AGE DETERMINATION FROM PUBIC SYMPHYSEAL CHANGES- AN AUTOPSY STUDY

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ABSTRACT

BACKGROUND

Biological identity is one of the first things to be established when analysing skeletal, badly decomposed or otherwise unidentified human remains. The determination of age at death is an important component of identity establishment. Pubic symphysis examination is one of the reliable methods of age estimation. We attempt to determine the age of deceased from pubic symphysis using Suchey-Brooks method and to find the accuracy of Suchey-Brooks method in our population. From among the cases brought for autopsy at Department of Forensic Medicine, Government Medical College, Kottayam, Kerala, from 01/03/2012 to 28/02/2013, 316 cases were included in the study. Their pubic symphysis were harvested. Age determined using Suchey-Brooks method and compared with their chronological age.

The aim of the study is to-

1. Determine the age of deceased from pubic symphysis using Suchey-Brooks method.
2. Compare the age determined by Suchey-Brooks method and chronological age and find the accuracy of Suchey-Brooks method in our population.

MATERIALS AND METHODS

Study Design- Descriptive study- Cross-sectional study, Centre of Study- Department of Forensic Medicine, Government Medical College, Kottayam, Study Sample- From the cases brought for medicolegal postmortem examination in the Department of Forensic Medicine, Government Medical College, Kottayam, Kerala, a sample of 316 cases were selected. To make the distribution among various age groups, even the total sample divided for the age group, which resulted in having 60 samples per age group. Age groups were considered as Group 1- Age between 18-25 years; Group 2- Age between 25-35 years; Group 3- Age between 35-45 years; Group 4- Age between 45-55 years; Group 5- Age between 55-65 years.

Inclusion Criteria- 1. Cases with known age; 2. Cases whose age between 18 and 65 years.
Exclusion Criteria- 1. Unknown cases; 2. Known cases with doubtful age; 3. Individuals having pubic bone trauma involving the symphysis; 4. Individuals displaying pelvic pathologies affecting pelvic girdle.
Tools-

1. Structured proforma, it is used to gather sociodemographic details of the subjects and to record the physical examination findings.
2. Suchey-Brooks method of age estimation from pubic symphysis.

RESULTS

Out of the 316 cases, 243 were males and 73 were females. In males, highest number of cases falls in phase 5 and lowest in phase 1 of Suchey-Brooks system. In females, highest number of cases falls in phase 1 and lowest in phase 3. Relief of the symphyseal surface, delimitation, symphyseal rim and pubic tubercle were found to be reliable indicators in estimating age from pubic symphysis. In males, when means of my study was compared with that of Suchey-Brooks method, it was found that means differ in less than 4 years in all phases except in phase 4. In females, in all phases, differences between the mean ages of our population and the Suchey-Brooks series were less than three years. Age estimation by Suchey-Brooks method is comparatively reliable in individuals up to 30 years of age, but less reliable at higher ages. Suchey-Brooks method can be applied for both sexes in our population.

CONCLUSION

Following conclusions could be drawn from the study results- Relief of the symphyseal surface, delimitation, symphyseal rim and pubic tubercle to be reliable indicators in estimating age from pubic symphyseal surface using Suchey-Brooks method. All six phases of Suchey-Brooks method can be applied in our population. Suchey-Brooks method can be applied for both sexes. Caution should be exercised while applying Suchey-Brooks method to cases falling in phase 4. Suchey-Brooks method is reliable in individuals up to 30 years of age, but less reliable at higher ages. Race and environmental factors does not seem to play a significant role in morphological changes in the pubic symphysis.

KEYWORDS

Age Determination, Pubic Symphysis, Suchey-Brooks Method.

BACKGROUND

In a large study of male pubic symphysis, Katz and Suchey in 1986 pointed out considerable problems with the samples and techniques of both Todd and McKern and Stewart. The Suchey-Katz sample was large, documented, modern sample of 739 males autopsied at the Department of Chief Medical Examiner-Coroner, County of Los Angeles. Ages at death ranged from 14 to 92 years and contained individuals from a diverse background (birthplaces in 32 countries). The pubic symphysis were first scored according to the Todd (1921) and McKern and Stewart (1957) methods. The observed ranges were found to be much wider than those reported in the original studies. Their results supported earlier studies that found the Todd system systematically overages individuals and that neither the Todd nor the McKern and Stewart system can account for the sum total of human variation, especially in older age phases. Furthermore, Katz and Suchey rejected the three-component approach of McKern and Stewart asserting that the three components do not vary independently and that an approach focusing on the entire pattern of morphological change, i.e., Todd's phase method is easier to use.[1] In light of these conclusions, they proposed a modified Todd method where the 10 phases have been reduced to six phases, now referred to as Suchey-Brooks method.[1,2]

In 1990, Brooks and Suchey added 273 female pubic symphyses to the original male sample of 739 individuals to refine the morphological descriptions of the six phases and present sex-specific age ranges. So, this method was first adopted for males and later for females. They reported that previous research justified the need for a separate set of standards for females because of shape and pregnancy-related changes in the pelvis.[1,2]

While the method is known as Suchey-Brooks method, the publications are Katz and Suchey (1986) and Brooks and Suchey (1990).[2]

Characteristic morphology of each phase of the Suchey-Brooks system.[3]

Phase I- Symphyseal face has a billowing surface (ridges and furrows), which usually extends to include the pubic tubercle. The horizontal ridges are well-marked and ventral bevelling maybe commencing. Although, ossific nodules may occur on the upper extremity, a key to the recognition of this phase is the lack of delimitation of either extremity (upper or lower).

Mean age; range- Male=18.5; 15-23/Female=19.4; 15-24.

Phase II- The symphyseal face may still show ridge development. The face has commencing delimitation of lower and/or upper extremities occurring with or without ossific nodules. The ventral rampart maybe in beginning phases as an extension of the bony activity at either or both extremities.

Mean age; range- Male=23.4; 19-34/Female=25; 19-40.

Phase III- Symphyseal face shows lower extremity and ventral rampart in process of completion. There can be a continuation of fusing ossific nodules forming the upper extremity and along the ventral border. Symphyseal face is smooth or can continue to show distinct ridges. Dorsal plateau is complete. Absence of lipping of symphyseal dorsal margin; no bony ligamentous outgrowths.

Mean age; range- Male=28.7; 21-46/Female=30.7; 21-53.

Phase IV- Symphyseal face is generally fine grained, although remnants of the old ridge and furrow system may still remain. Usually, the oval outline is complete at this stage, but a hiatus can occur in upper ventral rim. Pubic tubercle is fully separated from the symphyseal face by definition of upper extremity. The symphyseal face may have a distinct rim. Ventrally, bony ligamentous outgrowths may occur on inferior portion of pubic bone adjacent to symphyseal face. If any lipping occurs, it will be slight and located on the dorsal border.

Mean age; range- Male=35.2; 23-57/Female=38.2; 26-70.

Phase V- Symphyseal face is completely rimmed with some slight depression of the face itself relative to the rim. Moderate lipping is usually found on the dorsal border with more prominent ligamentous outgrowths on the ventral border. There is little or no rim erosion. Breakdown may occur on superior ventral border.

Mean age; range- Male=45.6; -27-66/Female=48.1; 25-83.

Phase VI- Symphyseal face may show ongoing depression as rim erodes. Ventral ligamentous attachments are marked. In many individuals, the pubic tubercle appears as a separate bony knob. The face maybe pitted or porous giving an appearance of disfigurement with the ongoing process of erratic ossification. Crenulations may occur. The shape of the face is often irregular at this stage.

Mean age; range- Male=61.2; 34-86/Female=60; 42-87.9.

MATERIALS AND METHODS

The selected subjects were moved to the autopsy table where they were examined as per the usual autopsy norms. The neck to pubic incision was done as per the usual guidelines until root of pubis. The tissues around the pubic bones were dissected apart and the pubic bones were exposed. The segments of pubic bone on both sides were cut by sawing at the superior and inferior ramus 2.5 cm from

symphysis pubis freeing the two pubic bones with the symphysis intact. This specimen was taken to the lab of the Department of Forensic Medicine, Medical College, Kottayam, and was first tagged with the postmortem number. Then, they were immersed in 2% potassium hydroxide solution and boiled for two hours. Bones were washed in plain water and immersed in chloroform to dissolve fat. Again, the bones were washed in plain water dried in sun. The bones were repeatedly examined with soft force to find for separation of the bones. Once found separated, the investigator will proceed to examination of the ridges on the bones in the region of the pubic symphysis. It was graded from 1 to 6 as per the Suchey-Brooks criteria. Any doubtful cases were consulted with the guides for expert opinion. After the proper categorisation of the ridges, the postmortem numbers will be looked back to find the real age of the deceased to which the comparisons are to be made.

Statistical Analysis

The success in the performance of an ageing method can be defined as the proximity of an age estimate to an individual's actual chronological age. The investigator analysed the success in the performance of the Suchey-Brooks method by comparing with the chronological age. It was analysed using SPSS V 19 involving Z-test and other relevant analysis.

RESULTS

The study sample is constituted by 316 cases brought for autopsy to Department of Forensic Medicine, Government Medical College, Kottayam. Gender distribution among the population is as follows.
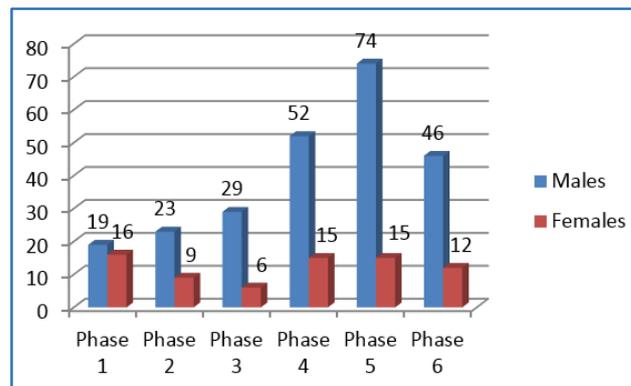
Distribution of Gender Among the Study Population

The study sample consisted of 243 males and 73 females accounting for 77% and 23%, respectively.
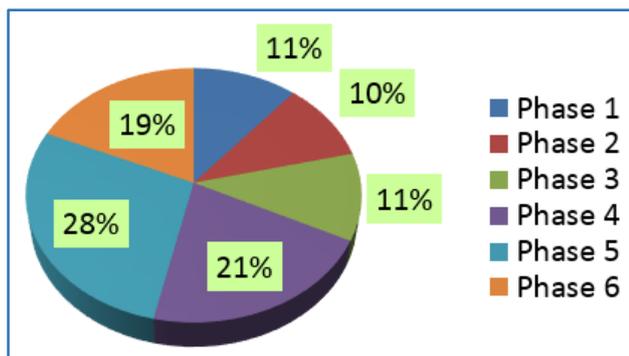
Graph 1. Distribution of Cases in Various Phases among the Study Population

Phase 5 constituted the largest group with 89 cases and phase 2 constituted the smallest group with 32 cases.

Graph 2.Distribution of Gender among Various Phases

Highest number of males was in phase 5 and lowest number in phase 1. Highest number of females was in phase 1 and lowest number in phase 3.

Descriptive Statistics of Various Phases in the Present Study among Males

After applying Suchey-Brooks method to our study, the mean age of males for phase 1 was found to be 20.26; for phase 2, the mean was 24.04; for phase 3, the mean was 29; for phase 4, the mean was 42.26; for phase 5, the mean was 45.96 and the mean was 57.78 for phase 6. The standard deviation was highest for phase 4 having a value 10.21 and lowest for phase 1 with the value of 1.8.

Phases	N	Mean	S.D.	Range
Phase 1	19	20.26	1.8	18-24
Phase 2	23	24.04	2.27	21-30
Phase 3	29	29	2.27	25-34
Phase 4	52	42.26	10.21	25-65
Phase 5	74	45.96	7.1	32-62
Phase 6	46	57.78	4.5	50-65
Total	**243**	**41.38**	**13.45**	**18-65**

Table 1. Descriptive Statistics of Various Phases in the Present Study among Males

	Kottayam Standards	Suchey Brooks
Phase 1	18-24	15-23
Phase 2	21-30	19-34
Phase 3	25-34	21-46
Phase 4	25-65	23-57
Phase 5	32-62	27-66
Phase 6	50-65	34-86

Table 2. Comparison of Age Ranges between this Study and that of Suchey-Brooks Study among Males

For phase 1, the range of age of males in our study was 18-24 compared with 15-23 in Suchey-Brooks study. For phase 2, our age range was 21-30 compared with 19-34 of Suchey-Brooks method. For phase 3, age range in our study was 25-34 compared with 21-46 in SB method. For phase 4, age range in our study was 25-65 compared with 23-57 in SB method. For phase 5, the age range in our study was 32-62 compared with mean of 27-66 in SB study. For phase 6, our age range was 50-65 compared with that of 34-68 in SB method.
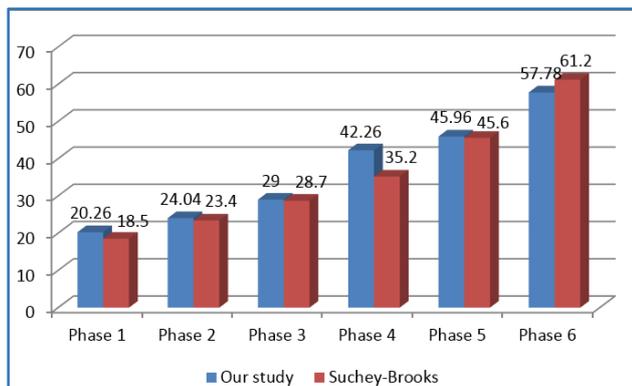
Graph 3. Comparison of Means between Cases in Present Study and that of Suchey-Brooks Standards among Males

For phase 1, the mean age of males in our study was 20.26 compared with 18.5 in Suchey-Brooks study. Applying Z-test, the 95% range of males in our study population falls within the range of 16.62-23.88 years, which includes the SB mean for phase 1.

For phase 2, the mean was 24.04 compared with 23.4 of Suchey-Brooks method. Applying Z-test, the 95% range of males in our study population falls within the range of 19.5-28.58 years, which includes the SB mean for phase 2 for males.

For phase 3, mean in present study was 29 compared with mean of 28.7 in SB method. Applying Z-test, the 95% range of males in our study population falls within the range of 24.46-33.54 years, which includes the SB mean for phase 3.

For phase 4, mean in present study was 42.26 compared with 35.2 in SB method. Applying Z-test, the 95% range of males in our study population falls within the range of 21.84-62.68 years, which includes the SB mean for phase 4.

For phase 5, the mean was 45.96 compared with mean of 45.6 in SB study. Applying Z-test, the 95% range of males in our study population falls within the range of 31.76-60.16 years, which includes the SB mean for phase 5.

For phase 6, our mean was 57.8 compared with that of 61.2 in SB method. Applying Z-test, the 95% range of males in our study population falls within the range of 48.78-66.78 years, which includes the SB mean for phase 6.

Phases	N	Mean	S.D.	Range
Phase 1	16	20.31	2.33	18-24
Phase 2	9	24.56	1.67	21-26
Phase 3	6	31	3.67	27-36
Phase 4	15	37.53	5.69	29-49
Phase 5	15	46.2	4.78	38-55
Phase 6	12	58	10.17	28-65
Total	**73**	**36.79**	**14.28**	**18-65**

**Table 3. Descriptive Statistics of Various Phases in Present Study among Females**

After applying Suchey-Brooks method to my study, the mean age for females in phase 1 was found to be 20.31. For phase 2, the mean was 24.56. For phase 3, the mean was 31. For phase 4, the mean was 37.53. For phase 5, the mean was 46.2 and the mean was 58 for phase 6. The standard deviation was highest for phase 6 having a value 10.17 and lowest for phase 2 with the value of 1.67.

	Our Study	Suchey Brooks
Phase 1	18-24	15-24
Phase 2	21-26	19-40
Phase 3	27-36	21-53
Phase 4	29-49	26-70
Phase 5	38-55	25-83
Phase 6	28-65	42-87

Table 4. Comparison of Ranges between Cases Done at Kottayam and that of Suchey-Brooks among Females

For phase 1, the range of age of females in our study was 18-24 compared with 15-24 in Suchey-Brooks study. For phase 2, our age range was 21-26 compared with 19-40 of Suchey-Brooks method. For phase 3, age range in our study was 27-36 compared with 21-53 in SB method. For phase 4, age range in our study was 29-49 compared with 26-70 in SB method. For phase 5, the age range in our study was 38-55 compared with mean of 25-83 in SB study. For phase 6, our age range was 28-65 compared with that of 42-87 in SB method.
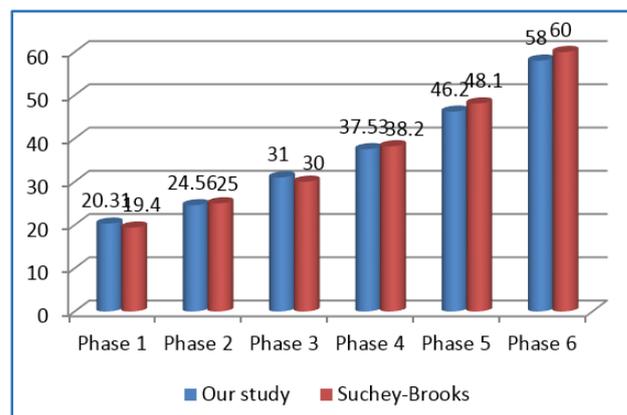
Graph 4. Comparison of Means between Cases Analysed and that of Suchey-Brooks Standards among Females

For phase 1, the mean age of females in our study was 20.31 compared with 19.4 in Suchey-Brooks study. Applying Z-test, 95% range of females in our study population falls within the range of 15.65-24.97 years, which includes the SB mean for phase 1 for females.

For phase 2, our mean was 24.56 compared with 25 of Suchey-Brooks method. Applying Z-test, 95% range of females in our study population falls within the range of 21.22-27.9 years, which includes the SB mean for phase 2 for females.

For phase 3, mean in present study was 31 compared with mean of 30 in SB method. Applying Z-test, the 95% range of females in our study population falls within the range of 23.66-38.34 years, which includes the SB mean for phase 3.

For phase 4, mean in present study was 37.53 compared with 38.2 in SB method. Applying Z-test, the 95% range of females in our study population falls within the range of 26.15-48.91 years, which includes the SB mean for phase 4.

For phase 5, the mean in this study was 46.2 compared with mean of 48.1 in SB study. Applying Z-test, the 95% range of females in our study population falls within the range of 36.64-55.76 years, which includes the SB mean for phase 5.

For phase 6, our mean was 58 compared with that of 60 in SB method. Applying Z-test, the 95% range of females in our study population falls within the range of 37.66-78.34 years, which includes the SB mean for phase 6.

DISCUSSION

Estimating the age-at-death of adult skeletal remains is one of the most important aspects of establishing identity. On the basis of the morphological changes related to the ageing process, age is estimated from the pubic symphysis and articular surface of the ilium. Suchey-Brooks method is considered to be the most reliable method for estimating age from pubic symphysis. We attempted to study the accuracy of Suchey-Brooks method in our population.

Sample- 316 cases brought for autopsy to Department of Forensic Medicine, Government Medical College, Kottayam, out of which 243 males and 73 females were studied. Suchey-Brooks system was developed with a reference sample of 1255.

Morphological Characteristics

Number of ridges and furrows ridges and furrows were in decreasing order when going from phase 1 to phase 6. Ridges and furrows were prominent and numerous in phase 1 and almost nil in phases 3 to 6. This is in agreement with the Suchey-Brooks method. When Telmon et al in 2005 in France applied the Suchey-Brooks method to three-dimensional computed tomographic reconstructions of the pubic symphysis, he found excellent agreement between the results of analysis of bone samples and those of the three-dimensional images, in particular regarding ridges.[4]

Smoothness of surface of pubic symphysis.

The pubic symphyseal surface was becoming smoother when going from phase 1 to phase 6. Pubic symphyseal surface was smooth in 100% cases in phase 5 and phase 6. Pubic symphyseal surface was rough in 100% cases in phase 1 and phase 2. This is in agreement with the Suchey-Brooks method.

Depression of pubic symphyseal surface.

The pubic symphyseal surface was depressed in phase 4-6. Most of the cases in phase 5 showed depression of pubic symphyseal surface. Phase 1-3 are devoid of depression in their pubic symphyseal surface. This is an agreement with the Suchey-Brooks method.

Separation of pubic tubercle in each phase.

Separation of pubic tubercle from symphyseal face is becoming more when going from phase 1 to phase 6. Suchey-Brooks method mentions about the presence of pubic tubercle appearing as a separate knob in phase 6 in many individuals, which we could not find in our study.

The study carried out in 2007 by Djuri et al in Balkans found that the most reliable indicators in both sexes were the relief of the symphyseal surface, lipping, symphyseal rim

and dorsal margin.[5] In our study, we found that the relief of the symphyseal surface, delimitation, symphyseal rim and pubic tubercle to be reliable indicators.

Comparison of Mean Ages
Males
Phase 1

For phase 1, the mean age of males in our study was 20.26 compared with 18.5 in Suchey-Brooks study. Applying Z-test, the 95% range of males in our study population falls within the range of 16.62-23.88 years, which includes the SB mean for phase 1 for males. This says that the same system can be applied in our population without variation.

Phase 2

For phase 2, our mean was 24.04 compared with 23.4 of Suchey-Brooks method. Applying Z-test, the 95% range of males in our study population falls within the range of 19.5-28.58 years, which includes the SB mean for phase 2 for males. This says that the same system can be applied in our population without variation.

Phase 3

For phase 3, mean in our study was 29 compared with mean of 28.7 in SB method. Applying Z-test, the 95% range of males in our study population falls within the range of 24.46-33.54 years, which includes the SB mean for phase 3. This says that the same system can be applied in our population without variation.

Phase 4

For phase 4, mean in present study was 42.26 compared with 35.2 in SB method. Applying Z-test, the 95% range of males in our study population falls within the range of 21.84-62.68 years, which includes the SB mean for phase 4. This says that the same system can be applied in our population without variation.

Phase 5

For phase 5, the mean in present study was 45.96 compared with mean of 45.6 in SB study. Applying Z-test, the 95% range of males in our study population falls within the range of 31.76-60.16 years, which includes the SB mean for phase 5. This says that the same system can be applied in our population without variation.

Phase 6

For phase 6, our mean was 57.8 compared with that of 61.2 in SB method. Applying Z-test, the 95% range of males in our study population falls within the range of 48.78-66.78 years, which includes the SB mean for phase 6. This says that the same system can be applied in our population without variation. This is in contrast with the study carried out in 2007 by Djueic et al in Balkans, which found that the mean values of the sixth age category differed significantly compared with the original model.[5]

Females
Phase 1
For phase 1, the mean age of females in our study was 20.31 compared with 19.4 in Suchey-Brooks study. Applying Z-test, 95% range of females in our study population falls within the range of 15.65-24.97 years, which includes the SB mean for phase 1 for females. This says that the same system can be applied in our population without variation.

Phase 2
For phase 2, our mean was 24.56 compared with 25 of Suchey-Brooks method. Applying Z-test, 95% range of females in our study population falls within the range of 21.22-27.9 years, which includes the SB mean for phase 2 for females. This says that the same system can be applied in our population without variation.

Phase 3
For phase 3, mean in our study was 31 compared with mean of 30 in SB method. Applying Z-test, the 95% range of females in our study population falls within the range of 23.66-38.34 years, which includes the SB mean for phase 3. This says that the same system can be applied in our population without variation.

Phase 4
For phase 4, mean in our study was 37.53 compared with 38.2 in SB method. Applying Z-test, the 95% range of females in our study population falls within the range of 26.15-48.91 years, which includes the SB mean for phase 4. This says that the same system can be applied in our population without variation.

Phase 5
For phase 5, the mean in this study was 46.2 compared with mean of 48.1 in SB study. Applying Z-test, the 95% range of females in our study population falls within the range of 36.64-55.76 years, which includes the SB mean for phase 5. This says that the same system can be applied in our population without variation.

Phase 6
For phase 6, our mean was 58 compared with that of 60 in SB method. Applying Z-test, the 95% range of females in our study population falls within the range of 37.66-78.34 years, which includes the SB mean for phase 6. This says that the same system can be applied in our population without variation. We found that in all six phases in both sexes Suchey-Brooks method can be applied in our population with more reliability in younger individuals. This finding is in agreement with the following studies.

Limitations of the Study
- Including cases above 65 years of age would have increased the reliability of the study.
- Increasing the proportion of females in sample would increase the reliability of the study.

Future Implications
More studies need to be carried out in India to test the widespread applicability of Suchey-Brooks method. Studies using 3D imaging techniques should be carried out in India also which is the need of the time. To improve the reliability of Suchey-Brooks method in older age groups, a seventh phase has been suggested by some researchers with subsequent studies disagreeing with the seventh phase. More studies need to be carried out in this direction.

CONCLUSION
Following conclusions could be drawn from the study results-
- Relief of the symphyseal surface, delimitation, symphyseal rim and pubic tubercle to be reliable indicators in estimating age from pubic symphyseal surface using Suchey-Brooks method.
- All six phases of Suchey-Brooks method can be applied in our population.
- Suchey-Brooks method can be applied for both sexes.
- Caution should be exercised while applying Suchey-Brooks method to cases falling in phase 4.
- Suchey-Brooks method is reliable in individuals up to 30 years of age, but less reliable at higher ages.
- Race and environmental factors does not seem to play a significant role in morphological changes in the pubic symphysis.

Summary
The current study was designed as a cross-sectional study. Our aim was to find the applicability of Suchey-Brooks method of age estimation from pubic symphysis to our population. Sample was constituted by 316 cases brought for autopsy at Department of Forensic Medicine, Government Medical College, Kottayam, from 01/03/2012 to 28/02/2013. Their pubic symphyses were harvested. Age determined using Suchey-Brooks method and compared with their chronological relief of the symphyseal surface, delimitation, symphyseal rim and pubic tubercle to be reliable indicators in estimating age from pubic symphyseal surface using Suchey-Brooks method.

We found that all six phases of Suchey-Brooks method can be applied in our population. Suchey-Brooks method can be applied for both sexes. We should be cautious while applying Suchey-Brooks method to cases falling in phase 4. Suchey-Brooks method is reliable in individuals up to 30 years of age, but less reliable at higher ages. We found that race and environmental factors does not seem to play a significant role in morphological changes in the pubic symphysis.

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