu O <i>et al.</i> ¹⁰	Turkey	23.11	22.88
Present study	India	22.25±1.35	21.96±1.50

CONCLUSION

Radiological assessment of the pelvis can serve as a reliable method for estimating an individual's age during their second and third decades of life. This modality is preferred due to its quick, non-invasive nature and ease of performing and assessing the fusion. However, further research is needed to effectively apply this method to populations from different geographical locations.

ACKNOWLEDGEMENTS

None.

CONFLICTS OF INTEREST

The author declared no conflicts of interest.

ETHICAL ISSUES

The study was conducted after obtaining approval from the Institutional Ethics Committee of the University College of Medical Sciences, University of Delhi, via letter no. IEC-HR/2019/41/36.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

NV: Drafting the work and revising it critically for important intellectual content; final approval of the version to be published. **H:** Acquisition of data for the work and final approval of the version to be published. **JVS:** Revising the work critically for important intellectual content; final approval of the version to be published. **PD:** Revising the work critically for important intellectual content; final approval of the version to be published.

REFERENCES

1. Biswas G. *Review of Forensic Medicine and Toxicology*. 2nd ed. Delhi: Jaypee Brothers Medical Publisher; 2012. p45-56.
2. Kerley ER. Estimation of skeletal age: After about age 30 years. In: *Textbook of Biological Anthropology of the Human Skeleton*. 3rd ed. USA: John Wiley & Sons; 1970. p.57-70.
3. India Code. *Indian Penal Code - Section 361*. Available from: https://www.indiacode.nic.in/show-data?actid=AC_CEN_5_23_00037_186045_1523266765688§ionId=46132§ionno=361&orderno=405 [Accessed 22nd August 2024].
4. India Code. *Indian Penal Code – Section 87*. Available from: https://www.indiacode.nic.in/show-data?actid=AC_CEN_5_23_00037_186045_1523266765688§ionId=45821§ionno=87&orderno=91#:~:text=Nothing%20which%20is%20not%20intended [Accessed 22nd August 2024].
5. Singh J, Chavali K. Age estimation from clavicular epiphyseal union sequencing in a Northwest Indian population of the Chandigarh region. *Journal of Forensic and Legal Medicine*. 2011;18(2):82–7. <https://doi.org/10.1016/j.jflm.2010.12.005>.
6. Vij K. Identification. In: *Textbook of Forensic Medicine, Principles and Practice*. 1st ed. Edinburgh: Churchill Livingstone; 2001. p74-82.
7. Sankhyan S. Age and ossification of some hip bone centres in Himachal Pradesh. *Journal of Forensic Medicine & Toxicology*. 1993;10:3-5.
8. Bartolini V, Pinchi V, Gualco B, *et al*. The iliac crest in forensic age estimation: evaluation of three methods in pelvis X-rays. *International Journal of Legal Medicine*. 2017;132(1):279-88. <https://doi.org/10.1007/s00414-017-1629-z>.
9. Wittschieber D, Vieth V, Timme M, Dvorak J, Schmeling A. Magnetic resonance imaging of the iliac crest: age estimation in under-20 soccer players. *Forensic Science, Medicine, and Pathology*. 2014;10(2):198-202. <https://doi.org/10.1007/s12024-014-9548-5>
10. Ekizoglu O, Inci E, Erdil I, *et al*. Computed tomography evaluation of the iliac crest apophysis: age estimation in living individuals. *Internal Journal of Legal Medicine*. 2016;130(4):1101-7. <https://doi.org/10.1007/s00414-016-1345-0>