SRYAHWA PUBLICATIONS

Archives of Reproductive Medicine and Sexual Health
ISSN: 2639-1791 | Volume 4, Issue 1, 2025
https://doi.org/10.22259/2639-1791.0401001

RESEARCH ARTICLE

Obstetric Dimensions of South Indian Females Analyzed Using Reconstructed Computed Tomography Images – a Pilot Study

Ananthi Varadarajan[2], Girishya Bollyamoni[1], Sumi Borah[1], Sathya Bharathy Sathyanathan[3], Prakash Seppan[1]

[1]Department of Anatomy, Dr. Arcot Lakshmanasamy Mudaliar Postgraduate Institute of Basic Medical Sciences, University of Madras, Taramani Campus, Chennai 600 113, Tamil Nadu, India.
[2]Department of Anatomy, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India.
[3]Department of Electrical Engineering, Loyola-ICAM College of Engineering and Technology, Chennai, India.

Received: 09 May 2025 Accepted: 23 May 2025 Published: 28 May 2025

Corresponding Author: Prakash Seppan, Department of Anatomy, Dr. Arcot Lakshmanasamy Mudaliar Postgraduate Institute of Basic Medical Sciences, University of Madras, Taramani Campus, Chennai, Tamil Nadu 600113, India.

Abstract

The human pelvic dimorphism makes it significant for anatomical, anthropological and forensic investigations. The normal pelvic shape may vary considerably in different races and regions. Surprisingly, very few studies are reported from the Indian population on female pelvis measurements and almost nil in peninsular India. Thus, a study using state-of-art technology (CT) on live subjects (especially in this region) is warranted. The present study analyzed normal female pelves in and around Chennai, India, to determine the reproductive and obstetric challenges. Comparing the anatomical dimensions of women in age groups of 25-35 and 35-45. Analyses indicated that the age of the subjects at the time of measurement would be an important consideration before utilizing pelvic data for a particular application. This study forms a report on anthropometric measurements of adult female pelvis from the south Indian population through CT imaging as a tool for acquiring data from live samples. This study compared the anatomical dimensions of the pelvic bone in modern-day women with reference to two age groups, i.e., 25-35 and 35-45. The data indicate a change in pelvic measurements between these two age groups from the same geographical region, though it is not statistically significant. This indicates the possibility of slight degree of variability during ageing, which could be progressive.

1. Introduction

The human pelvic dimorphism makes it significant for anatomical, anthropological and forensic investigations. The normal pelvic shape may vary considerably in different races and regions. There will be corresponding changes according to age, which significantly influence the course of labour in an ethnic group. During the evolution of erect posture and human bipedalism, the pelvis has been an important component, and its ability to accommodate enough room for viable full-term fetuses is another key aspect of pelvis development. Further evidence suggests that nutritional stress can cause flattening of the pelvic inlet, leading to cephalopelvic disproportion and obstructive labour, a condition more prevalent in developing countries (Konje and Ladipo, 2000). All these facts indicate the importance of anthropometric and pelvimetric analyses. Most data were collected from articulating the disarticulated hip bones with the sacrum, and studies were more concerned with sexual dimorphism. Hence, focuses on functional obstetric significance are fewer, especially from the Indian population.

Literature indicates that the age of the subjects at the time of measurement would be an important consideration before utilizing pelvic data for a particular application. Surprisingly, very few studies are reported from the Indian population on female

Citation: Ananthi Varadarajan, Girishya Bollyamoni, Sumi Borah, *et al*. Obstetric Dimensions of South Indian Females Analyzed Using Reconstructed Computed Tomography Images – a Pilot Study. Archives of Reproductive Medicine and Sexual Health. 2025; 4(1): 1-7.

pelvis measurements and almost nil in peninsular India. Thus, a study using state-of-art technology (CT) on live subjects (especially in this region) is warranted.

In this paper, we analyze the obstetric dimensions of normal female pelves from the population in and around Chennai city (Southern part of India) using reconstructed computerized tomography images. The objective was to analyze the pelvis to determine the reproductive challenges and obstetric viewpoint of the South Indian population regarding the present lifestyle. Comparing the anatomical dimensions of women in age groups of 25-35 and 35-45.

2. Methods

For this study, one hundred and ten female pelvis (reconstructed) CT images of known background information such as age, occupation and obstetric history were analyzed. These subjects/samples were obtained from hospitals in and around Chennai. Female subjects aged 25 and 50 were used for this study; people over 50 were excluded, and their nativity was confirmed through their biographies. Measurements of the true pelvis were taken using siba-software®. Human ethics committee clearance was obtained from Dr ALMPGIBMS, University of Madras (IHEC approval No: UM/IHEC/18-2013-I).

The following parameters were recorded, and anatomical dimensions of the female pelvic bone were analyzed with reference to two age groups, i.e., 25-35 and 35-45. (Figure 1-3).

2.1 Inlet Measurements (Figure 1)

Three diameters are measured in the Inlet of the pelvis; they are;

- Antero-posterior diameter: from the sacral promontory to the superior border of the back of the pubic symphysis
- Transverse diameter: from the widest points between the brim of the pelvis
- Right oblique and Left oblique diameter: From one sacro-iliac joint to opposite side of ilio-pubic eminence.

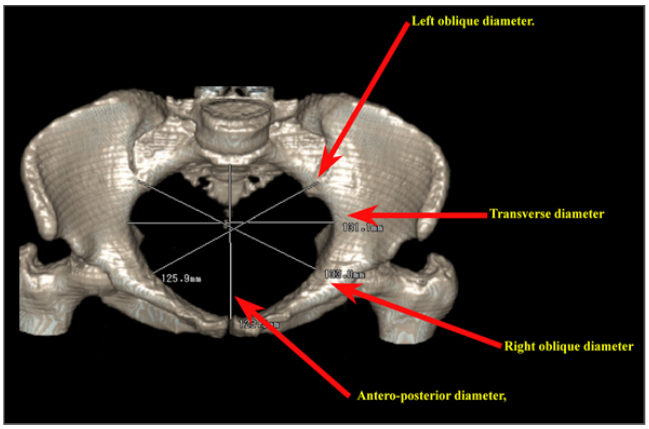


Figure 1. *Antero-posterior examination (from superior aspect) of a reconstructed CT pelvis. In the image the various measurement /references that are taken for the analysis at the Inlet of the pelvis were shown.*

2.2 Cavity (Mid-Pelvic Level) Measurements (Figure 2)

Extending from the pelvic brim to the pelvic outlet.

- Antero-posterior diameter: Points from the fourth sacral vertebra to the middle of the back of pubic symphysis.
- Transverse diameter (Inter-spinous): Distance between the tips of ischial spines

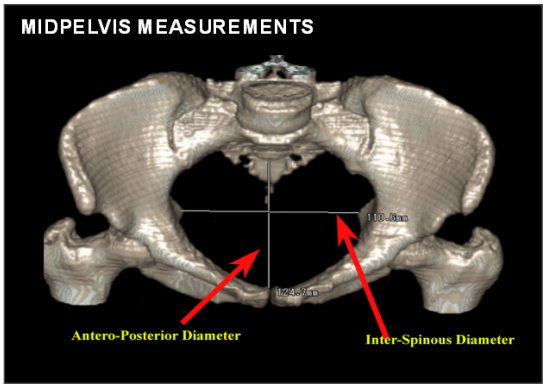


Figure 2. *Antero-posterior examination (from superior aspect) of a reconstructed CT pelvis. In the image the various measurement /references that are taken for the analysis at the mid-pelvis level were shown.*

2.3 Outlet Measurements (Figure 3)

- Anteroposterior diameter: Distance between the tip of the coccyx to the inferior border of the back of pubic symphysis.
- Transverse (intertuberous) diameter: Distance between the medial borders of ischial tuberosities.

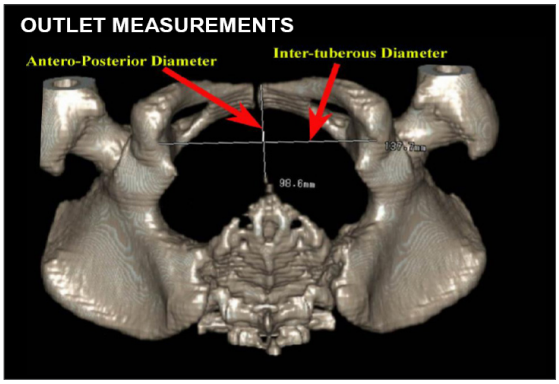
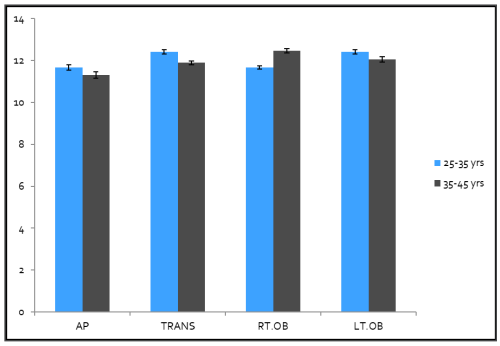


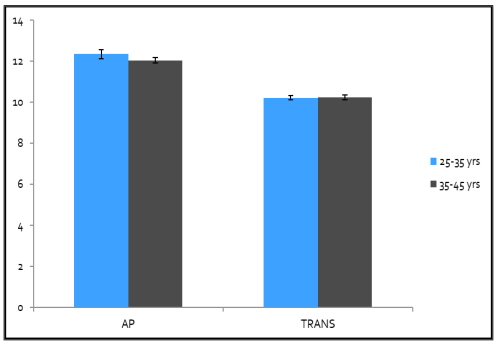
Figure 3. *Antero-posterior examination (from inferior aspect) of a reconstructed CT pelvis. In the image the various measurement /reference s taken for the analysis at the Inlet of the pelvis were shown.*

3. Results and Discussion

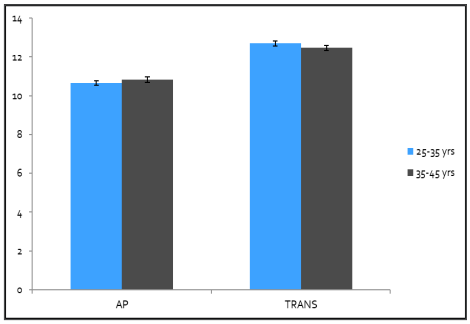
The anatomical dimensions of the pelvic bone in modern-day or present-day women in and around Chennai (India) with reference to two age groups, i.e., 25-35 and 35-45, were compared using reconstructed CT images. Results were presented in graphs 1-3 and Table.



Graph 1. *Pelvic Inlet measurements- Shows various measurements (in cm) of the pelvis at the level of the inlet. (AP) Antero-posterior Diameter, (TRANS) Transverse Diameter, (RT. OB) Right oblique and (Lt.OB) left oblique Diameters. Data are presented in ±SEM.*



Graph 2. *shows the Anteroposterior Diameter and transverse Diameter of the pelvic cavity.*



Graph 3. *shows the AnteroposteriorDiameter and transverse Diameter of the pelvic outlet.*

Table 1. *Showing comparison of Pelvimetry data from various studies/population*

Parameters Average value (cm)	INLET				MID-PELVIS		OUTLET	
	AP	TRANS	RT.OB	LT.OB	AP	TRANS	AP	TRANS
Whites & Negroid	11.2	13.1	12.5	12	13	9.5	12.5	11.8
Southern Nubian	10.3	11.6	11.3	11.1	11.5	9.1	11.1	9.7
African -American Women	11.7	11.8	*Not Available*	*Not Available*	*Not Available*	10.3	11.7	11.8
South Indians **PRESENT STUDY**	**11.8**	**12.5**	12.3	12.0	**12.1**	10.1	**10.8**	**12.5**

The data indicate a change in pelvic measurements between these two groups from the same geographical region, though it is not statistically significant. This indicates the possibility of a slight degree of variability during ageing, and changes may be progressive. There seem to be secular changes and inherent intra-populational variation in the pelvis (Schroeder et al., 1997). Thus, the age of the subjects at the time of measurement is an important consideration before utilizing pelvic data for a particular application (Hulth et al., 1995), including its usefulness in identifying the sex of the skeletal remains from geographic area, clinical, gynaecological and anatomical (paleodemography and paleopathology) correlations (Meindl et al., 1985; Armelagos and Van Gerven, 2003; Yurka, 2014). This also signifies that comparing anatomical data on other ethnic populations should be carefully corrected/calibrated with age and method adapted to acquire data.

Human diversity in India is complicated, and many units are spread across the country (Singh, 1998). Anthropologically, the populations consist of four major ethnic categories, which include the Australoid, Indo-Caucasoid, Indo-Mongoloid and Negrito populations. These origins are linguistically (broadly) classified as Indo-European, Dravidian, Austro-Asiatic and Sino-Tibetan speakers. The complex structure of the Indian population is attributed to persistent migrations, which seem to have started around 70,000 years ago, by the Austric speakers, followed by the Dravidian speakers from Middle Asia and the Sino-Tibetan speakers from China and Southeast Asia, around 8000 to 10,000 years ago. The recent major migration is believed to have occurred around 4000 years ago by numerous entries of Indo-European speakers (Gadgil, 1997).

With so much internal migration and no clear report or poor self-revelling ability on their true ancestry, it is quite a difficult task to carry out an anthropological analysis and arrive at a consensus at this time. Though many studies on the female pelvis have been conducted in various countries or ethnic groups, it is surprising that very few studies are reported from the Indian population (the world's largest populated nation) on female pelvis measurements and seemingly nil in peninsular India. Thus, this study forms the first in the South Indian population using state-of-the-art technology (reconstructed CT) to provide revelation for future studies on anatomical quantification or measurement.

The collected data, when compared with other ethnic groups (shown in Table), indicate a change in some of the parameters. However, arriving at a consensus towards variation patterns among these data is difficult. Nevertheless, with greater sample size, these data could bring solid anatomical records, which are currently underway.

Analyses of the pelvis in various ethnic populations show the complex history of heredity and environmental interactions. The female pelvis's evolution has been influenced by environmental, civilization and cultural aspects (Baird, 1945, 1969; Thoms et al., 1939; Thoms, 1956; Maclanghlin and Bruce, 1986; Krishan, 2007). Further, it is influenced by the physical constitution of origin and ethnicity regarding multiple differences. Literature indicates that the age of the subjects at the time of measurement would be an important consideration before utilizing pelvic data for a particular application. Analyses of pelvic measurements in south Indian women revealed variations in terms of Inlet, mid-pelvis, and outlet presented in the study and compared to other studies from similar origin (CT technique)

Some studies have shown maternal height, shoe size and weight for identifying women with inadequate pelvises through anthropometric measurements (Kennedy and Greenwald, 1981; Frame et al., 1985; Mahmood et al., 1988; Van Bogaert, 1999). However, subsequent studies suggest that the predictive values of maternal height and shoe size are too low to justify obstetric intervention; therefore, the collection of maternal height and shoe size is probably redundant in management (Awonuga *et al*., 2007).

It is noteworthy that cephalopelvic disproportion can never be predicted with anthropometric measurement

alone, as it depends on several maternal and fetal factors other than just the dimensions of the material pelvis, such as fetal size degree of stretch in the maternal pelvis, the capacity of the fetal head to mould, the position adopted by women during labour, and fetal position. Nevertheless, its recognition and indication of possible cephalopelvic disproportion is necessary at every childbirth to prevent the session complication associated with undiagnosed disproportion. It has been shown that the pelvic inlet of females grew rapidly for approximately 18 months at puberty, which is the reality of typical female size and form. The change in the shape of the pelvic inlet was mainly due to the growth of pubic bone. Hence, age becomes an important criterion for utilizing pelvic data.

It is important to recognize that the ever-increasing cesarean section rate is a global phenomenon that is not accompanied by a reduction in perinatal morbidity and mortality. Patients' autonomy should always be respected, but it is the investigator's responsibility to ensure that adequate and unbiased information is provided so that these decisions are more likely to result in good outcomes. Measuring the pelvic cavity in pregnant females is important because the fetus passes through the narrower opening of the lesser pelvis at birth (Gerard and Sandra, 1996). The Hipbone reflects the differences between the two sexes and the special adaptation of the female hipbone for childbearing. WHO norms (2009) suggest that a rate of 5-15% is considered an acceptable range for C-sections, as per medical indications. However, in India, especially in urban areas, C-sections increased up to 32.6 % in Chennai (Sreevidya and Sathiyasekaran, 2003) and some of the regions of India (Padmadas et al., 2000; Pai, 2000).

The prospect of an unnecessary cesarean and its implications in future pregnancies can then be avoided. Although the results of this study are of primary importance to obstetricians practising in this region, they may also be relevant to obstetricians in several parts of the world to which women from this region have emigrated.

4. Conclusions

This study forms a report on anthropometric measurements of adult female pelvis from the south Indian population through CT imaging as a tool for acquiring data from live samples. This study compared the anatomical dimensions of the pelvic bone in modern-day women with reference to two age groups, i.e., 25-35 and 35-45. The data indicate a change in pelvic measurements between these two age groups from the same geographical region, though it is not statistically significant. This indicates the possibility of slight degree of variability during ageing, which could be progressive.

Author contributions

Ananthi Varadarajan (AV), Girishya Bollyamoni (GB), Sumi Borah (SB), Sathya Bharathy Sathyanathan (SBS), Prakash Seppan(PS)

AV: Performed the experimental, data collection and statistical analysis; performed the experiment and consolidated data. GB and SB: Manuscript formatting, proofreading, data check and consolidation. SBS and PS: Conceived the study idea, methodology design, acquiring funding for the research, consolidating data, and writing the manuscript. All authors participated in interpreting the results, reviewing manuscript drafts, and approving the final version submitted for publication. In addition, all authors read and approved the final manuscript.

Declarations

Funding Declaration

This work has not received any funding

Data availability

We declare that materials described in the manuscript, including all relevant raw data, can be available to any scientist wishing to use them for non-commercial purposes after submitting the final report to the funding agency and with the consent of the funding agency.

Conflict of interest

None of the authors has any financial/commercial conflicts of interest to declare.

Statement of ethics

Human ethics committee clearance was obtained from Dr.ALMPGIBMS, University of Madras (IHEC approval No: UM/IHEC/18-2013-I).

All the authors have given their consent to publish.

5. References

1. Rizk DE, Czechowski J, Ekelund L.(2004) Dynamic assessment of pelvic floor and bony pelvis morphologic condition with the use of magnetic resonance imaging in a multiethnic, nulliparous, and healthy female population. Am J Obstet Gynecol. Jul; 191(1):83-9.
2. Awonuga AO, Merhi Z, Awonuga MT, Samuels TA, Waller J, Pring D. Anthropometric measurements in the diagnosis of pelvic size: An analysis of maternal

height and shoe size and computed tomography pelvimetric data. Arch Gynecol Obstet. 2007; 276(5): 523-8.

3. Patriquin ML, Steyn M, Loth SR (2002) Metric assessment of race from the pelvis in South Africans. Forensic Sci Int. Jun 25; 127(1-2):104-13.
4. Benjamin SJ, Daniel AB, Kamath A, Ramkumar V. (2012) Anthropometric measurements as predictors of cephalopelvic disproportion: Can the diagnostic accuracy be improved? Acta Obstet Gynecol Scand. Jan; 91(1):122-7.
5. Steyn M, Patriquin ML(2009)Osteometric sex determination from the pelvis—does population specificity matter? Forensic Sci Int. Oct 30; 191(1-3):113.
6. Gonzalez PN, Bernal V, Perez SI (2009) Geometric morphometric approach to sex estimation of human pelvis. Forensic Sci Int. Aug 10; 189(1-3):68-74.
7. Dixit SG, Kakar S, Agarwal S, Choudhry R.(2007) Sexing of human hip bones of Indian origin by discriminant function analysis. J Forensic Leg Med. Oct; 14(7):429-35.
8. González PN., Bernal V, Perez SI, Barrientos G, (2007) Analysis of dimorphic structures of the human pelvis: its implications for sex estimation in samples without reference collections, Journal of Archaeological Science, Volume 34, Issue 10, October, 1720-30
9. Steyn M, Işcan MY.(2008) Metric sex determination from the pelvis in modern Greeks. Forensic Sci Int. Jul 18;179(1):86.
10. Sibley LM, Armelagos GJ, Van Gerven DP (1992) Obstetric dimensions of the truepelvis in a medieval population from Sudanese Nubia. Am J Phys Anthropol. Dec;89(4):421-30.
11. Luo YC.(1995) Sex determination from the pubis by discriminant function analysis.Forensic Sci Int. Jun 30;74(1-2):89-98.
12. Ekanem T, Udongwu A, & Singh SP (2009). Radiographic determination of sex differences in ischiopubic index of a Nigerian population. The Internet Journal of Biological Anthropology, 3(2).
13. Schroeder, C. F., Schmidtke, S. Z., & Bidez, M. W. (1997). Measuring the human pelvis: A comparison of direct and radiographic techniques using a modern United States–based sample. American journal of physical anthropology, 103(4), 471-479.
14. Kirchengast, S., & Hartmann, B. (2007). Short stature is associated with an increased risk of caesarean deliveries in low risk population. Acta Medica Lituanica, 14(1), 200.
15. Michel, S. C., Rake, A., Treiber, K., Seifert, B., Chaoui, R., Huch, R. Kubik-Huch, R. A. (2002). MR obstetric pelvimetry: effect of birthing position on pelvic bony dimensions. American Journal of Roentgenology, 179(4), 1063-1067.
16. E. Ikhena, AWF Halligan, NJ Naftalin, S. (1999). Has pelvimetry a role in current obstetric practice?. Journal of Obstetrics & Gynecology, 19(5), 463-465.
17. Connolly, G., & McKenna, P. (2001). Maternal height and external pelvimetry to predict cephalo-pelvic disproportion in nulliparous African women. BJOG: An International Journal of Obstetrics & Gynaecology, 108(3), 338-338.
18. Nagesh, K. R., Kanchan, T., & Bastia, B. K. (2007). Sexual dimorphism of acetabulum–pubis index in South-Indian population. Legal Medicine, 9(6), 305-308.
19. Handa VL, Lockhart ME., Fielding JR., Bradley CS., Brubakery, L., Cundiffy, GW., ... & Richter, H. E. (2008). Racial differences in pelvic anatomy by magnetic resonance imaging. Obstetrics and gynecology, 111(4), 914.
20. Candice PY Wang D.Wei ching Tan.Devendra Kanagalingam., Hak koon tanWhy we do caesars: A Comparison of the trendsin caeserian section delivery over a decade.,Ann Acad Med Singapore 42:408-12,2013.
21. Danial aronson. Ruben Kier.CT Pelvimetry : The fovea are not an accurate landmark for the level of the iscial spines American roentgen ray society 1990.
22. Meindel R.S .,Russell K.S.,Recent advances in method and theory in paleodemograghy.Annual rev Anthropol.27,375-399,1998.
23. M. Krogman, M.Y.Iscan, The Human Skeleton in Forensic Medicine, Charles C. Thomas, Springfield, IL, 1986.
24. Holland, T.D., 1991. Sex assessment using the proximal tibia. Am. J. Phys. Anthropol. 85, 221e227
25. Greulich WW, Thomas H. The growth and development of the pelvis of individual girls before, during and after puberty. Yale J Biol Med 1944;17:91–7.
26. Schroeder CF, Schmidtke SZ, Bidez MW. Measuring the human pelvis: a comparison of direct and radiographic techniques using a modern United States--based sample. Am J Phys Anthropol. 1997;103(4):471-9.
27. Hulth A, Johnell O, and Nilsson BE (1995) Osteoarthritis and late growth. Clin. Orthop. 313:159–168.
28. Kennedy JL, Greenwald E (1981) Correlation of shoe size and obstetric outcome: an anthropometric study. Am J Obstet Gynecol 140:466–467
29. Frame S, Moore J, Peters A, Hall D (1985) maternal height and shoe size as predictors of pelvic disproportion: an assessment. Br J Obstet Gynaecol 92:1239–1245.

30. Mahmood TA, Campbell DM, Wilson AW (1988) Maternal height, shoe size, and outcome of labour in white primigravidas: a prospective anthropometric study. BMJ 297:515–517.
31. Van Bogaert LJ (1999) The relation between height, foot length, pelvic adequacy and mode of delivery. Eur J Obstet Gynecol Reprod Biol 82:195–199.
32. Sreevidya, S. and Sathiyasekaran, B. (2003), High caesarean rates in Madras (India): a population-based cross sectional study. BJOG: An International Journal of Obstetrics & Gynaecology, 110: 106-111.
33. Armelagos, G. J., & Van Gerven, D. P. (2003). A century of skeletal biology and paleopathology: Contrasts, contradictions, and conflicts. American Anthropologist, 105(1), 53-64.
34. Meindl, R. S., Lovejoy, C. O., Mensforth, R. P, & Don Carlos, L. (1985). Accuracy and direction of error in the sexing of the skeleton: Implications for paleodemography. American Journal of Physical Anthropology, 68(1), 79-85.
35. Yurka, Laura Natalie, "An Evaluation of Metric Methods of Race Differentiation in the Human Pelvic Girdle for the Application of Expert Witness Testimony" (2014). Master's Theses. 58. http://aquila.usm.edu/masters_theses/58.
36. Singh KS: India's Communities. People of India. National Series Volume IV. India: Oxford University Press; 1998.
37. Gadgil M, Joshi NV, Shambu Prasad UV, Manoharan S, Patil S: Peopling of India. In The Indian human heritage Edited by: Balasubramanian D, Rao NA. Hyderabad, India: Universities Press; 1997:100-129
38. World Health Organization, UNFPA, UNICEF and AMDD (2009): "Monitoring Emergency Obstetric Care: a Handbook", WHO, Geneva.
39. Padmadas, S. S., Kumar S. S., Nair S. B., Kumari A. K. R. (2000): "Caesarean section delivery in Kerala, India: evidence from a National Health Survey". Social Science and Medicine, 51:511-521.
40. Pai M. (2000): "Unnecessary Medical Interventions: Caesarean Sections as a Case Study", Economic and Political Weekly, 35(31): 2755-2761.