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## The anterior dimensions of the pelvis in male and female Nigerians

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### Summary

A retrospective study on the anteroposterior X-ray films of the pelvis of 40 male, and 31 female Nigerians was undertaken to verify if there was any significant difference in the values of the transverse diameter of the inlet (TID), bicristal diameter (BCD), bituberal diameter (BTD), and subpubic angle (SA) between the male and the female, between the younger age group (21-45 years) and the older age group (46-70 years) in each sex, using the student's t-test.

Results showed that TID, BTD and SA each was significantly greater in the female than in the male ( $P < 0.001$ ). BCD showed no significant difference between the sexes ( $P > 0.05$ ). SA was significantly greater in the older age group than in the younger age group ( $P < 0.05$ ) while the other variable showed no significant difference. TID showed significant positive correlation with BCD, and BTD in the female ( $P < 0.05$ ), and with BCD, BTD, and SA in the male ( $P < 0.05$ ). The value of SA in female is obtuse but overlaps between acute and obtuse in males. Ninety-three per cent of the female pelvis had subpubic angle above the  $111.3^\circ$  demarking point (DP) but none of the male or female pelvis was marked out by the lower or upper demarking points of BCD, suggesting a relevance of DP of SA in sex discrimination. The mean ratio of TID to BTD was 1.5:1 in the male and 1.2:1 in the female suggesting a gynaecoid tendency in the latter.

This study provided data that can be useful for clinical and radiological pelvimetry for use in obstetrical care of Nigerian women, and normal values for Nigerian male and female.

### Resumé

Une étude rétrospective sur l'antéropostérieure des rayons - X du pelvis de 40 mâles et 31 femelles Nigériennes pour déterminer l'importance de la différence aux valeurs du diamètre transverse d'entrée (DTE), le diamètre bicristal (DBC), le

diamètre bitubéral (DBT), et l'angle sous pubique (AS), entre le mâle et la femelle, et entre les jeunes (21-45 ans) et les plus vieux (46-70 ans) dans chaque sexe employant l'épreuve-t des étudiants. Le résultat a montré que le DTE, DBT et SA étaient plus remarquables chez les femelles que chez les mâles ( $P < 0.001$ ). Il n'y avait pas de différence entre le DBC des deux sexes ( $P > 0.05$ ). AS était plus remarquable chez les plus vieux que chez les jeunes ( $P < 0.05$ ), tandis que les autres variables n'ont montré aucune importance. Il n'y avait pas de différence à la limite confiance de DTE, DBT, et AS entre le mâle et la femelle ce qui suggère l'utilité de la limite confiance dans la séparation des sexes. DTE a montré une corrélation importante et positive avec DBC et DBT chez la femelle ( $P < 0.05$ ) et avec DBC, DBT et AS chez le mâle ( $P < 0.05$ ). Les valeurs de AS chez les femelles sont obtus mais sont entre acut angle et obtus chez les mâles. Quarante-trois pourcents (93%) du pelvis des femmes ont mesuré au-dessus de SA,  $111.3^\circ$  (DP) mais aucun des deux pelvis (mâle et femelle) était classé sur la base de DP de BCD. Le ratio moyen de TID à BTD était 1.5:1 chez les mâles et 1.2:1 chez les femelles, ce qui suggère une tendance gynécologique chez la dernière.

Cette étude a fourni des chiffres qui peuvent être utiles au domaine clinique et pour mesurer le rayon-X du pelvis. Cela peut être utile au domaine obstétrique des femmes Nigériennes et des valeurs normales de BCD, TID, SA, BTD pour les mâles et femelles Nigériens.

### Introduction

The bony pelvis provides attachment for the musculature of the trunk and lower limbs; transmits the weight of the body from the vertebral column to the femora, contains and protects the pelvic viscera. In the female the cavity of the pelvis has to be large enough to allow the passage of the foetus during parturition. Differences in the features and dimensions of the male, and the female pelvis are

noticeable even at foetal stage [1] but these differences become more remarkable after puberty [2]. Sexual differences in skeletal pelvis are very useful in forensic medicine, obstetrics, and anthropology. Several investigators [3,4,5] have carried out work to assess the features of the pelvis that were valuable in sex discrimination. Variables such as the transverse inlet diameter (TID), bicristal diameter (BCD), bituberal diameter (BTD), and subpubic angle (SA) have been measured independently for such verification. Little information is available on the concurrent measurement of these variables on the same pelvis, and correlation between these variables have not been reported. The subpubic angle is reported to be obtuse in the female, and acute in the male [6,7]. But Romanes [8] reported that the subpubic angle of the pelvis is obtuse in the female, and overlaps between acute and obtuse in the male. Little is known about the range, and confidence intervals of the subpubic angle in the male, and the female. Mean values of subpubic angle of the male were not actually reported by previous authors [6,7,8]. Information is also lacking on whether the difference in the values of TID, BCD, BTD and SA between the younger and the older age groups in each sex is significant. Very few of the published work on sexual dimorphism of the pelvis were conducted on Africans [10], making it necessary for more work on Africans. Much of the work on Nigeria female bony pelvis [11,12] were conducted on lateral X-ray films, and the values of the TID, BTD and SA which can be measured only in anteroposterior X-ray films could not therefore be recorded. The present work conducted on the anteroposterior X-ray films of the pelvis of Nigerians was therefore undertaken to establish the range, mean, and confidence interval of TID, BCD, BTD and SA in the male, and in the female; find whether the difference between the male and female sex with regard to TID, BCD, BTD and SA is significant; assess in each sex whether there is significant difference between the younger and older age groups with regard to TID, BCD, and SA; assess whether the correlation between the variables in each sex is significant; evaluate male and female measurements using demarking ranges of these variables.

### Materials and methods

Anteroposterior X-ray films of the pelvis of 40 male, and 31 female Nigerians ages between 21 and 70

years were used. They had reported at the casualty unit of Obafemi Awolowo University Teaching Hospital, Ile-Ife, Nigeria, between 1985 and 1990 for suspected injuries to the lower limbs. The X-ray films were taken as described by Nwoha [9]. There was no report on whether or not the female cases had reached menopause. So menopause was not taken into account in sorting the ages of the female cases. Values obtained for each sex were kept separate, and with the aid of a ruler the following variables were measured to the nearest 0.1cm (fig. 1):

- (1) bicristal diameter (BCD); measured as the maximum distance between the outer lips of the iliac crests.
- (2) transverse diameter of the inlet (TID); measured as the maximum transverse diameter of the inlet of the lesser pelvis.
- (3) bituberal diameter (BTD); measured as the distance between the lowest points on the ischial tuberosities.

Two separate points on each of the ischiopubic rami were marked on a transparent paper placed over the X-ray film. The two points were joined by a straight line: the two straight lines were drawn to meet. The angle between the intersection of two straight lines (one line through M and O, and another through N and P) (fig. 1) is the subpubic angle and was measured in degrees with the help of a protractor.

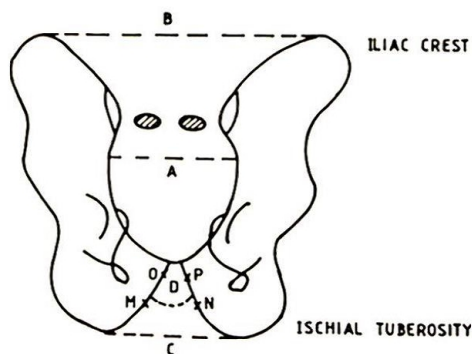


Fig. 1: An anteroposterior illustration of the human bony pelvis showing A, the transverse inlet diameter (TID), B the bicristal diameter (BCD), C the bituberal diameter, and D the subpubic angle (SA)



In order to correct for magnification error resulting from the use of X-ray films, magnification factors were calculated. A bony pelvis was X-rayed using the same methods as was used for the specimens. Absolute values of the variables were obtained from the X-ray films of the bony pelvis. Values were also obtained directly from the bony pelvis itself. The two sources were compared and magnification factor calculated. BCD, and TID, each had a magnification factor of 0.9. BTD had a magnification factor of 0.8 while SA recorded no magnification. The final (corrected) value recorded for each specimen variable was obtained by multiplying the value obtained on the X-ray film by the magnification factor.

Using the student's t-test the values of the variables between the male, and the female sexes, and between the younger (21-45 years) and older (46-70 years) age groups in each sex were compared for significant difference. Confidence interval was calculated for each variable in each sex at 95 per cent confidence level for use in separating the male sex from the female sex. Using Pearson's product of moment correlation coefficient, the variables were correlated for significant association. Demarking ranges of the variables, calculated as mean  $\pm$  3 SD [13] and Demarking Points (DP) which are the lower

and upper limits of the demarking range of each variable were used to classify the sex of the pelvis. The ratio of TID to BTD was calculated in each sex to help determine the type of female pelvis.

## Results

The results of the study are presented in tables 1 to 6. Table 1 shows that there is significant difference between the male sex, and the female sex with regard to the transverse diameter of the inlet (TID) ( $P < 0.001$ ). For each variable except BCD the value obtained for the female is significantly greater than that obtained for the male. There is no significant difference between the sexes with regard to BCD ( $P > 0.05$ ). At 95 per cent confidence level there was no overlap in the confidence intervals of the male, and the female sexes with regard to TID, BTD, and SA, but there was overlap in the confidence intervals between the sexes with regard to BCD. Out of the 40 males: studied 49 per cent fell within the CL of TID, 45 per cent within the CL of BTD, and 40 per cent within the CL of SA. Out of the 31 females studied 80 per cent had values above the lower limit of CL of TID (12.4cm), 70 per cent above the lower limit of CL of BTD (10.1cm) and 72 per cent above the lower limit of CL of SA (131.5°).

**Table 1:** Range, confidence interval (CL), and students t-test between the values of the variables in the male (n=40) and in the female (n=31) Nigerians

Description	Male				Female				P level
	Range	CL	Mean	SE	Range	CL	Mean	SE	
Transverse diameter (TID)(cm)	10.3 to 13.7	11.4-11.8	11.6	0.1	11.0-14.4	12.4	12.6	0.1	0.001
Bicristal diameter (BCD)(cm)	23.06 to 32.2	26.3-27.3	26.8	0.3	24.3-30.4	26.9 to 27.9	27.4	0.3	NS
Bituberal diameter (BTD) (cm)	7.0 to 9.0	7.8-8.2	8.0	0.1	9.1-13.5	10.1 to 10.9	10.5	0.2	0.001
Subpubic angle (SA) <sup>o</sup>	72.0 to 135.0	97.4	102.9	3.0	100.0 to 165.0	131.5 to 143.3	137.4	3.1	0.001

The range, confidence interval (CL) mean transverse inlet diameter (TID), bicristal diameter (BCD), bituberal diameter (BTD), and subpubic angle (SA) of the male and female pelvis. SE is the standard error of mean and P is the level of significance using the student's t-test. NS represents not significant.



**Table 2:** Range, and student's t-test between the values of the variables in the younger age group (21-45 years) and older age group (46-70 years) male Nigerians (n=40).

Description	Younger age group (21-45 years)			Older age group (46-70 years)			P-level
	Range	Mean	SE	Range	Mean	SE	
Transverse diameter (TID)(cm)	10.4-13.1	11.4	0.1	10.3-13.7	11.7	0.7	NS
Bicristal diameter (BCD)(cm)	24.9-29.7	27.0	0.3	23.9-32.2	26.5	0.5	NS
Bituberal diameter (BTD)(cm)	7.0-9.2	8.1	- 0.2	7.0-9.5	7.9	0.2	*NS
Subpubic angle (SA)(°)	72.0-132.0	97.5	3.5	80.0-135.0	108.8	4.0	0.04

The range, mean, and standard error of mean (SE) of the transverse inlet diameter (TID), bicristal diameter (BCD), bituberal diameter (BTD), and the subpubic angle (SA) of the pelvis in the younger age group (21-45 years) and older age group (46-70 years) male Nigerians. P. is the level of significance of the difference between the two groups using the student's t-test. NS represents not significant.

**Table 3:** Range, and student's t-test between the values of the variables in the younger age group (21-45 years) and older age group (46-70 years) female Nigerians (n=31).

Description	Younger age group (21-45 years) n=12			Older age group (46-70 years) n=19			P-level
	Range	Mean	SE	Range	Mean	SE	
Transverse diameter (TID)(cm)	11.0-14.0	12.3	0.3	11.8-14.4	12.7	0.1	NS
Bicristal diameter (BCD)(cm)	24.3-30.2	26.8	0.6	25.2-30.2	27.7	0.3	NS
Bituberal diameter (BTD)(cm)	9.3-11.5	10.2	0.3	9.0-11.7	10.3	0.2	NS
Subpubic angle (SA) (°)	100.0-160.0	128.3	0.6	110.0-165.0	143.2	0.7	0.02

The range, mean, standard error of mean (SE) and the level of significance of the difference in the transverse inlet diameter (TID), bicristal diameter (BCD), bituberal diameter (BTD) and subpubic angle (SA) between females of the younger age group (21-45 years) and older age group (46-70 years) using the student's t-test. NS represents not significant.

**Table 4:** Pearson's product of moment correlation coefficient for the variables in female Nigerians (n=31)

Description	Subpubic angle (SA)	Bicristal diameter(BCD)	Inlet transverse diameter (TID)	Bituberal diameter (BTD)
Subpubic angle (SA)	1.00			
Bicristal diameter (BCD)	0.06NS	1.00		
Inlet transverse diameter (TID)	0.07NS	0.58**	1.00	
Bituberal diameter (BTD)	0.05NS	0.09NS	0.36*	1.00

Pearson's product of moment correlation coefficient between subpubic angle (SA), bicristal diameter (BCD), transverse inlet diameter (TID), and bituberal diameter (BTD) of the pelvis of female Nigerians. \* represents significance at  $P < 0.05$ , \*\* significance at  $P < 0.001$ , NS not significant.

**Table 5:** Pearson's product of moment correlation coefficient for the variables in female Nigerians (n=40)

Description	Subpubic angle (SA)	Bicristal diameter(BCD)	Inlet transverse diameter (TID)	Bituberal diameter (BTD)
Subpubic angle (SA)	1.00			
Bicristal diameter (BCD)	0.14NS	1.00		
Inlet transverse diameter (TID)	0.31*	0.54**	1.00	
Bituberal diameter (BTD)	0.06NS	0.30*	0.35*	1.00

Pearson's product of moment correlation coefficient between subpubic angle (SA), bicristal diameter (BCD), transverse inlet diameter (TID), and bituberal diameter (BTD) of the pelvis of male Nigerians. \* represents significance at  $P < 0.05$ , \*\* significance at  $P < 0.001$ , and NS not significant.

**Table 6:** Demarking range, demarking point and % of male or female pelvis classified

Description	Demarking range	Male		Female	
		Demarking point	% classified	Demarking point	% classified
Transverse inlet diameter (TID)	10.5-13.7cm	10.5cm	18	13.7cm	6
Bicristal diameter (ECD)	21.7-31.9cm	21.7cm	0	31.9cm	0
Bituberal diameter (BTD)	7.5-10.4cm	7.5cm	45	10.4cm	63
Subpubic angle	85.2-111.3°	85.2°	23	111.3°	93

Demarking range, demarking point (DP) of transverse inlet diameter (TID), bicristal diameter (BCD), bituberal diameter (BTD), subpubic angle (SA) and the percentage of male, and female pelvis classified. < indicates that values below demarking point and > values above the demarking point are classified.



The value of SA in the older age group is significantly greater than in the younger age group in the male sex ( $P < 0.04$ ) (table 2), and in the female sex ( $P < 0.02$ ) (table 3). There is no significant difference between the younger and older age groups with regard to TID, BCD and BTd in the male, and in the female sex ( $P > 0.05$ ). Table 4 shows that in the female TID is significantly correlated with BCD and BTd, but has no significant correlation with SA. Table 5 shows that in the male, there is significant correlation between BTd, and BCD, and SA, and BTd. The correlation between BTd and BCD is significant; but that between BTd and BCD is not significant ( $P > 0.05$ ). Demarking Points (DP) of 21.7cm and 31.9cm of BCD classified none of the male and female pelvis respectively while DP of 85.2° and 111.3° of SA classified 23% and 93% of the male and female pelvis respectively (table 6). The mean ratio of TID to BTd was approximately 1.5:1 in the male and 1.2:1 in the female.

## Discussion

This study was a retrospective one and the data obtained depended on the X-ray films available. Only anteroposterior films of the pelvis were available. There was no available information on whether or not the women had reached menopause. So the age of the grouping of the females was not based on age at menopause. It was reported in fig. 1 that the transverse diameter of the pelvic inlet (TID), the bituberal diameter (BTd), and the subpubic angle (SA) were significantly higher in the female sex than in the male sex ( $P < 0.001$ ), and that at 95 per cent confidence level there was no overlap in the values of these variables recorded for the male, and the female. This shows that the three variables have differing dimensions between male and female pelvis and supports previous authors who had noted differences between the male and female pelvis with regard to these dimensions [3-10, 14 and 15]. It was found that in each sex, the subpubic angle of the older age group was significantly greater than of the younger age group ( $P < 0.05$ ). TID, BCD, and BTd each showed no significant difference between the younger and older age groups. In the female, increase in the size of the transverse diameter of the pelvic inlet is associated with increase in the bicristal diameter, and the bituberal diameter, but not in the subpubic angle. Also in the male increase in TID is associated with increase in BCD, BTd and SA.

There was no previous report correlating the values of these variables in the female or male pelvis. The report of the TID in this work is very important, being the first documented on Nigerians, and one of the few on Blacks. The mean value of 12.6cm of TID reported for Nigerians is higher than the value of 11.5cm reported for the Bantus of South Africa by Heyns and Shippel [10]. This calls for more work on the TID of Blacks as this is likely to vary with geographic regions. Kolawole *et al* [11] had further emphasised the importance of the measurement of TID in Blacks when after comparing the anterior-posterior diameter (APD) of the pelvic inlet in Nigerian and Welsh women, he stated that the problem of pelvic disproportion in black women is more with TID than APD. It was reported that 93% of the female pelvis were classified by demarking point (DP) of 111.3° of the subpubic angle (SA) while none of the male or female pelvis was classified by demarking points of BCD (table 6). This indicates the usefulness of DP of SA in sex discrimination and further suggests a strong female type (gynaecoid) pelvis in the Nigerian women studied. The 7% that could not be classified by the 111.3° DP of SA might be abnormal or belong to the male type (android) pelvis. The finding that the mean ratio of TID to BTd was 1.5:1 in the male and 1.2:1 in the female strongly supports the above view that the pelvis of the Nigerian female generally tends to the gynaecoid type. A confirmation of the gynaecoid tendency in Nigerian female bony pelvis will depend on the report of Caldwell and Moloy [14] and Caldwell, Moloy and D'Esopo [15] that the measurement of the depth of the pelvis and the angle of the greater sciatic notch determines the type of the female pelvis. Such a work will utilise anteroposterior, and lateral X-ray films of the pelvis taken concurrently on the same person.

## Conclusion

It is concluded that the subpubic angle in the female is obtuse, while in the male it overlaps between acute and obtuse; the subpubic angle is greater in the older age group (46-70 years) than in the younger age group (21-45 years); positive correlation exists between TID, BTd and BCD but not with SA in the female. There is no distinction between the pelvis of the male and female Nigerians with regard to the BCD, but slight with regard to the TID and large with regard to the outlet measurements (SA and

BTD). The female pelvis generally tends to the gynaecoid type. Demarking points of SA are useful in sorting the male from the female pelvises.

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