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ULTRASONOGRAPHIC UTERINE DIMENSIONS IN NON-PREGNANT ADULT FEMALES AT AGBOR DELTA STATE; ESTABLISHMENT OF NORMS

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ABSTRACT

This study evaluated the normal uterine size (longitudinal, transverse and anteroposterior dimensions) of the non-pregnant uterus with use of ultrasonography. The study was carried out amongst women in Ika South Delta State, Nigeria. Uterine dimensions were determined by real time trans-abdominal pelvic ultrasound scan in Agbor, Delta State. A cross-sectional study of normal uterine size of 300 women aged 17-47 years was conducted by ultrasonographic measurements. The women were divided into three groups - 100 nulligravida, 100 primigravida and 100 multigravida women according to gravidity. Findings showed that mean uterine sizes of 56.1 mm x 46.7 mm x 41.8 mm for nulligravida women, 63.0mm x 52.0mm x 46.3mm for primigravida, 70.0mm x 56.4mm x 50.9mm for multigravida women and 63.0mm x 51.7mm x 46.3mm for overall total. Uterine size in non-pregnant women was significantly correlated with gravidity and the study also predicted uterine size using linear multiple regression lines.

Keywords: Uterine dimensions, Ultrasonography, Gravidity, Agbor

INTRODUCTION

The uterus commonly called womb is described as a thick walled hollow muscular organ of the female reproductive system (Keith *et al*., 2014). A non-gravid uterus i.e. a non-pregnant uterus is located at the pelvis with the fundus/uterine body lying in the urinary bladder and the cervix lying between the rectum and the urinary bladder (Keith *et al*., 2014). The form and size of the14uterus has been reported to change with the obstetric history of an individual (Keith *et al*., 2014).

According to Waldroup and Liu in 1997, during fetal life usually at the beginning of the first trimester, size of the uterus increases at a very slow rate but towards the end of the first trimester, uterine size increases at a faster rate. This increase in size at the end of the first trimester has is as a result of production of maternal estrogen (Waldroup and Liu, 1997). Immediately after delivery, there is a decrease in uterine size because of the dramatic decline in maternal oestrogen production (Waldroup and Liu, 1997).

Between the pre pubertal stage (i.e. ages of 2 and 8 years), uterine length is less than 35 mm, with an anteroposterior diameter of 10 mm (Badouraki *et al.*, 2008).During the pubertal stage proper, the endocrine cells of the ovaries begin to secrete hormones which cause the uterus to appear as a pear shaped organ(Herter *et al.*, 2002). During a woman's lifetime, morphological changes in the uterus are prominent in the muscular layer of the body of the uterus (Emera *et al.*, 2012). The fundus of the uterus becomes thicker with each pregnancy. After menopause, the fundus reverts to its pubertal form in such a way that it can be palpated over the cervix, at which time its size is similar to that of a cup. An anterior posterior length of 10 cm is considered to be normal for a woman of reproductive age (Ziereisen *et al.*, 2005).

Ultrasonography, a non-invasive technique has been reported to be frequently applied in the assessment of the female genital tract; this is due to the fact that it limits patients level of exposure to ionizing radiations and permits multi-sectioning scanning of soft tissues such as the uterus (Mihu and Mihu, 2011). According to Henry and Mohammed (2016), ultrasonography is particularly suited for diagnostic investigation of uterine tissues.

In uterine ultrasonography, a pelvic ultrasound scan which includes a trans-abdominal or a trans-vaginal scan is used in visualizing the uterus (Henry, 2016). Trans-abdominal scan allows the visualization of the size and position of the uterus with aid of the urinary bladder while the trans-vaginal scan visualizes the internal anatomy of the uterus (Henry and Mohammed, 2016).

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The uterus displays three prominent regions of different echogenicity in sonography; the myometrium which forms the outer smooth muscle layer of the uterus is represented by a thick homogenous band of low to medium echogenicity, and the endometrial lining which is represented by a moderate to high amplitude thin echogenic stripes less bright than the echoes seen in the vagina (Leone *et al.*, 2010).

In reproductive medicine, gravidity and parity is described as two major concepts associated with the number of times a reproducing female has been pregnant and carried to a viable gestational age (Creinin and Simhan, 2009). The word gravida, is derived from the Latin word "Gravid" meaning heavy and it is commonly used to refer to a pregnant woman (Creinin and Simhan,2009). Gravidity is described as the number of times a woman has been pregnant regardless of whether there was spontaneous abortion, still birth or live birth. Nulligravida is used to refer to a woman who has never been pregnant; while primgravida and multigravida are used to refer to women that has been pregnant once and women that has been pregnant more than one time, respectively (Creinin and Simhan,2009).

Reproducing women may also be described based on parity; i.e. the number of pregnancies that proceeds to viable gestational age. Creinin Simhan (2009), stated that a woman who has never carried a pregnancy beyond 20 weeks is nulliparous, whereas a woman who has given birth once before is primiparous while a woman who has giving birth more than once is described as multiparous (Creinin and Simhan,2009).

Karl *et al*. conducted an in vivo study on uterine dimensions of fertile women in 1984. The cavimeter was used to assess the uterine sound length, the functional length of the cervix, including the zone of internal cervical os and the fundus transversal diameter. This study noted that parity, uterine length and width increases with advance in age (Karl *et al*., I984)

Merz *et al.* (1996) measured the uterine and ovarian sizes in 765 pre and postmenopausal women by transvaginal ultrasound. Subjects were classified into nullipara, primipara and multipara while postmenopausal women age was separated into two groups based on age since menopause i.e. < 5 years and > 5 years since menopause. In premenopausal group, parity related enlargement in uterine size was observed between nulliparous, primiparous and multiparous women while after menopause, a significant reduction in uterine size and in corpus cervix ratio was observed. The study also recorded that endometrial thickness in premenopausal women did not exceed 4mm on day 4 and 8mm on day 8 of the menstrual cycle; in the postmenopausal group, endometrial thickness did not exceed 5mm (mean 3.6mm) (Merz *et al.*, 1996).

Liliane *et al*. (2002), carried out a study on ovarian and uterine sonography in healthy girls between 1 and 13 years old. Findings from their study indicated a positive relationship between uterine and ovarian growth with age and puberty. Uterine length showed the best fit correlation with age (Liliane *et al*., 2002)

Verguts *et al.* (2003), conducted a retrospective study on the normative data for uterine size according to age and gravidity and possible roles of the classical golden ratio. They reported that increased gravidity is associated with greater uterine length and this difference persists throughout life. They study also demonstrated that uterine proportion is hypothesized to conform to the classical golden ratio 1.618. The researchers noted that uterine dimensions, decreases with increase age (Verguts *et al.*, 2003).

Esmaelzadeh *et al*. (2004), carried out a study which was aimed at determining the efficacy of ultrasonographic assessment of the uterus size in women of reproductive age. Uterine dimensions showed a significant relationship with parity and age and a no significant relationship with body mass index (BMI) (Esmaelzadeh *et al.*, 2004).

A similar study was carried out by Seffah and Adanu in 2004, to determine the sonographic determination of uterine size in young Ghanaian women.This study reported a mean length of 7.1 ± 1.1 cm, mean width of 4.6 ± 0.9 cm and mean transverse diameter of 2.9 ± 0.5 cm. It also recorded a no significant relationship between mean uterine measurements and the number of years a woman has been having regular menstrual cycles and a no significant relationship between present in mean uterine size when the different stages of the menstrual cycle were compared (Seffah and Adanu, 2004).

Another study by Beryl *et al*. (2010), which was aimed at estimating the width of normal uterine cavity at the fundus and evaluating its relationship to parity,

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gravidity, prior caesarean delivery, uterine volume and age of women reported a strong correlation between the width of the uterine cavity and endometrial echo width. They study also demonstrated a no significant relationship between prior caesarean delivery and width of the uterine cavity or between women age and the width of the uterine cavity (Beryl *et al.*, 2010).

A prospective study conducted by Ikpe *et al*. (2012), on the ultrasound evaluation of the uterine size and endometrial changes in some normal menstrual cycle females in South-East and South-South Nigeria showed mean values for the endometrial thickness (ET) as 3.2 ± 1.1mm, the antero-posterior length (AP) 4.0 ± 3.2mm, and width of the uterus (W) 5.2 ± 4.2cm for women under menstrual phase.[18] Uterine dimensions of subjects during proliferative phase, was 7.5 ± 1.9mm, 4.1 ± 0.6cm, 7.4 ± 2.7cm and 5.3 ± 2.0 cm respectively while dimensions under secretory phase was 9.4 ± 1.9mm, 4.2 ± 0.4cm, 7.9 ± 4.5cm and 5.9 ± 3.4cm respectively (Ikpe *et al.*, 2012).

A study by Sirisena *et al.* (2015), reported a uterine size of 8.24cm x 4.75cm x 3.77cm (length x width x AP diameter) for overall total, 7.46cm x 4.22cm x 3.30cm for nulliparous women, 8.49cm x 4.87 x 3.81cm for primiparous women and 9.10cm x 5.36cm x 4.36 cm for multiparous women living Jos state, Nigeria. A significant correlation was demonstrated between uterine size, parity and age across the studied population (Sirisena et al., 2015).

Another study compared uterine dimensions using uterine sounding and ultrasonography (Canteiro *et al.*, 2010). They study reported a mean uterine length difference of 0.28, mean endometrial cavity length of 3.84 ± 0.03cm in nulligravida and 4.25 ± 0.03cm in parous women using uterine sounding and 3.70 ± 0.03 and 3.84 ± 0.03cm respectively. However, using any of the technique, the mean length of the endometrial cavity recorded was >3.6cm (Canteiro *et al.*, 2010). In addition, Moawia *et al*. (2013), also reported an increase in uterine dimensions with increase in age apart from cervical length that showed a mean decrease with increasing of age or years since menopause.

Diabia *et al*. (2001) carried out a study which attempted to establish normal values of uterine dimension in nulliparous reproductive age of negro origin. Uterine dimensions were determined by trans-abdominal sonography in 100 nulliparous Nigerian women aged 17-43 years. The mean uterine length was 7.30 ± 1.30cm, mean transverse diameter was 4.76 ± 0.79cm and mean antero-posterior diameter was 3.57 ± 0.60cm. Positive correlation was found to exist between age, weight, and heights of subjects and the various uterine dimensions determined. 89% of the subjects had an anteverted uterus, 1% axial uterus and 10% had a retroverted uterus (Diabia *et al*., 2001).

Studies have reported uterine size criteria such as height, weight, other body indices are influenced by nutrition, race, environment and heredity (Spiroff and Galass, 1999). Several studies have reported the determination of uterine dimensions in fertile women with emphasis on parity and gravidity (Merz *et al.*, 1996; Liliane *et al.*, 2002; Beryl *et al.*, 2010; Verguts *et al.*, 2013; Sirisena *et al.*, 2015).

Other studies have compared several techniques in estimating uterine dimensions (Merz *et al.*, 1996; Liliane *et al.*, 2002; Beryl *et al.*, 2010; Verguts *et al.*, 2013). The current study was designed due to the non-availability of a comprehensive data base of no population specific standards for estimating uterine dimensions among normal adult Nigerians in Delta state as well as establishing the normal uterine dimensions for the studied population. Our study for the first time determined the normal uterine size for nulligravida, primigravida and multigravida females in Agbor, Delta State, Nigeria. Findings from the study will be useful to the gynaecologists and obstetricians and to the sonologist in evaluating women in Agbor and for predicting the risk of developing some reproductive diseases such as uterine myoma, uterine smooth muscle tumors, and adenomyosis in the studied population.

MATERIALS AND METHODS

Study area: The study area is Agbor. It was chosen based on the fact that after a thorough literature search, no study was found documentIng uterine dimensions of non-pregnant women in Agbor, Delta State, Nigeria, thus providing a useful (for the obstetrician/ gynaecologist and the sonologist) anthropometric data for the region studied: It is a town in Ika south local government area of Delta State, Nigeria. According to a study by Iduwe in 1940, the indigenes of Agbor town are of Ika descent, an Igbo speaking group with some Bini influence. The

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people of Agbor have traditionally relied on farming for food and commercial purposes.

Sample size: The study is a prospective study, which involved a total number of 300 females of reproductive age between the ages of 17 – 47 years. All trans-abdominal pelvic ultrasound scan carried out by the radiologist at Central Hospital Agbor for nulligravida, primigravida and multigravida females during the duration of this research which met the selection criteria were considered for this study.

Selection criteria: Females still within the specified reproductive age, who at the time of study was not pregnant; all within the age of 17 – 45 years that are from Agbor and had no case of myometrial mass and endometrial fluid collection was considered. Consequently, pregnant women were excluded.

Ethical consideration: Approval for this study was sought from the ethical review committee of the Department of Anatomy and Cell Biology, Delta State University, Abraka and from the management board of Central Hospital Agbor, all in Delta state, Nigeria.

Data collection: The ultrasound scan was performed real-time with 3.5MHz curvilinear probe (transducer). A trans-abdominal pelvic sonography is best performed through a distended urinary bladder. The urine filled bladder acts as a sonographic window permitting clear visualization of pelvic viscera. It places the uterus in a more horizontal position relative to the ultrasound beam, resulting in better quality images. The patient was asked to lie on the examination table in a supine position. The abdomen and pelvic regions were exposed and ultrasound gel applied on the pelvic region. The gel helps the probe make good contact with the body and eliminate air pockets between the probe and skin that block transmission of the sound waves. The probe is placed on the body and moved back and forth over the pelvic region until the desired images are captured. Once the imaging is complete, the gel was wiped off the skin using a tissue paper and the Radiologist would then analyze the images. Longitudinal dimension of the uterus is the distance measured from the fundus of the uterus to the external os of the cervix on a longitudinal view. The transverse dimension of the uterus is the maximum distance measured at the level of the uterine fundus on a transverse view. While the anteroposterior dimension of the uterus is the maximum anterior and posterior distance measured in the mid portion of the uterine body also in a transverse view. Method was adopted from previous studies (Ezmaelzadeh *et al.*, 2004; Sirisena *et l.*, 2015).

Data analysis: Results of mean uterine size were expressed in mean, range and standard deviations. Data were subjected to SPSS (Version 26), and were analyzed using correlation and regression at a confidence level of 95.0% which was used to test the relationship between age and uterine dimensions. Levels of significance were determined at ($P < 0.05$).

RESULTS

The descriptive statistics of subjects' gravida expressed in Mean and Standard Deviation as presented in Table 1, shows the dimensions measured in the three gravida groups. The subjects that belonged to the multigravida group had the highest mean value, followed by primigravida and then the nulligravida.

Table 1: Descriptive statistics of Nulligravida, Primigravida and Multigravida group

Parameters	Mean ± Standard deviation		
	Nulligravida	**Primigravida**	**Multigravida**
Age	26.25±6.24	29.73±5.64	34.70±6.58
LDU	56.13±7.07	63.02±6.61	69.89±8.57
TDU	46.72±6.07	52.00±6.18	56.38±8.38
APDU	41.80±7.19	46.27±5.62	50.89±8.63

Key: LDU: longitudinal dimension of uterus; TDU: Transverse dimension of uterus; APDU: Anteroposterior dimension of uterus. N = 100 for each group.

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The table above showed the descriptive statistics of subjects' gravida expressed in mean and standard deviation. Of the dimensions measured in the three gravida groups, subjects that belonged to the multigravida group had the highest mean in the three dimensions measured. This was followed by primigravida and nulligravida.

Table 2: Descriptive statistics of the total groups

Parameters	Minimum	Maximum	Mean
LDU	40.60	88.20	63.01±9.33
TDU	31.80	78.90	51.69±7.99
APDU	25.30	77.10	46.34±8.13

Key: LDU: longitudinal dimension of uterus; TDU: Transverse dimension of uterus; APDU: Anteroposterior dimension of uterus. N = 300 for all the groups.

Table showed the descriptive statistics of the total uterine dimension measured in all the groups expressed in mean and standard deviation.Also, from the table, the values for the calculation of mean uterine size was calculated in this form; (LDU ± S.D.) x (TDU ± S.D.) x (APDU ± S.D) Overall total Group:Mean age = 30.2 ± 7.06years; Uterine size = (63.0 ± 9.33) mm x (51.7 ± 7.99) mm x (46.3 ± 8.16) mm

Table 3: Correlation between age and uterine dimension in the total of all groups

Uterine dimensions	Correlation coefficient (r)	P- value
LDU	0.461	<0.001*
TDU	0.397	<0.001*
APDU	0.402	<0.001*

Key: LDU: longitudinal dimension of uterus; TDU: Transverse dimension of uterus; APDU: Anteroposterior dimension of uterus. N = 300 for all the groups. ($p \leq 0.05$)

Table 3 showed a correlation between age and uterine dimensions in all the three groups combined. All parameters measured showed a positive significant correlation. The strongest and highest correlation with gravidity was noted with LDU with a correlation coefficient of 0.461; this was followed by APDU (r = 0.402) and TDU (r = 0.397)
.

Table 4: Multiple regression table for uterine dimensions measured.

Uterine dimension	Equation	p-value	Adjusted r^2
LDU	0.257 (Age) + 2.770 (gravidity) + 51.185	<0.001*	0.349
TDU	0.191 (Age) + 2.048 (gravidity) + 42.883	<0.001*	0.260
APDU	0.245 (Age) + 1.703 (gravidity) + 36.410	<0.05*	0.209

Key: LDU: longitudinal dimension of uterus; TDU: Transverse dimension of uterus; APDU: Anteroposterior dimension of uterus. N = 300 for all the groups. ($p \leq 0.05$).

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The regression table showed the final models for estimating any of the uterine dimensions using age and gravidity. They multiple regression table also showed significant results in all uterine dimensions measured ($p<0.05$). in addition, the regression model for LDU gave the highest percentage of coefficient of determination of 35%. This was followed by TDU (26%) and APDU (21%)

DISCUSSION

The uterus which is part of the female reproductive system has been demonstrated to undergo changes, with the obstetric history, age and body habitus during a woman's lifespan (Waldroup and Liu, 1997; Keith *et al.*, 2014) This changes is attributed to production of maternal estrogen as reported by Waldroup and Liu (1997).Although studies have showed that uterine growth is dependent on height and weight, it is also affected by other body indices which may be affected by nutrition, race, environment, and heredity (Spiroff and Galass, 1999; Sadler, 2000).

Our study evaluated the normal uterine size for nulligravida, primigravida and multigravida females in Agbor, Delta State, Nigeria with the use of ultrasound. It demonstrated differences in their mean uterine size, a strong correlation between gravidity and uterine dimension and multiple regression prediction of uterine dimensions among the studied population.

The highest mean uterine size obtained from the three different groups of gravidity studied was seen in the multigravida group. According to Creinin and Simhan (2009), multigravida is a term used to refer to women that has been pregnant more than once. This finding implies that the higher the numbers of pregnancies, the higher the uterine size while the lower the number of pregnancies, the lower the uterine size. From our study, it was clearly demonstrated that uterine size for multigravida females in the studied population, is given by 70.0mm x 56.4mm x 50.9mm. The uterine size value obtained from this study was lower than that obtained by Sirisena *et al*. (2014), who noted a uterine size of 9.10cm x 5.36cm x 4.36mm in multiparous women. It was also lower in the study by Merz *et al*. (1996) and Esmaelzadeh *et al.* (2004), who recorded uterine sizes of 92.0mm x 51.0mm x 43.0mm and 90.8mm x 51.7mm x 43.0mm respectively.

The multigravidas were closely followed by the primigravida's which is a term used to refer to women which has been pregnant once (Creinin and Simhan, 2009). Our study recorded a lower mean uterine dimension of 63.0mm x 52.0mm x 46.3mm against 83.0mm x 46.0mm x 39.0mm and 84.9mm x 48.7mm x 38.1mm previously reported by (Merz *et al*. (1996) and Sirisena *et al*. (2015) respectively.

Further, a similar observation was noted in the nulligravidas. Our study demonstrated a mean uterine size of 56.1 mm x 46.7 mm x 41.8 mm for nulligravida females. This was also lower than the values obtained from other studies. Merz *et al.* (1996), reported this 73.0mm x 40.0mm x 37.0mm, Diabia *et al*. in 2001, recorded a mean uterine size of 7.30cm x 4.76mm x 3.57cm in a Nigerian population while Esmaelzadeh *et al.* (2004), reported 72.8mm x 42.0mm x 32.4mm in an Iranian population.

This result pattern therefore indicated that Agbor women have lower uterine sizes as compared to other studied populations. Reasons for these observed differences could be attributed to height, growth status of individuals and weight which has been previously reported to affect the stature of an individual.

Findings from this study also demonstrated a statistical significant relationship between age and uterine size. The strongest highest correlation was evidenced in the longitudinal dimension of the uterus ($r = 0.461$). This was closely followed by anterior posterior diameter ($r = 0.402$). This significant positive relationship may be due to changes over a woman's lifespan in ovarian estrogen secretion. The uterus goes through cyclical changes. Initially, it is a pea shaped organ in the prepubertal stage, it then grows in size during the woman's reproductive stage and regresses at menopause to its pubertal form (Waldroup and Liu, 1997).Similar result pattern was observed by Diabia *et al.* in 2001,and Esmaelzadeh *et al*. (2004).

This present study reported that the best model for estimating uterine size using age and gravidity is

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the model derived from the longitudinal dimension of the uterus (0. 257 (Age) + 2.770 (gravidity) + 51.185). This is because it gave the highest percentage of determination of 35%. This implied that this study has successfully created a model for the estimation of uterine size using age and gravidity in the studied population.

Conclusion

The current study displayed a significant relationship between age and uterine dimension among the studied population. It derived the mean uterine sizes of non-pregnant Agbor woman according to their gravidity and has created a regression model for the estimation of uterine size among the studied population.

Declaration

The authors declare that there was no conflict of interest in the design or preparation of this article.

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Authors Contributions:

Chris-Ozoko: Principal Investigator, Conceived and designed the research.
SA:Data acquisition, analysis, or interpretation of data for the work.
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OJ: Obtained the ethical clearance**,** accountable for all aspects of the work and ensuring accuracy.

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