

Anogenital Distance of Newborns and Causes of Variation in Zaria, Northern Nigeria

¹O.M. Avidime, ¹K.V. Olorunshola and ²A.A.U. Dikko

¹Department of Human Physiology, Faculty of Medicine, Ahmadu Bello University,
Zaria, Nigeria

²Department of Human Physiology, Faculty of Medicine, Bayero University, Kano, Nigeria

Abstract: The aim of this study is to determine the anogenital distance in male and female newborns in Zaria and possible causes of variation. The anogenital distance (AGD), serum testosterone and anthropometric measurements of 200 newborns was measured (100 male, 100 female). Data obtained were analysed using Student t-test, ANOVA and Pearson's correlation as applicable. The mean total anogenital distance was 22.53 ± 0.70 mm, (males: 31.11 ± 0.64 mm and in females: 13.89 ± 0.26 mm). Newborns of Igbo ethnicity had the highest mean AGD of 32.77 ± 1.63 mm (males) while the females had a mean anus to fourchette distance of 14.63 ± 1.14 mm. There was significant positive correlation between anogenital distance and head circumference in male newborns and birth weight in female newborns in the population examined ($p < 0.05$). Testosterone concentration, placenta weight, birthlength and birthorder did not correlate with Anogenital distance. It is concluded that ethnicity, birth weight and head circumference significantly affect anogenital distance in the population examined in Zaria, Nigeria.

Key words: Anogenital distance, anthropometric, ethnicity, umbilical cord testosterone

INTRODUCTION

Anogenital distance (AGD) is the distance between the anus and the base of the penis in males and anus to fourchette (AF) distance in females and is a sexually dimorphic index that, on average, is twice as great in males as in females, and serves as a marker of proper male development. (Callegari *et al.*, 1987, Salazar-Martinez *et al.*, 2004; Weisse, 2006).

The utility of Anogenital Distance (AGD) measurement in humans is supported by experimental data in primates showing that *in utero* exposure of females to androgenic agents increased AGD (Hendrickx *et al.*, 1987). The purported mechanism by which androgens increase AGD in females is by inducing "labioscrotal fusion" (in normal males fusion begins caudally and proceeds ventrally, presumably androgens in females act the same way) (Callegari *et al.*, 1987).

Measuring the anogenital distance in neonatal humans has been suggested as a non-invasive method to predict neonatal and adult reproductive disorders such as cryptorchidism and hypospadias (Hsieh *et al.*, 2008). Abnormal AGD is associated with premature breast development in young girls (Colón *et al.*, 2000).

Measurement of AGD using a flexible ruler which conformed to the natural curves of the perineum and measurement under anesthesia improved accuracy by eliminating any motion artefact. (Hsieh *et al.*, 2008)

Some factors such as gestational age, ethnicity, race and birth weight, intrauterine exposure to steroids and endocrine disruptors are known to affect AGD (Callegari *et al.*, 1987; Phillip *et al.*, 1996, Salazar-Martinez *et al.*, 2004). The major ethnic groups in Nigeria are Hausa, Yoruba, Igbo and other minorities grouped together as others

In Nigeria, there is extensive use of pesticides with little or no regulation of its use, cosmetics, diet and household items containing endocrine disrupting chemicals with deleterious effects on reproductive and endocrine homeostasis consequent on reproduction/fertility (Olorunshola *et al.*, 2009). To the best of our knowledge, there is no report on AGD in newborns in Nigeria, consequently, this study was designed to determine the anogenital distance in Zaria and attempt to determine possible causes of variation.

The aim of this study is to determine the anogenital distance in newborns and possible causes of variation in Zaria, Northern Nigeria.

Corresponding Author: Ohunene M. Avidime, Department of Human Physiology, Faculty of Medicine, Ahmadu Bello University, Zaria, Nigeria. Tel: +2348037053285

MATERIALS AND METHODS

Study design: This study is a cross sectional study conducted in Zaria, Northern Nigeria between June and August 2010. Questionnaires were used to obtain pregnancy history. Measurement of birth weight, birth length, head circumference and anogenital distance in newborns from consenting parturients were recorded.

Demography of study area: Zaria is a cosmopolitan city in Kaduna State, Nigeria inhabited by about 408,198 people as stated by the 2006 census report (Wikipedia, 2011). Different tribes and ethnic groups can be found in Zaria, the three major ethnic groups: Hausa, Yoruba, Igbo and minorities grouped together as others. Zaria occupies a portion of the high plains of Northern Nigeria, 652.6 m above sea level and some 950 km from the coast at 11°04'N, 7°42'E. Zaria is the second largest city in Kaduna State of Nigeria with many tertiary institutions of learning and research including Ahmadu Bello University Zaria.

The climate is Savannah with annual rainfall ranging from 0.0 to 816.0 mm/month and minimum and maximum temperature 15.3 and 36.25°C, respectively.

Ethical consideration: The study recruited parturients only after detailed explanation as to the nature and benefit of the study had been given, and verbal and or written consent obtained

Approval for this study was obtained from the Ethical Committee on Human Research of the Ahmadu Bello University Teaching Hospital, Shika, Zaria, Nigeria.

Study population: The study population used was consecutive consenting parturients in labour at the Ahmadu Bello University Teaching Hospital, Shika-Zaria, Hajiya Gambo Sawaba General Hospital, Kofan Gayan, Zaria, Major Ibrahim B. General Hospital, Sabon Gari, Zaria and Salama Infirmary, Zaria

Exclusion criteria: Non-consenting parturients and newborns with obvious anogenital anomalies such as imperforate anus and ambiguous genitalia were excluded from the study.

Subjects: A total of two hundred (200) newborns were recruited for the study, the first one hundred male and first one hundred female deliveries without any obvious anogenital anomalies which took place within the period of July and August 2010 in the aforementioned hospitals. Following admission into the labour room, structured questionnaires were administered to consenting

parturients within 6 h of birth to obtain sociodemographic details of mothers including family history and that of the husband, history of drug intake, cigarette smoking, alcohol consumption, obstetric history and ethnicity.

Anogenital distance measurement: The newborn infant was kept in the dorsal decubitus position; with the aid of an assistant, both hips were flexed and light pressure was exerted on the newborn's thighs until the assistant's hand touched the subject's abdomen. Measurements were made with flexible tape. Distance was measured from the center of the anus to the posterior convergence of the fourchette (where the vestibule begins) in female infants and from the center of the anus to the junction of the smooth perineal skin with the rugated skin of the scrotum in male infants. Results were recorded in millimetres (Callegari *et al.*, 1987). Gestational age was estimated according to the Dubowitz scoring system (Dubowitz *et al.*, 1970).

Other anthropometric measurements were determined as follows:

Birth weight: Without clothing the newborns were weighed on a basinet weighing scale. Weight was taken to the nearest 10 g (Athreya, 1980).

Birth length: Birth length was measured in the supine position, the feet were held against a fixed foot piece at the 0 mark and a movable head piece was brought to touch firmly against the vertex. The readings were recorded to the nearest 1 cm (Athreya, 1980).

Head circumference: Head circumference was measured using a non-stretchable tape over the maximum point of occipital protuberance and above the superior orbital ridges anteriorly (Athreya, 1980).

Placenta weight: The placenta was tied in a polythene bag and weighed on a basinet scale. Placenta weight was taken to the nearest 10g (Athreya, 1980).

Statistical analysis: All data was recorded as mean \pm SEM and was subjected to statistical analysis using Student t-test, Analysis of Variance and Pearson's Correlation test where applicable. A p value of equal to or less than 0.05($p \leq 0.05$) was considered statistically significant.

The Statistical Package for the Social Science (SPSS) for Windows Version 17.0 was used for all calculations and statistical analysis.

Table 1: Anogenital distance by ethnicity and sex

Tribe	Mean±SEM		
	Male	Female	Total
Hausa	31.38±0.88	13.85±0.31	24.07±1.03
Yoruba	27.50±1.92	13.43±0.61	17.65±1.63
Igbo	32.77±1.63	14.63±1.14	22.76±1.95
Others	30.52±1.30	13.77±0.36	21.38±1.29
Total	31.11±0.64	13.89±0.26	22.50±0.70

Table 2: Mean anogenital distance, testosterone concentration, placenta weight and some anthropometric measurements of newborns

	Mean±SEM		
	Male (n = 100)	Female (n = 100)	Total (n = 100)
AGD (mm)	31.11±0.64	13.89±0.26	22.50±0.70
T. Conc (ng/mL)	2.78±0.30	2.09±0.22	2.44±0.19
Placenta wt(kg)	0.88±0.26	0.69±0.02	0.78±0.10
Birth length (cm)	50.13±0.40	49.24±0.37	49.19±0.27
Head circum(cm)	34.45±0.21	34.23±0.21	34.34±0.15
Birth weight (kg)	3.23±0.06	3.04±0.05	3.03±0.04

Table 3: Correlation matrix of AGD and testosterone, birth weight, head circumference, birth length and placenta weight (n = 100) in females

Variables	TC	PW	AGD	HC	BL	BW
TC	1	0.12	-0.05	0.25	-0.09	0.27
PW		1	-0.01	0.04	0.20	0.11
AGD			1	0.17	0.10	0.23 ^a
HC				1	0.382 ^c	0.52 ^c
BL					1	0.44 ^c
BW						1

TC: Testosterone Concentration; PW: Placenta Weight; AGD: Anogenital Distance; HC: Head Circumference; BL: Birth Length; BW: Birth Weight; a = p<0.05; b = p<0.01; c = p<0.001

RESULTS

Anogenital Distance (AGD): Table 1 shows the mean anogenital distance of the newborns of the different ethnic groups used in this study. The total mean AGD of the newborns was 22.50±0.70, 31.11±0.64 mm in males and in females the total anus to fourchette distance was 13.89±0.26 mm.

Newborns of Igbo ethnicity had the highest mean AGD; 32.77±1.63 mm in males and 14.63±1.14 mm in females, while Yorubas had a mean AGD 27.50±1.92 in males and 13.43±0.61 mm. Hausas had a mean AGD of 31.38±0.88mm in males and 13.85±0.31 mm in females. There was no statistically significant difference between Hausas and Yorubas (p>0.05)

Table 2 shows the mean of other parameters measured. Mean birth length for male newborns was 50.13±0.40 cm, while in females 49.24±0.37 cm. There was no statistical significance between them (p = 0.83). Mean head circumference in males was 34.45±0.21 cm

Table 4: Correlation matrix of AGD and testosterone, birth weight, head circumference, birth length and placenta weight (n = 100) in males

Variables	TC	PW	AGD	HC	BL	BW
TC	1	-0.06	0.26	-0.09	0.14	0.08
PW		1	0.07	0.45 ^c	0.23	0.53 ^c
AGD			1	0.23 ^a	0.04	0.15
HC				1	0.48 ^c	0.56 ^c
BL					1	0.43 ^c
BW						1

TC: Testosterone Concentration; PW: Placenta Weight; AGD: Anogenital Distance; HC: Head Circumference; BL: Birth Length; BW: Birth Weight; a = p<0.05; b = p<0.01; c = p<0.001

and in females 34.23±0.21 cm, this was statistically significant (p = 0.50) while mean birth weight was 3.23±0.06 kg in males and 3.04±0.05 kg in females was also not statistically significant (p = 0.88).

Table 3 and 4 show correlation between the parameters used, in females there was positive correlation between birth weight and anogenital distance, head circumference and birth length and also positive correlation between head circumference and birth length.

In males, there was positive correlation between head circumference and anogenital distance, placenta weight, birth length and birth weight, there was also positive correlation between birth weight and placenta weight, birthlength.

DISCUSSION

The anogenital distance examined in this population showed that male values are higher than female values. The report is not different from other investigations which reported higher values for males (Salazar- Martinez *et al.*, 2004), this clearly shows the sexual dimorphism in males and females (Weisse *et al.*, 2006).

The mean anogenital distance in this study was 22.52 mm (males and females), higher than 18mm which was obtained by Salazar- Martinez *et al.* (2004). Values obtained by Salazar-Martinez *et al.* (2004) for males and females were 21 and 11 mm, respectively. The Salazar-Martinez *et al.* (2004) study was conducted in Morelos, Mexico. In this study, values obtained were 31.11 mm in males and the anus to fourchette (AF) distance was 13.89 mm in females, higher than the values obtained in the study by Salazar-Martinez *et al.* (2004), this could probably attributed to geographical differences and environmental factors as reported by Salazar-Martinez *et al.* (2004), while they had a mean birth weight of 3.07 and 3.06 kg for males and females, respectively. A total mean birth weight of 3.23 kg was obtained for males and 3.04±0.56 kg for females was obtained in this

study comparable to the values obtained by Salazar-Martinez *et al.* (2004).

Other literature cited in this study did not separate the newborns by weight classification. (Swan *et al.*, 2005; Salazar-Martinez *et al.*, 2004; Phillip *et al.*, 1996; Callegari *et al.*, 1987).

Callegari *et al.* (1987) used a mean birth weight of 2.53 kg. The mean anus to fourchette (AF) distance in their study was 10.9 mm. Philips *et al.* (1996) used a birth weight above 2.75 kg and they got an anus to fourchette (AF) distance value of 16.1 mm in Jews and 16.5 mm in Bedouins as compared to 13.89 mm in this study, which is a lower value.

The highest value for AGD in males in this study was 44.00 mm in a newborn that weighed 2.20 kg while the lowest was 17 mm in a newborn that weighed 1.45 kg. Probably this shortened AGD could be attributed to the low birth weight. It is also reported that phthalate exposure in utero could lead to decreased AGD (Barlow and Foster, 2003; Foster *et al.*, 2000; Hendrickx *et al.*, 1987).

The highest anus to fourchette (AF) distance was 30 mm in a newborn that weighed 3.0 kg while the lowest AF distance was 8.00 mm in a newborn weighing 2.0 kg. This high AF distance value was obviously not related to birth weight. It could have been as a result of chemical exposure in utero as a result of cosmetic use or exposure to pesticides, androgenic agents, etc., or diet as suggested by Hauser (2005), Swan *et al.* (2005), Farr (2003) and Hendrickx *et al.* (1987). The reduced AF distance may also be related to diet (Tou *et al.*, 1998). There was ethnic difference in this study as in the investigation by Philips *et al.* (1996). In the various ethnic groups in this study, There was statistically significant difference in the AGD between the different ethnic groups ($p<0.05$).

CONCLUSION

We conclude that the anogenital distance in the population studied is not different from that found in other regions and AGD positively correlated with head circumference in males and birth weight in females.

ACKNOWLEDGMENT

The authors acknowledge the assistance of the Medical Director and staff of Salama Infirmary, Zaria, Nigeria, the tireless support of Dr. Solomon Avidime of the Department of Obstetrics and Gynaecology, Ahmadu Bello University Teaching Hospital, Zaria, Nigeria, Maternity Wards of St. Luke's Hospital, Wusasa, and

Hajiya Gambo Sawaba General Hospital, Kofan Gayan, Zaria and Dr. Olugbenga Oguntunde for the statistical analysis.

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