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Sexual Dimorphism in Pelvic Dimensions: A Comprehensive Comparative Analysis of Transverse and Sagittal Diameters in Males and Females

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Abstract
Background: Sexual dimorphism in pelvic anatomy is a critical area of study due to its implications in childbirth, pelvic surgery, and biomechanical stability. Differences between male and female pelvic structures reflect evolutionary adaptations, hormonal influences, and functional demands. This study evaluates transverse and sagittal pelvic diameters, pelvic angles, and pelvic indices in a diverse population to assess gender-based differences.
Methods: A total of 300 participants (200 females and 100 males) were included in the study. Measurements were taken for transverse pelvic diameters (inlet, midplanes, and outlet), sagittal diameters, pelvic angles (sacral slope, pelvic inclination, and subpubic angle), and pelvic indices. Statistical analysis was conducted to determine the presence of significant sexual dimorphism across these parameters.
Results: Females exhibited significantly larger transverse pelvic diameters compared to males across all planes: inlet (12.839 vs. 11.403 cm, $p = 0.000$), midplane 1 (11.485 cm vs. 10.387 cm, $p = 0.000$), midplane 2 (9.835 cm vs. 8.857 cm, $p = 0.000$), and outlet (9.221 cm vs. 9.012 cm, $p = 0.015$). Sagittal pelvic diameters were also consistently larger in females, with significant differences at the inlet (12.039 cm vs. 10.313 cm, $p = 0.000$), midplane 1 (11.532 cm vs. 9.942 cm, p=0.000), and midplane 2 (11.065 cm vs. 10.302 cm, p=0.000). Sacral slope and pelvic inclination were significantly higher in females (sacral slope: 36.727° vs. 36.204°, $p = 0.000$; pelvic inclination: 63.376° vs. 61.384°, $p = 0.001$), suggesting adaptations for pregnancy and parturition. However, no significant gender-based differences were observed in the subpubic angle or pelvic indices at the inlet, midplanes, or outlet except for a lower mean pelvic index in females at the outlet ($p = 0.000$).
Conclusion: The study confirms significant sexual dimorphism in pelvic anatomy, particularly in transverse and sagittal diameters, sacral slope, and pelvic inclination. These findings highlight the evolutionary and functional adaptations of the female pelvis for childbirth and its dynamic interplay with spinal mechanics.
Keywords: Pelvic dimensions, sexual dimorphism, transverse diameters, sagittal diameters, sacral slope, pelvic inclination, coefficient of dimorphism, gender differences.

INTRODUCTION

The human pelvis is a structurally complex and functionally essential component of the skeletal system. It plays a pivotal role in providing stability to the upper body, facilitating locomotion, protecting vital internal organs, and serving as a conduit for neurovascular structures. Additionally, the pelvis is a key determinant in obstetrics, particularly for females, where its dimensions and morphology directly influence the ease of childbirth.[1] As such, a detailed understanding of pelvic anatomy is indispensable across various disciplines, including clinical medicine, radiology, orthopedics, and forensic sciences.

A striking feature of the human pelvis is the pronounced sexual dimorphism that arises due to evolutionary and functional adaptations.[2,3] The male pelvis is generally narrower and sturdier, optimized for bipedal locomotion and the support of greater muscle mass. In contrast, the female pelvis is broader, with a more circular inlet, larger subpubic angle, and less pronounced promontory, adaptations that facilitate parturition.[4] These anatomical differences are the result of evolutionary pressures balancing the requirements of efficient bipedalism with obstetric needs—a phenomenon referred to as the "obstetric dilemma." Advancements in imaging technologies, particularly computed tomography (CT), have revolutionized the study of pelvic anatomy. Unlike traditional cadaveric studies, CT imaging provides precise, reproducible, and non-invasive measurements of pelvic dimensions, allowing for a more detailed and quantitative analysis of structural differences. Despite this, there remains a paucity of comprehensive data comparing multiple pelvic parameters—such as transverse and sagittal diameters, pelvic angles, and pelvic indexes—between genders in healthy populations. Most available studies are either limited to specific dimensions or lack sufficient statistical power due to small sample sizes or narrow demographic ranges.[5-7]

Understanding these gender-specific differences has significant clinical implications. For instance, precise knowledge of pelvic dimensions is critical in obstetric care for anticipating complications such as cephalopelvic disproportion and determining the feasibility of vaginal delivery. Similarly, in orthopedic and trauma surgery, gender-specific variations in pelvic morphology influence the planning and execution of procedures like pelvic fixation, hip arthroplasty, and sacral surgeries. Moreover, these differences are increasingly recognized in forensic sciences for their utility in gender identification, particularly in medico-legal investigations involving skeletal remains.[8]

This study seeks to address these gaps by conducting a detailed comparative analysis of pelvic anatomy in males and females using CT imaging. By examining transverse diameters, sagittal diameters, pelvic angles, and pelvic indexes across a wide age range, the research aims to provide a comprehensive dataset that elucidates the extent of sexual dimorphism in pelvic morphology. Additionally, this study investigates the statistical significance of these differences, offering perspectives into their clinical relevance. The findings of this research are anticipated to contribute to the existing body of knowledge by providing a robust framework for understanding gender-based variations in pelvic anatomy.

METHODS

The study was conducted in the Department of Anatomy in collaboration with the Department of Radiodiagnosis and Imaging at Government Medical College and associated hospitals in Srinagar, a tertiary care facility in the Kashmir Valley serving a population of approximately 10 million. The research included patients who underwent abdomino-pelvic or pelvic computed tomography (CT) scans for various clinical indications as determined by their treating physicians. This was a prospective observational study carried out over a period of two and a half years, from March 2022 to September 2024. A total of 300 patients, comprising 200 females and 100 males, were included. Ethical clearance for the study was obtained from the Institutional Ethical Committee of Government Medical College Srinagar. The study adhered to ethical guidelines and ensured that all participant data were anonymized and treated with confidentiality. The inclusion criteria specified that only Kashmiri patients who were advised to undergo abdomino-pelvic CT scans and were certified as normal by a radiologist were eligible for the study. Patients were excluded if they were of non-Kashmiri origin, had pelvic fractures, specific bone diseases, polytrauma, or pelvic masses, or if they were younger than 18 years or older than 70 years. All CT examinations were performed using a 256-slice multi-detector CT scanner (Siemens Healthineers) following standard pelvic imaging protocols. Image acquisition was performed with a slice thickness of 1.5 mm, and dosimetry was managed according to established guidelines. Analysis was conducted on a three-dimensional (3D) workstation (IntelliSpace® Portal-Multimodality; Philips Healthcare) utilizing multi-planar rendered images with surface-shaded 3D rendering. Pelvic measurements were obtained from coronal and sagittal CT images, and oblique multiplanar reformatted (MPR) images were used for detailed evaluation. Sagittal and transverse diameters of the lesser pelvis were assessed at four specific anatomical levels: the inlet (inlet plane), the level of acetabular centers (midplane 1), the level of ischial spines (midplane 2), and the outlet (outlet plane). Transverse parameters and one pelvic angle were measured in the coronal plane. Specific measurements included:

1. *Transverse diameter of the inlet:* The widest distance between the arcuate lines.
2. *Transverse diameter of midplane 1 (biacetabular diameter):* The distance between the centers of the acetabula.
3. *Transverse diameter of midplane 2 (bispinous diameter):* The narrowest distance between the two ischial spines.
4. *Transverse diameter of the outlet (bituberous diameter):* The widest distance between the inner margins of the ischial tuberosities.
5. *Subpubic angle:* The angle formed by the inferior pubic rami.

Sagittal pelvic dimensions and two pelvic angles were assessed in the sagittal plane using precise anatomical landmarks:

- *Sagittal diameter of the inlet:* Measured as the distance between the anterosuperior border of the pubic symphysis and the promontory of the sacrum.
- *Sagittal diameter of midplane 1:* Defined as the distance between the posterior midpoint of the pubic symphysis and the anterior point located between the second and third sacral vertebrae.
- *Sagittal diameter of midplane 2:* Measured as the distance between the inferior border of the pubic symphysis and the anterior point between the fourth and fifth sacral vertebrae.
- *Sagittal diameter of the outlet:* The distance from the inferior border of the pubic symphysis to the tip of the coccyx.
- *Sacral slope:* The angle formed between the superior surface of the first sacral vertebra and a horizontal plane.
- *Pelvic inclination:* The angle between the pelvic inlet and a horizontal plane.

This comprehensive CT pelvimetry approach provided high-precision anatomical measurements that were critical for the study's objectives, offering valuable insights into pelvic anatomy across genders and facilitating detailed comparisons of pelvic parameters.

Statistical Analysis: Data analysis was performed using SPSS (version 23). Descriptive statistics were summarized as means and standard deviations (SD) for continuous variables. Independent-sample t-tests were utilized to compare male and female measurements, with a p-value < 0.05 considered statistically significant. The normality of the data was tested using the Shapiro-Wilk test, with a $p > 0.05$ indicating a normal distribution. The coefficient of dimorphism (CD) was calculated to assess the extent of sexual dimorphism in pelvic dimensions

RESULTS

Out of a total of 300 individuals included in the study, 200 were female, accounting for 66.7% of the study population, while 100 were male, representing 33.3%. This distribution highlights a predominance of female participants in the study cohort (see fig 1)

Fig 1: Gender distribution of study participants

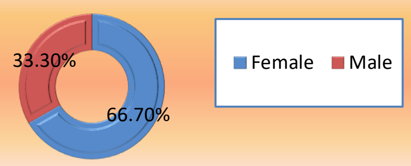


Table 1: Comparison of Transverse Diameters among Male and Female

Parameters	Gender	N	Mean	SD	Coeff. of dimorphism	P value
Inlet	Female	200	12.8390	1.00681	106.47	0.000*
	Male	100	11.4028	0.78348		
Mid plane 1	Female	200	11.4852	0.86565	107.29	0.000*
	Male	100	10.3869	1.06619		
Mid plane 2	Female	200	9.8347	1.42296	119.87	0.000*
	Male	100	8.8569	0.74815		
Outlet	Female	200	9.2205	0.90923	119.71	0.015**
	Male	100	9.0171	0.52516		

*denotes statistically significant as P value ≤ 0.001, **denotes statistically significant as P value ≤ 0.05

Table 2: Comparison of Sagittal Diameters among Male and Female

Parameters	Gender	N	Mean	SD	Coeff. of dimorphism	P value
Inlet	Female	200	12.0388	0.85575	104.53	0.000*
	Male	100	10.3132	0.90681		
Mid plane 1	Female	200	11.5315	0.94717	102.90	0.000*
	Male	100	9.9421	0.95319		
Mid plane 2	Female	200	11.0650	1.02381	105.41	0.000*
	Male	100	10.3024	1.02626		
Outlet	Female	200	9.5969	0.81031	104.06	0.681
	Male	100	9.6415	1.01419		

*denotes statistically significant as P value ≤ 0.001

Table 1 compares the transverse pelvic diameters between male and female participants. The mean inlet diameter was significantly larger in females (12.839 ± 1.006 cm) compared to males (11.403 ± 0.783 cm) with a coefficient of dimorphism of 106.47 and a highly significant p-value of 0.000. Similarly, the mean diameter at midplane 1 (biacetabular diameter) was greater in females (11.485 ± 0.866 cm) than in males (10.387 ± 1.066 cm), yielding a coefficient of dimorphism of 107.29 and a p-value of 0.000. At midplane 2 (bispinous diameter), females also exhibited a larger mean diameter (9.835 ± 1.423 cm) compared to males (8.857 ± 0.748 cm), with a coefficient of dimorphism of 119.87 and a significant p-value of 0.000. For the outlet (bituberous diameter), females had a slightly larger mean diameter (9.221 ± 0.909 cm) than males (9.017 ± 0.525 cm), with a coefficient of dimorphism of 119.71 and a p-value of 0.015, indicating statistical significance at the 0.05 level. These findings reveal consistent sexual dimorphism in transverse pelvic diameters, with females exhibiting larger measurements across all planes, which is statistically significant in all cases.

Table 2 provides a comparison of sagittal pelvic diameters between male and female participants. The mean sagittal diameter at the inlet was significantly larger in females (12.039 ± 0.856 cm) compared to males (10.313 ± 0.907 cm), with a coefficient of dimorphism of 104.53 and a highly significant p-value of 0.000. Similarly, at midplane 1, females exhibited a greater mean diameter (11.532 ± 0.947 cm) than males (9.942 ± 0.953 cm), with a coefficient of dimorphism of 102.90 and a p-value of 0.000. At midplane 2, the sagittal diameter was also larger in females (11.065 ± 1.024 cm) compared to males (10.302 ± 1.026 cm), yielding a coefficient of dimorphism of 105.41 and a significant p-value of 0.000. However, at the outlet, the mean sagittal diameter was comparable between females (9.597 ± 0.810 cm) and males (9.642 ± 1.014 cm), with a coefficient of dimorphism of 104.06 and a p-value of 0.681, indicating no statistically significant difference. These results highlight notable sexual dimorphism in sagittal pelvic diameters, with females exhibiting consistently larger diameters at the inlet and midplanes, while differences at the outlet were not statistically significant.

Table 3: Comparison of Sagittal Diameters among Male and Female

Parameters	Gender	N	Mean	SD	Coeff. of dimorphism	P value
Sacral Slope	Female	200	36.7265	2.71694	100.00	0.000*
	Male	100	36.2040	3.11646		
Pelvic Inclination	Female	200	63.3755	6.62896	103.57	0.001*
	Male	100	61.3840	3.87590		
Subpubic Angle	Female	200	96.8845	14.30772	103.23	0.166
	Male	100	95.3500	4.44807		

*denotes statistically significant as P value ≤ 0.001

Table 4: Comparison of Pelvic Indexes among Male and Female

Parameters	Gender	N	Mean	SD	Coeff. of dimorphism	P value
Inlet	Female	200	0.9739	0.11942	98.94	0.113
	Male	100	0.9550	0.08360		
Mid plane 1	Female	200	1.0395	0.09887	95.58	0.09
	Male	100	1.0209	0.08836		
Mid plane 2	Female	200	1.0908	0.16724	88.00	0.737
	Male	100	1.0841	0.15274		
Outlet	Female	200	1.0205	0.10855	86.17	0.000*
	Male	100	1.0767	0.13689		

*denotes statistically significant as P value ≤ 0.001

Table 3 presents a comparison of pelvic angles between male and female participants. The mean sacral slope was slightly higher in females (36.727 ± 2.717°) compared to males (36.204 ± 3.116°), with the coefficient of dimorphism (100.00), yielding a highly significant p-value of 0.000. Similarly, pelvic inclination was significantly greater in females (63.376 ± 6.629°) than in males (61.384 ± 3.876°), yielding a coefficient of dimorphism of 103.57 and a p-value of 0.001. In contrast, the subpubic angle showed no statistically significant difference between females (96.885 ± 14.308°) and males (95.350 ± 4.448°), with a coefficient of dimorphism of 103.23 and a p-value of 0.166. These findings indicate that while sacral slope and pelvic inclination demonstrate statistically significant sexual dimorphism, the subpubic angle does not show a meaningful difference between genders in this study cohort.

Table 4 compares the pelvic indexes between males and females across four parameters: Inlet, Mid plane 1, Mid plane 2, and Outlet. For the Inlet, females have a slightly higher mean pelvic index (0.9739) compared to males (0.9550), with a coefficient of dimorphism of 98.94. However, the difference is not statistically significant, as indicated by the P value of 0.113. Similarly, for Mid plane 1, females have a mean pelvic index of 1.0395, while males have 1.0209, yielding a coefficient of dimorphism of 95.58, with a P value of 0.09, suggesting no significant difference between the genders. For Mid plane 2, the mean pelvic index for females (1.0908) is slightly higher than for males (1.0841), with a coefficient of dimorphism of 88.00, and the P value of 0.737 further confirms the lack of significant gender differences. However, for the Outlet, females have a lower mean pelvic index of 1.0205 compared to males, who have a mean of 1.0767. This difference is statistically significant, with a P value of 0.000 and a coefficient of dimorphism of 86.17. Therefore, the Outlet parameter shows a notable pelvic index difference between males and females.

Fig 2: Spider diagram showing comparison of Transverse diameters between males and females

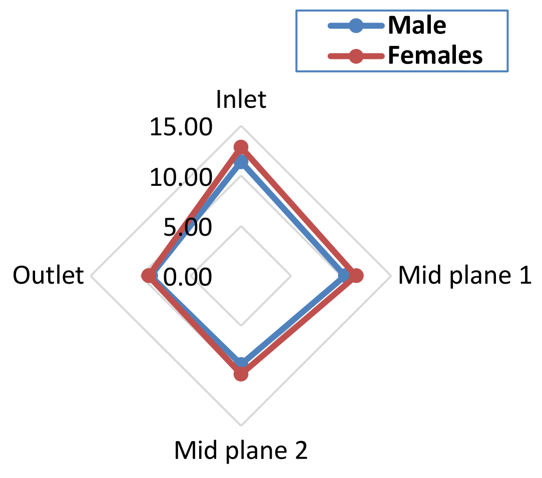


Fig 3: Spider diagram showing comparison of Sagittal Diameters among Male and Female

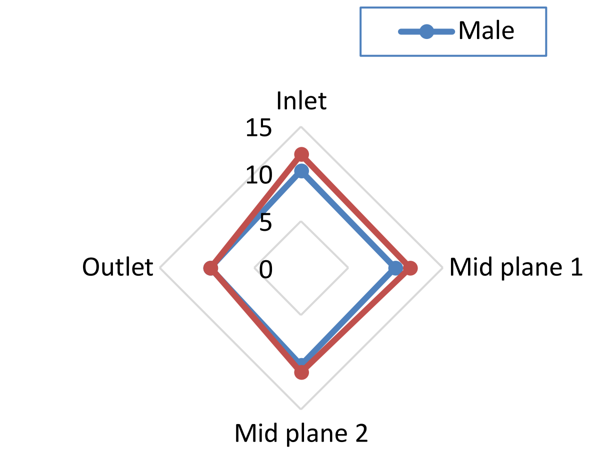


Fig 4: Spider diagram showing comparison of Pelvic Angles among Male and Female

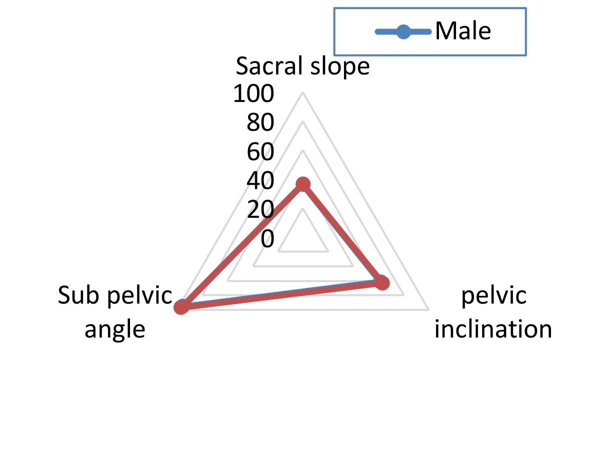
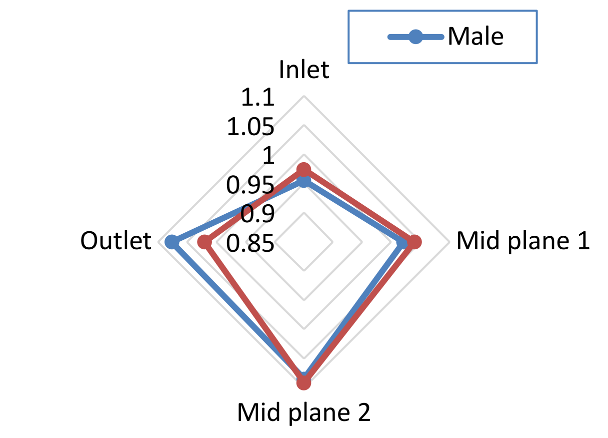


Fig 4: Spider diagram showing comparison of Pelvic Indexes among Male and Female



The spider diagrams illustrate comparisons of pelvic dimensions and angles between males and females. Figure 2 compares transverse diameters at different planes of the pelvis (inlet, outlet, mid-plane 1, and mid-plane 2), showing similar values between genders with minor variations. Figure 3 focuses on sagittal diameters at the same planes, revealing a close alignment between males and females. In contrast, the pelvic angles depicted in Figure 4 (including sacral slope, sub-pelvic angle, and pelvic inclination) demonstrate notable differences, particularly in the sacral slope and sub-pelvic angle. Finally, the comparison of pelvic indexes in Figure 4 shows a high degree of similarity between genders, with slight variations observed at the outlet and mid-plane 2. These diagrams emphasize subtle anatomical differences in pelvic measurements across genders.

DISCUSSION

The present study provides an in-depth examination of sexual dimorphism in pelvic anatomy, specifically through the measurement of transverse and sagittal pelvic diameters, pelvic angles, and pelvic indices. A total of 300 individuals (200 females and 100 males) were included, revealing significant gender-based differences in these anatomical parameters, with females generally exhibiting larger measurements in most cases. These findings contribute to our understanding of sexual dimorphism in the pelvis, with implications for obstetric practice, particularly in the context of childbirth and pelvic surgery.

The study results demonstrated consistent and statistically significant sexual dimorphism in the transverse pelvic diameters. Females had larger measurements than males at the inlet (12.839 ± 1.006 cm vs. 11.403 ± 0.783 cm, p = 0.000), midplane 1 (biacetabular diameter) (11.485 ± 0.866 cm vs. 10.387 ± 1.066 cm, p = 0.000), and midplane 2 (bispinous diameter) (9.835 ± 1.423 cm vs. 8.857 ± 0.748 cm, p = 0.000). For the outlet (bituberous diameter), females had a slightly larger mean diameter (9.221 ± 0.909 cm) than males (9.017 ± 0.525 cm), with a coefficient of dimorphism of 119.71 and a p-value of 0.015, indicating statistical significance at the 0.05 level. These findings reveal consistent sexual dimorphism in transverse pelvic diameters, with females exhibiting larger measurements across all planes, which is statistically significant in all cases. These results align with the literature, which consistently reports that females have wider pelvic diameters, especially at the inlet, midplanes, and outlet. Studies such as those by Kolesova O et al (2017), Delprete H et al., (2017) and Kanahashi T et al., (2024) have similarly documented larger transverse diameters in females, which is essential for accommodating the fetal head during vaginal delivery.[9-11] The significant differences observed in our study may reflect both the evolutionary adaptation of the female pelvis for childbirth and the influences of hormones like estrogen and progesterone, which mediate pelvic changes during puberty and pregnancy (Huseynov A et al., 2016).[12]

The results for sagittal pelvic diameters indicated that females exhibited consistently larger sagittal diameters at the inlet and midplane 1 when compared to males, with these differences being statistically significant (p = 0.000). Specifically, the mean sagittal diameter at the inlet was 12.039 ± 0.856 cm in females versus 10.313 ± 0.907 cm in males, and at midplane 1, the corresponding diameters were 11.532 ± 0.947 cm and 9.942 ± 0.953 cm, respectively. At midplane 2, the difference was still significant but smaller (11.065 ± 1.024 cm vs. 10.302 ± 1.026 cm, p = 0.000). This continuing pattern supports the broader concept of sexual dimorphism in pelvic structure, which has been extensively documented in the literature. Our results are in line with other studies that report larger pelvic dimensions in females, which are thought to facilitate childbirth by providing greater space for the passage of the fetus through the birth canal (Schultz A et al., 1949 and Tague R et al 1989 and Moffett E et al., 2017).[13-15] The larger diameters in females at these levels are likely a result of evolutionary adaptations for parturition, where a wider and more capacious pelvic inlet and midplane can accommodate the passage of a newborn during labor. However, the most intriguing finding emerged at the outlet, where no significant difference was observed between males (9.642 ± 1.014 cm) and females (9.597 ± 0.810 cm) (p = 0.681). This lack of sexual dimorphism at the outlet is unusual given the well-documented differences in other pelvic measurements.[9] The outlet is the final part of the pelvic canal through which the fetus passes during delivery, and typically, one might expect a more substantial difference in dimensions between sexes to accommodate the neonatal head size. The absence of a significant difference at the outlet could be attributed to compensatory anatomical changes or a trade-off in the pelvic architecture. Some studies suggest that the outlet diameter in both sexes might be constrained by other factors, such as sacral slope or the positioning of the coccyx (Kolesova O et al., 2017).[9]

In the present study, the findings on sacral slope and pelvic inclination highlight significant sexual dimorphism in pelvic anatomy, whereas the subpubic angle shows no statistically significant difference between sexes. Specifically, the mean sacral slope was slightly higher in females (36.727 ± 2.717°) compared to males (36.204 ± 3.116°), with a coefficient of dimorphism of 100.00 and a highly significant p-value of 0.000. The sacral slope, an important parameter in pelvic alignment, is known to influence the biomechanical stability of the spine and pelvis. The slightly higher sacral slope in females may be an adaptation to the demands of pregnancy, where an increased lumbar lordosis and sacral slope help to maintain balance and offset the anterior shift in the center of gravity caused by the growing fetus. The observed higher sacral slope in females compared to males aligns with the findings of Bailey et al., (2016) who reported a greater sacral slope in females when standing.[16] This relationship between sacral slope and posture further emphasizes the dynamic role of pelvic and spinal anatomy in accommodating functional and biomechanical demands. The greater sacral slope observed in females suggests a structural adaptation that contributes to increased lumbar lordosis when standing, as also noted by Bailey et al., (2016)[16] This adaptation may enhance balance and load distribution during bipedal locomotion, especially in females, whose pelvises are optimized for reproductive functions such as pregnancy and childbirth. Interestingly, Bailey et al., (2016) also noted that these differences in lumbar lordosis were not evident in the supine position, implying a potentially greater range of motion in the female spine. This flexibility may provide biomechanical advantages during various activities, including labor, where changes in pelvic alignment are critical for facilitating fetal descent. In our study, the significantly higher sacral slope in females supports the notion that these anatomical differences are not merely static but are influenced by dynamic postural and functional requirements. These findings underscore the interplay between pelvic geometry and spinal mechanics, which are influenced by both structural and functional factors. Similarly, pelvic inclination was significantly greater in females (63.376 ± 6.629°) than in males (61.384 ± 3.876°), with a coefficient of dimorphism of 103.57 and a p-value of 0.001. Pelvic inclination reflects the orientation of the pelvic plane in relation to the body's vertical axis and is crucial for pelvic stability and mobility. The higher values observed in females are consistent with the findings of Bode T et al., (2024) and Hay O et al., (2015) who also noted greater pelvic inclination in females. These differences reflect broader pelvic adaptations for reproductive functions, including a larger and more flexible pelvic cavity, which are critical for accommodating childbirth. In contrast, the subpubic angle showed no statistically significant difference between females (96.885 ± 14.308°) and males (95.350 ± 4.448°), with a coefficient of dimorphism of 103.23 and a p-value of 0.166. Although the subpubic angle is frequently described as wider in females, as noted by Dolphens M et al. (2013) and Kolesova O et al. (2017), contributing to a broader pelvic outlet, the absence of a significant difference in this study may indicate population-specific variability or differences in measurement methodologies.[9,19] Additionally, soft tissue factors, such as ligament flexibility and joint elasticity, may compensate for skeletal dimensions, potentially reducing the observed differences in this parameter between sexes.

The comparison of pelvic indexes across parameters revealed significant differences only at the outlet, where females had a lower mean pelvic index (1.0205) compared to males (1.0767), with a highly significant P value (P = 0.000). In contrast, differences at the Inlet, Mid plane 1, and Mid plane 2 were not statistically significant. These findings align with studies by Fox KC (2020) and Delprete H (2017), which highlight broader pelvic dimensions in females for childbirth.[10,20] The significant difference at the outlet reflects male pelvic adaptations for greater stability and load-bearing, as noted by Leong A et al. (2006), while the lower index in females supports flexibility for parturition, consistent with Kjeldsen L et al. (2021).[21,22] Population-specific variability and compensatory soft tissue adaptations may explain the lack of significant differences in other parameters, suggesting functional adaptations beyond skeletal structure.

CONCLUSION

The present study provides a comprehensive analysis of sexual dimorphism in pelvic anatomy through the assessment of transverse and sagittal pelvic diameters, pelvic angles, and pelvic indices. The findings demonstrated consistent and statistically significant differences between males and females across most parameters, with females generally exhibiting larger measurements, particularly in transverse and sagittal diameters. These differences align with established literature and reflect evolutionary adaptations in the female pelvis to accommodate childbirth, mediated by hormonal influences and biomechanical demands. The significant variation observed in sacral slope and pelvic inclination further underscores the dynamic interplay between pelvic and spinal anatomy in females, optimizing balance and load distribution during pregnancy and bipedal locomotion. Notably, the absence of significant sexual dimorphism in certain parameters, such as the subpubic angle, highlights the potential influence of population-specific variability and compensatory adaptations, including soft tissue flexibility. Further research is warranted to explore population-specific differences and the impact of dynamic factors on pelvic structure and function.

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