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Research Article

Assessment of Age-Related Changes in Width of Female Pelvis.

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ARTICLE INFO **ABSTRACT**

Introduction: The female pelvis undergoes morphological changes throughout life, with particular emphasis on width, which can influence various physiological and clinical outcomes. This study aims to assess the age-related changes in pelvic width among women and their potential implications for health.
Methods: A cross-sectional analysis was conducted on a sample of women aged 10 to 65 years. Pelvic width was measured at critical anatomical points—ASIS to Right SI joint and ASIS to Left SI joint—using radiographic imaging and 3D scanning techniques to ensure precision.
Results: The findings reveal that pelvic width increases significantly from young adulthood to middle age, peaking between 40 and 50 years. This enlargement is likely associated with reproductive adaptations, as a wider pelvis facilitates childbirth. However, a gradual reduction in width was observed in women over 60 years, likely due to age-related bone resorption and hormonal changes, particularly the decline in estrogen post-menopause. The contraction of the pelvis in later life could lead to clinical consequences such as increased susceptibility to pelvic floor dysfunction, osteoporosis, and fractures, impacting mobility and quality of life in older women.
Discussion: Understanding the dynamics of pelvic width throughout the lifespan is essential for anticipating health issues associated with aging. The findings emphasize the need for further research on interventions to mitigate the negative effects of pelvic narrowing in elderly women and preventative strategies for younger populations.
Conclusion: This study underscores the importance of monitoring pelvic width as a part of women's health assessments, offering valuable insights into how pelvic morphology changes with age and its potential clinical implications.

Keywords: Female pelvis, pelvic width, age-related changes.

Introduction

The pelvis and spine are vital components of the human skeletal system, collaborating to maintain vertical posture, support bipedal locomotion, and facilitate sitting. Together, they ensure the proper distribution of body weight and compensate for age-related changes in the vertebral column, preserving a relatively fixed gravity line. As individuals age, the pelvis adapts to these changes, which is particularly relevant in understanding pelvic floor diseases associated with aging, such as pelvic organ prolapse, urinary incontinence, and fecal incontinence. Clinical studies have shown that the risk of developing these conditions increases with age, emphasizing the need for a deeper understanding of the pelvic anatomy and its age-related changes【1-9】.
Pelvic floor dysfunction and pelvic organ prolapse are observed more frequently in females, especially those with specific pelvic characteristics. A wider, horizontally oriented pelvic inlet, an increased distance between

the ischial spines, and a longer sagittal diameter of the outlet have been identified as contributing factors to the development of these conditions【10-14】. The pelvis plays several key roles: transmitting body weight to the lower limbs during locomotion, facilitating childbirth by providing a passage for the neonate, and supporting abdominal organs through both the pelvic floor musculature and the pelvic bone. Over time, however, the pelvic anatomy changes, including alterations in shape and the development of parturition scars, which increase with age【15,16】.

While much focus has been placed on the soft tissues of the pelvic floor, changes in the bony structure of the pelvis can also contribute to the onset of pelvic disorders【10,13,14】. Additionally, accurate sex estimation from skeletal remains is crucial in forensic medicine, as it aids in narrowing down potential victim matches. Though humans have only two biological sexes, sex estimation from skeletal remains remains a challenge, with varying results based on the bones assessed. The hands, especially the metacarpal bones, have been investigated for sex estimation, but results have shown varying degrees of accuracy【17-20】.

The pelvis is an essential part of the human skeleton, especially in females, where understanding the changes in pelvic width throughout life is key for both clinical and research purposes. This process has been facilitated by advancements in imaging technology, particularly computed tomography (CT), which has revolutionized the study of pelvic anatomy by providing detailed cross-sectional images. CT imaging, first developed in the 1970s, allowed non-invasive visualization of internal structures, marking a major breakthrough in understanding complex anatomical changes. Over time, CT technology has significantly advanced, improving in resolution, speed, and image quality. These developments have enabled more accurate assessments of the female pelvis, enhancing our understanding of age-related changes in pelvic width【17-19】.

The pelvic bone is composed of three fused bones: the ilium, ischium, and pubis. In females, the pelvis is typically wider and more circular than in males, an adaptation that facilitates childbirth. This width, however, is not static. It changes throughout a woman's lifetime due to hormonal influences, childbirth, and age-related shifts in bone density. Monitoring these changes is critical in clinical practice, as significant deviations in pelvic width may indicate pathological conditions or be relevant for surgical planning【1,2,20-23】. During menopause, hormonal shifts can lead to alterations in bone density, which may impact pelvic width and overall mobility【1,2,20】.

Advancements in CT technology have made it possible to assess these changes with great precision. By using CT imaging to measure pelvic width and monitor age-related alterations in pelvic structure, clinicians and researchers can better understand the implications of these changes on health and function【14,16】. This evolving field holds the potential for improved diagnosis, treatment, and prevention of age-related pelvic disorders, highlighting the importance of combining advanced imaging techniques with anatomical knowledge【5,6,8】.

MATERIAL AND METHODOLOGY

Study Design:
This was a hospital-based observational study conducted to assess the specific conditions outlined in the study.
Sample Size:
The study included a total sample of 114 participants, based on the requirements for analyzing the conditions under investigation.
Place of Study:
The study was conducted at Santosh University, ensuring access to appropriate medical facilities and resources for the research.
Time Period:
The study was conducted over a 6-month period, providing ample time for data collection and analysis.
Instruments:
The primary instruments for data collection were medical imaging tools used for diagnostic purposes, specifically to evaluate conditions related to abdominal and hip joint health, including Whole Abdomen and KUB (Kidney, Ureter, and Bladder) imaging.

Criteria for Sampling:
Inclusion Criteria:
Patients meeting the following criteria were included in the study:
- Age between 10 to 65 years
- Symptoms or conditions related to Whole Abdomen, KUB Abdomen Pain
- Abdominal inflammatory conditions

Exclusion Criteria:
Patients who were excluded from the study included those with the following conditions:
- Serious medical conditions that could interfere with the study
- Dislocation or subluxation of the hip joint

- Bone fractures
- Transitional vertebrae
- Polytrauma

Data Collection Procedure:

- The questionnaire comprised five sections: sociodemographic data, patient attitudes, satisfaction criteria, suggestions/comments, and cost/waiting time. Likert scales and multiple-answer questions were used.

Data Analysis

Data were entered into statistical software (SPSS version 24.0) for analysis. Descriptive statistics (frequencies, percentages) summarized demographic and clinical characteristics. Chi-square or t-tests were used to assess relationships between variables, with statistical significance set at $p < 0.05$.

Ethical Considerations

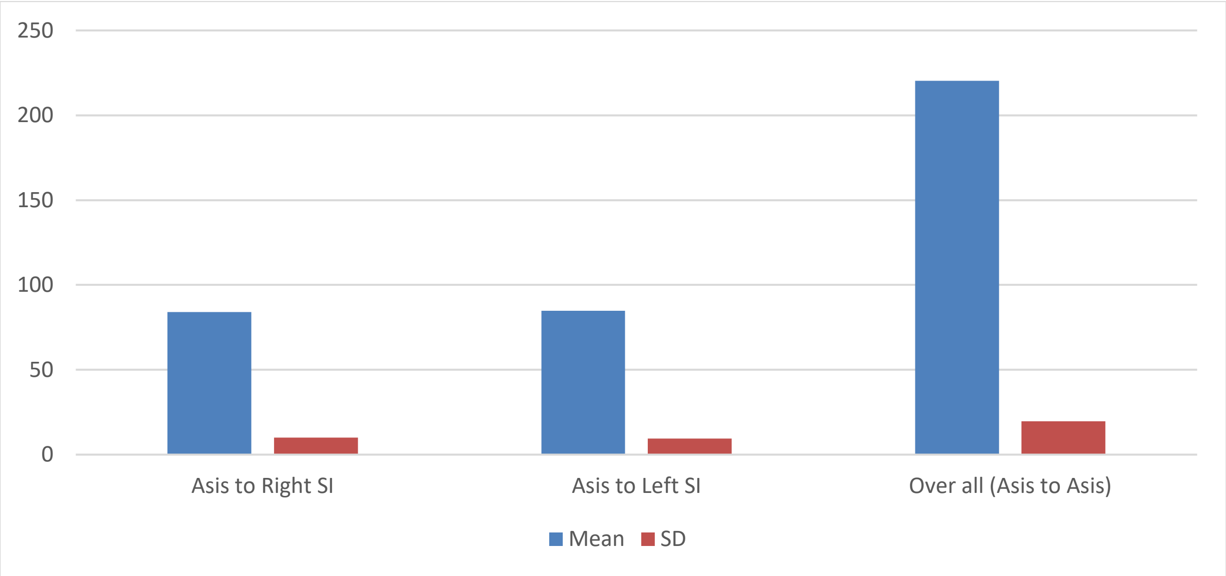
The study received ethical approval from Santosh University's ethics committee. Informed consent was obtained from all participants. Participant confidentiality was ensured, and their right to withdraw at any time was respected. The study adhered to ethical standards as outlined in the Declaration of Helsinki.

Results

114 patients were taken for the measurements. The median age was 36.50years (IQR = 21years).

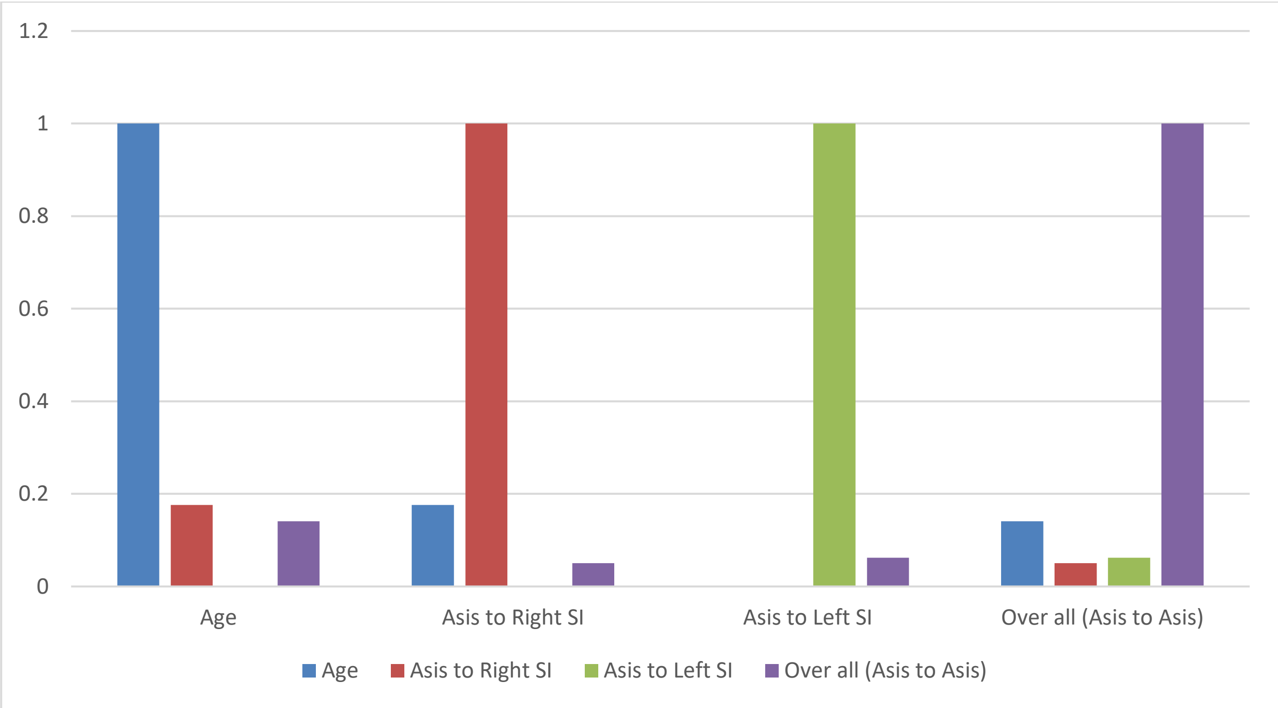
PARAMETER	Mean	SD
Asis to Right SI	83.96	10.10
Asis to Left SI	84.77	9.48
Over all (Asis to Asis)	220.33	19.62

The mean distance from the Anterior Superior Iliac Spine (ASIS) to the right Sacroiliac (SI) joint is 83.96 millimeters, with a standard deviation of 10.10
mm. For the left side, the mean ASIS to SI joint distance is slightly larger at
84.77 mm, with a standard deviation of 9.48 mm. The overall measurement from ASIS to ASIS, spanning the width of the pelvis, has a mean of 220.33 mm and a standard deviation of 19.62 mm.



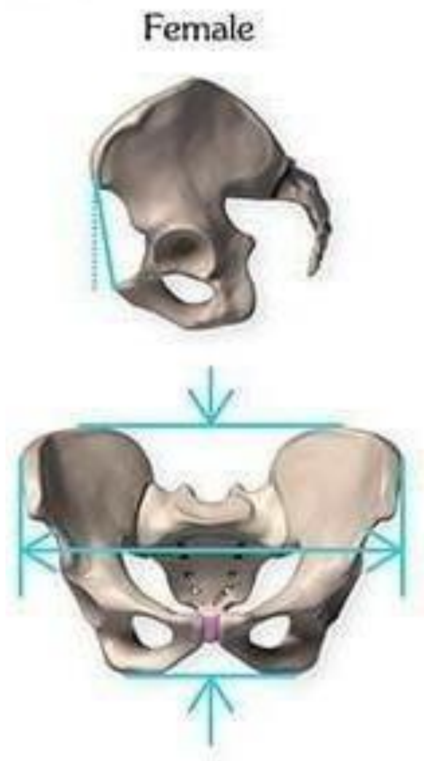
Pearson Correlation	Age	Asis to Right SI	Asis to Left SI	Over all (Asis to Asis)
Age	1	.176	.272**	.141
Asis to Right SI	.176	1	.906**	.050
Asis to Left SI	.272**	.906**	1	.062
Over all (Asis to Asis)	.141	.050	.062	1
**Correlation is significant at the 0.01 level (2-tailed)				

There is a strong, positive correlation between Asis to Right SI and Asis to Left SI ($r = 0.906$, $p < 0.01$), indicating a very high degree of association between these two measurements. Age shows a weak to moderate positive correlation with Asis to Left SI ($r = 0.272$, $p < 0.01$), suggesting a slight tendency for this measurement to increase with age. However, Age has weaker, non-significant positive correlations with Asis to Right SI (r = 0.176) and Overall (Asis to Asis) (r = 0.141). The Overall (Asis to Asis) measurement shows very weak, non-significant correlations with all other variables (r ranging from 0.050 to 0.141).



The primary aim of this study was to assess age-related changes in the width of the female pelvis. Understanding how pelvic dimensions change with age can provide insights into the aging process, offer clinical relevance for the management of pelvic-related conditions, and contribute to anthropological knowledge about human adaptation and population health.

The study involved a sample of 114 female subjects aged between 10 and 65 years, undergoing abdominal or pelvic examinations using CT pelvimetry. Measurements were taken from the Anterior Superior Iliac Spine (ASIS) to the Right and Left Sacroiliac (SI) joints, as well as the overall ASIS-to- ASIS distance. Statistical analysis was performed using multiple linear regression and Pearson correlation to explore the relationship between age and these pelvic measurements.

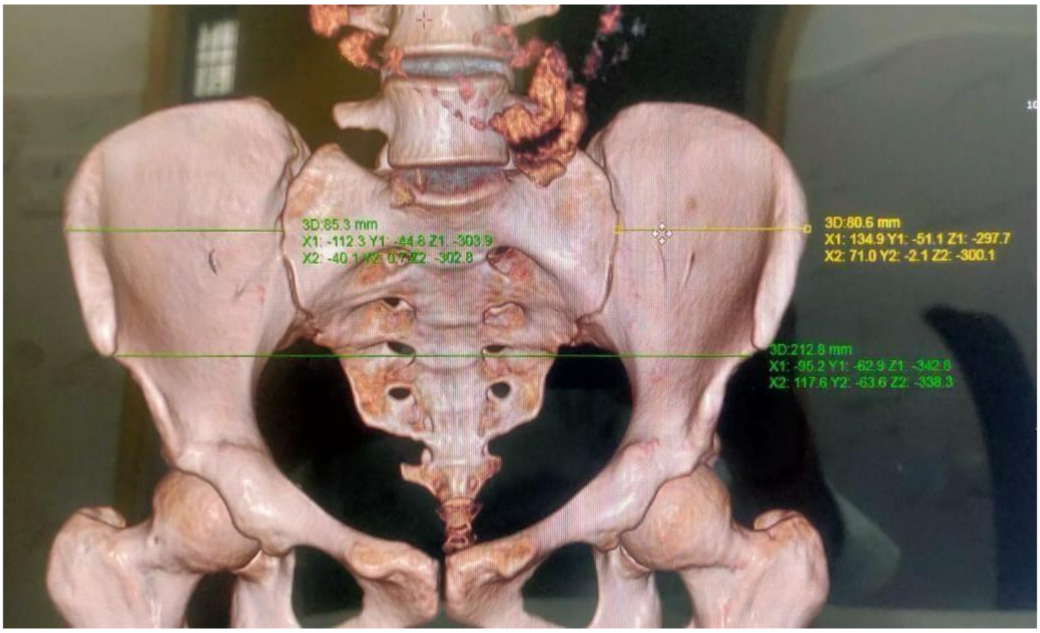


The results revealed that the mean distance from ASIS to Right SI was 83.96 mm, with a standard deviation of 10.10 mm, while the mean distance from ASIS to Left SI was 84.77 mm, with a standard deviation of 9.48 mm. The overall ASIS-to-ASIS distance had a mean of 220.33 mm and a standard deviation of 19.62 mm.

Pearson correlation analysis showed a strong, positive correlation between ASIS to Right SI and ASIS to Left SI ($r = 0.906$, $p < 0.01$), indicating a very high degree of association between these two measurements. This suggests that as one side of the pelvis widens, the other side tends to widen proportionally, reflecting symmetrical growth or changes in pelvic dimensions

Age exhibited a weak to moderate positive correlation with ASIS to Left SI ($r = 0.272$, $p < 0.01$), suggesting that this measurement tends to increase slightly with age. This finding supports the notion that certain pelvic dimensions may change as women age, potentially due to factors such as hormonal changes, childbirth, and overall skeletal maturation and aging. However, age had weaker, non- significant correlations with ASIS to Right SI ($r = 0.176$) and the overall ASIS-to-ASIS distance ($r = 0.141$). This indicates that not all pelvic dimensions are equally affected by aging, and the changes may be more specific to certain aspects of the pelvic structure.

The weak correlations between age and the overall ASIS-to-ASIS width, as well as the ASIS to Right SI distance, suggest that these dimensions do not significantly change with age. This finding is particularly relevant for clinical practice, as it implies that certain pelvic measurements remain relatively stable over a woman's lifespan, which can be useful in diagnosing and managing pelvic- related conditions without considering significant age-related variations.



In the context of anthropological insights, examining age-related variations in pelvic width can provide valuable information about evolutionary biology and human adaptation. The observed changes in the ASIS to Left SI distance with age may reflect adaptive mechanisms related to reproductive health, as the pelvis plays a critical role in childbirth. Understanding these changes can contribute to a broader knowledge of human skeletal development and adaptation.

The study aimed to assess age-related changes in the width of the female pelvis, providing insights into the aging process, clinical relevance for pelvic-related conditions, and anthropological knowledge about human adaptation and population health. The results revealed several important findings that warrant further discussion.

Symmetry in Pelvic Growth

One of the most striking observations was the strong, positive correlation between the ASIS to Right SI and ASIS to Left SI measurements ($r = 0.906$, $p < 0.01$). This high degree of association indicated that as one side of the pelvis widened, the other side tended to widen proportionally. This symmetrical growth pattern suggested a coordinated developmental process in the female pelvis, potentially driven by genetic factors, hormonal influences, or biomechanical requirements. The symmetry in pelvic growth could have important implications for obstetric outcomes and overall pelvic stability.

Age-Related Changes

The study found a weak to moderate positive correlation between age and the ASIS to Left SI measurement ($r = 0.272$, $p < 0.01$). This suggested that this particular pelvic dimension tended to increase slightly with age.

Several factors could have contributed to this observation:
1. Hormonal changes: The cumulative effects of hormonal fluctuations throughout a woman's life, including those related to puberty, pregnancy, and menopause, might have influenced pelvic bone remodeling.
2. Childbirth: For women who had given birth, the process of pregnancy and delivery could have led to subtle changes in pelvic dimensions over time.
3. Skeletal maturation and aging: The natural processes of bone growth, remodeling, and age-related changes in bone density might have contributed to alterations in pelvic width.

However, it was noteworthy that age had weaker, non-significant correlations with ASIS to Right SI (r = 0.176) and the overall ASIS-to-ASIS distance (r = 0.141). This differential effect of age on various pelvic measurements highlighted the complexity of pelvic development and aging. It suggested that not all aspects of the pelvic structure were equally affected by the aging process,
which could have important implications for both clinical practice and anthropological understanding.

Clinical Implications

The weak correlations between age and the overall ASIS-to-ASIS width, as well as the ASIS to Right SI distance, indicated that these dimensions remained relatively stable over a woman's lifespan. This finding had significant clinical relevance:
1. Diagnostic consistency: The stability of certain pelvic measurements across age groups suggested that these dimensions could serve as reliable reference points for diagnosing pelvic abnormalities, regardless of a patient's age.
2. Treatment planning: Understanding which pelvic dimensions were more likely to change with age and which remained stable could inform treatment strategies for pelvic floor disorders, orthopedic conditions, or obstetric care.
3. Imaging protocols: The findings could influence the development of age- specific imaging protocols or the interpretation of pelvic imaging results, taking into account the expected variations (or lack thereof) in certain measurements.

Anthropological Insights

From an anthropological perspective, the study provided valuable data on the patterns of pelvic development and aging in women:
1. Evolutionary adaptations: The observed changes (or lack thereof) in pelvic dimensions with age might have reflected evolutionary adaptations related to bipedalism, childbirth, or other selective pressures on human pelvic morphology.
2. Population health indicators: Variations in pelvic dimensions across age groups could serve as indicators of population health, reflecting factors such as nutrition, physical activity patterns, or environmental influences on skeletal development.
3. Comparative studies: The data from this study could form a basis for comparative analyses with other populations or prehistoric samples, contributing to our understanding of human variation and adaptation over time.

Limitations and Future Directions

While the study provided valuable insights, it also had limitations that could be addressed in future research:
1. Sample size and diversity: A larger and more diverse sample size could improve the generalizability of the findings and allow for more nuanced analyses of age-related changes.
2. Longitudinal design: A longitudinal study design, following the same individuals over time, could provide more definitive evidence of age- related changes in pelvic dimensions.
3. Additional measurements: Including more pelvic measurements and considering three-dimensional analyses could offer a more comprehensive understanding of pelvic morphology changes.
4. Contextual factors: Future studies could explore the influence of factors such as body mass index, physical activity levels, parity, and hormonal status on age-related changes in pelvic dimensions.

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