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# Sonographic evaluation of the Amniotic Fluid Index in normal singleton pregnancies in a Nigerian population.

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***Abstract:*** *Estimation of amniotic fluid volume is an integral part of the routine obstetric ultrasound scan and the amniotic fluid index (AFI) is one of the methods for doing this. Reduction or excessive production of amniotic fluid during pregnancy is also a strong predictor of possible associated congenital fetal anomaly. This study was to assess the AFI in Nigerian women and correlate same with their gestational age. It is a prospective cross sectional study of 300 scanned singleton pregnancies between 15-42 gestational ages. Their amniotic fluid indices were determined and correlated with their gestational age. A statistical analysis of data was done using the SPSS version 16, Chicago, Illinois. The study population mean AFI was 12.91±4.82cm, ranging from 4.17 – 22.05cm and a median of 12.56; the 5th and 95th percentile being 5.81 and 21.95 respectively. The mean AFI for preterm and term gestations were 12.70±5.02cm and 14.07±3.34cm respectively. There was no statistically significant difference between the mean AFI of the total study population and that of preterm and term gestations. The peak mean AFI value occurred at 28 weeks gestational age, with no bias in the distribution of amniotic fluid in the four quadrants of the uterus. Apart from establishing the normal AFI values in this environment, this study also showed that there was a weak positive correlation between gestational age and AFI, with no statistically significant difference in AFI of preterm and term gestations.*
***Key Words:*** *Amniotic fluid index, Nigeria, Singleton pregnancies, Ultrasound.*

## I. Introduction

Amniotic fluid surrounds the fetus throughout pregnancy providing its nutrition, support and warmth. It also helps in the development of the fetal lungs. The possible sources of amniotic fluid in the first trimester include a transudate of maternal plasma through the chorioamnion, or from fetal plasma through the highly permeable fetal skin, prior to keratinization[**1,2]**. In the second and third trimesters of pregnancy, amniotic fluid volume is maintained by a balance of fetal fluid production in lung fluid and urine, as well as fluid resorption in fetal swallowing and flow across the fetal membranes to the uterus[**2,3**]. Normal amniotic fluid volume varies with gestational age[**4**].

The amniotic fluid volume is an important marker of intrauterine fetal wellbeing, hence its quantification serves as a means of assessing fetal status[**2,3,5**,**6,7,8**]. and the AFI technique is a rapid, readily reproducible, non-invasive method of determining the amniotic fluid volume that was developed by Phelan and his colleagues[**9**]. It is calculated sonographically by the summation of the values of the vertical height of the largest amniotic fluid pockets (excluding umbilical cord and fetal parts) in each of the four quadrants of the gravid uterus, expressed in centimeters[**9**]. Its validity has been demonstrated by Moore and Cayle[**10**] as well as other authors[**11**]. Establishing normal values of the amniotic fluid volume for a given population will help in identifying oligohydramnnios and polyhydramnios and their attending complications.

Oligohydramnios has been defined as an amniotic fluid volume that is abnormally low for gestational age or a volume of less than 500 ml at term, while polyhydramnios is amniotic fluid volume greater than normal for gestational age or 2000 ml or more at term[**5,12**]. Oligohydramnios is associated with small for gestational age fetus, renal anomalies and urinary tract dysplasias[**5**] while polyhydramnios may be associated with fetal neural tube defects, central nervous system abnormalities affecting fetal swallowing, gastrointestinal obstructions, infections, isoimmunisation, gestational diabetes mellitus, non-immune fetal hydrops, chorioangioma of the placenta, and pulmonary hypoplasia[**6,13,14**].

Nigeria being the most populous black nation on earth, has a relatively diverse and heterogeneous population[**15**].

In this study the AFI among Nigerian women with uncomplicated singleton pregnancies was determined, and its variation with gestational age was also assessed.

## II. Materials And Methods

This was a prospective cross sectional study involving 300 pregnant women whose amniotic fluid indices were determined. It was conducted over a 12-month period using a portable Titan$^{R}$ 2.5 (Sonosite Inc, USA. 2004) machine with a curvilinear 3.5 MHz transducer.

**2.1 Setting and Study design:** The study center was the Radiology department of a University Teaching Hospital in Nigeria where approval was granted by the Research and Ethics committee and the procedures followed were in accordance with the ethical standards of the Helsinki Declaration.

The study subjects were those referred for routine obstetric ultrasound scanning from the antenatal clinic of the Obstetrics and Gynaecology Department and the General Practice Clinic who were between 15 – 42 weeks gestational age, with normal singleton pregnancies. Written informed consent was obtained from the study subjects after the study and its procedure had been adequately explained to them.

Their gestational age was calculated from the first day of the last normal menstrual period using the clinical history given or from a previous first trimester ultrasound scan. Subjects with complicated pregnancies, women who have suspected or previously confirmed polyhydramnios, oligohydramnios or intra uterine growth restriction in the index pregnancy, women with multiple gestations and women who were unsure of their dates were excluded from the study.

The study subjects were scanned in the supine position with the head propped up using a pillow to make them comfortable. The gravid uterus was divided into four quadrants using the linear nigra and the umbilicus as the vertical and horizontal reference points respectively. In pregnancies less than 24 weeks, the uterus was divided into two halves using the linear nigra as the reference point. The ultrasound probe was applied to the abdomen perpendicular to the abdominal skin and in the long axis of the patient. Gentle pressure was applied throughout the examination and each patient was scanned at a single visit only.

The largest amniotic fluid pockets in each quadrant were identified and the vertical diameter (in centimeters) were measured after making sure that there were no fetal parts or loops of umbilical cords within the pool. The dimensions measured for each of the four quadrants were then added up to give the amniotic fluid index. Each dimension was measured thrice and the average was taken for accuracy.

**2.2 Statistics and Data analysis:** The AFI values measured, biophysical information and all other data collected from each patient were recorded and entered into the patient's data form. These were then coded and transferred into a computer spreadsheet using Microsoft excel 2007(Microsoft Inc. USA) and Statistical Package for Social Sciences (SPSS) Chicago, Illinois, version 16.0. Paired t-test and other analysis were performed to compare between groups. For the graphics tables, figures, Microsoft excel were used. The entire statistical calculations were performed at the 95% confidence interval.

## III. Results

The age range of the study subjects was 18-45 years with a mean age of 29.78±4.48 years and median age of 30 years, while the gestational age was 15 - 42 weeks. The subjects' gravidity was from 1 to 8 with a mean of 3.03±1.49. Those who were gravida 3 had the highest frequency (31%). The minimum parity was 0 while the maximum was 5 with a mean of 1.34±1.15. Less than half of the study group was Primipara, 35%, **Table 1,** though they were the most frequent.

**Table 1** showing frequency distribution of patients' age group with parity.

| | Parity | | | | | | |
|---|---|---|---|---|---|---|---|
| Age Group (years) | 0 | 1 | 2 | 3 | 4 | 5 | Total |
| <20 | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| 20-24 | 12 | 9 | 0 | 0 | 0 | 0 | 21 |
| 25-29 | 42 | 40 | 34 | 3 | 0 | 0 | 119 |
| 30-34 | 19 | 44 | 41 | 12 | 0 | 2 | 118 |
| 35-39 | 0 | 12 | 8 | 1 | 12 | 2 | 35 |
| 40-44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| =45 | 0 | 0 | 0 | 0 | 4 | 0 | 4 |
| Total | 76 | 105 | 83 | 16 | 16 | 4 | 300 |

Just over a quarter of the study subjects were between the 25 – 29 weeks gestational age and they were the most frequent while the least frequent were those 40 weeks and above gestation age, 6.7%. The range of mean AFI across gestation in this study was 4.17-22.05. The mean amniotic fluid index (AFI) for preterm (<37weeks) gestation was 12.70 ± 5.02 while that for term gestation (≥37 weeks) was 14.07 ± 3.34. The mean AFI for the study population was 12.91± 4.82 with a median of 12.56, 5$^{th}$ percentile of 5.81 and 95$^{th}$ percentile of 21.95, **Fig. 1, Table 2**. There was no statistically significant difference between the overall AFI and the AFI in preterm and term gestations (P> 0.05). There was also no statistically significant difference between the AFI in the preterm gestation compared to that in term gestation.

Comparison of the mean vertical pockets of amniotic fluid in the different quadrants showed that there was no significant difference amongst the different quadrants.

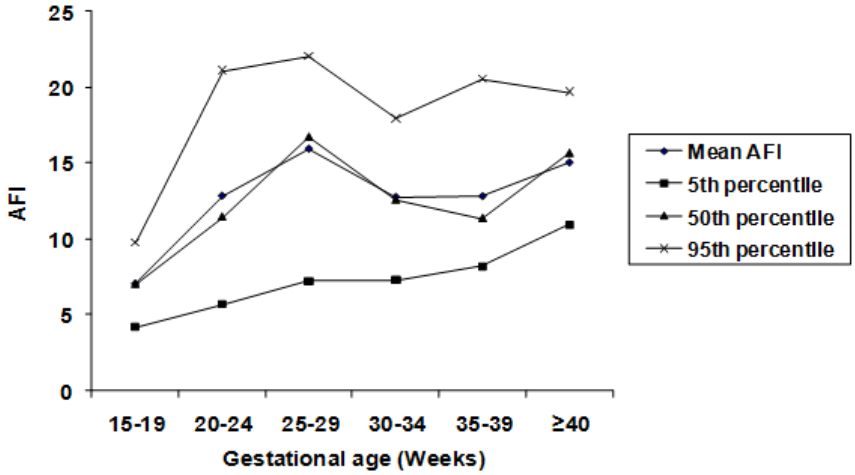


**Fig. 1:** Graph showing the variation of AFI with gestational age.

**Table 2:** Gestational age range and mean AFI in the study population

| GA (weeks) | No of Subjects | Mean AFI (cm) | 5$^{th}$ percentile | 50$^{th}$ percentile | 95$^{th}$ percentile |
|---|---|---|---|---|---|
| 15 – 19 | 47 | 7.04 | 4.17 | 7.00 | 9.75 |
| 20 – 24 | 41 | 12.84 | 5.70 | 11.45 | 21.12 |
| 25 – 29 | 82 | 15.94 | 7.20 | 16.73 | 22.05 |
| 30 – 34 | 41 | 12.77 | 7.25 | 12.56 | 17.95 |
| 35 – 39 | 69 | 12.81 | 8.18 | 11.36 | 20.56 |
| ≥40 | 20 | 15.04 | 10.92 | 15.66 | 19.70 |

### 3.1 Variation of AFI with gestational age

The amniotic fluid index in this study was found to rise steadily from 15-19 weeks gestational age group through the 20-24 weeks age group, reaching a peak in the 25-29 weeks gestational age group. Thereafter, the AFI values dropped in the 30-34 weeks gestational age group, remaining constant in the 35-39 weeks gestational age group after which it rises again in the 40-42 weeks gestational age group. Overall there was a weak positive correlation between gestational age and AFI, **Fig. 1**.

## IV. Discussion

The amniotic fluid plays a vital role in fetal nutrition and protection during intra uterine life, therefore its volume is routinely estimated as part of the obstetric ultrasound scan. In the second and third trimesters, amniotic fluid is produced by fetal lung secretions and fetal urine while it is resorbed by fetal swallowing and flow across fetal membranes to the uterus. A defect in any of the above processes can therefore lead to abnormal amniotic fluid volumes. The estimation of the amniotic fluid volume can ultimately serve as an indicator of possible congenital anomaly with consequent poor pregnancy outcome. Its assessment is therefore

an integral part of the obstetrician's decision taking on obstetric management and consequent pregnancy outcome, fetal and maternal mortality and morbidity and of course, safe motherhood.

The mean AFI in this study was similar to that reported by other workers in both African and Caucasian populations[**4,8,16**]. The AFI in this study increased steadily until it reached a peak at 28 weeks before gradually declining at 30 weeks, following which it remained relatively constant before rising again to reach another peak at 40 weeks. After 40 weeks, the AFI started to decline. The peak values of mean amniotic fluid index in this study were reached at 28 and 40 weeks gestation and the difference was not statistically significant, suggesting that the AFI did not change much between 28 weeks and 40 weeks. This finding was similar to those of Brace and Wolf[**4**], Alao et al[**8]** and Ott WJ[**17**] Alao et al[**8**] in their study in a western Nigerian population found that there was no statistically significant difference in the mean AFI between preterm and term gestations. This was also in keeping with the findings of Brace and Wolf[**4**] who concluded that there was no difference in the amniotic fluid index at 22 weeks and at 39 weeks gestation. However the values obtained in the present study were lower than those of Alao et al[**8]** The mean AFI for the preterm and term gestation in our study were 12.70±5.02 and 14.07±3.34 respectively, compared to 15.41±4.08 and 15.32 ± 4.35 in their study with a range in of 4.17 – 22.05 in our study and 7.90 -27.30 in their study.

The mechanisms that maintain amniotic fluid volume are fairly well understood from the second trimester onwards. The fetal kidneys are the major source of amniotic fluid production after the $10^{th}$ – $12^{th}$ week of gestation till term[**12,13,18,19**]. This is done by means of fetal urine production. Fetal urine production is said to increase 10-folds between 20 – 40 weeks of gestation[**20**], with rates of 400-1200ml/day documented at term[**2,16,18,21**]. The initial gradual rise of the amniotic fluid index noted in this study could be attributed to the increasing rate of urine production by the fetal kidneys with increasing maturity. Fetal lung fluid production is a minor contributor to the amniotic fluid volume and it is usually maximal near term due to increased maturity of the lungs at term[**5,13,18**]. This may also partially explain the second peak in AFI at term. However, since the amniotic fluid volume is determined by factors that affect production and resorption, fetal swallowing, transmembranous and intramembranous absorption, which are the main routes of removal of amniotic fluid, these definitely have significant roles in ultimately determining the amniotic fluid index. Fetal swallowing accounts for about half of the total amount of fluid removed[**13,14,18,19]**. After 40 weeks the fetal urine production wanes as a result of decreasing fetal growth and decreasing placental function hence the gradual drop in AFI noted in this study after 40 weeks gestation[**1,13,14,18,19**].

While various studies[**5,14]** recorded their peak AFI values at the $26^{th}$ week of gestation, the peak mean AFI value in the present study was recorded at the $28^{th}$ week of gestation. Salahuddin et al[**22**] using a longitudinal study obtained peak AFI values amongst Japanese women at 30 weeks gestation, and Birang[**19]** arrived at a peak mean AFI value at 27 weeks gestation in an Iranian population.

The variation of amniotic fluid index with gestational age in this study was quite different from the trend observed by Moore and Cayle[**10]** and several other workers who reported that the amniotic fluid index values for each week of gestation were specific for the gestational age. Therefore, there is a need to match the amniotic fluid index values to specific weeks of gestation. The difference in this finding may be due to racial and environmental factors, a reasoning which is buttressed by the fact that two previous studies carried out in southern Nigeria[8] and northern Nigeria[**14]** were at variance. Nigeria is a relatively heterogenous country and these studies were carried out in relatively geographically distinct parts of the country. The present study was done in south - south Nigeria and the findings were also more similar to those of the south western study.

A feature that is common to most other studies of amniotic fluid index is that there is a wide variation of "normal" AFI values within the same gestational week throughout pregnancy. This finding is not surprising though, as Brace and Wolf[**4]** had documented a wide variation in amniotic fluid volume at each gestational week in their study. However, they noted that despite the wide variation in amniotic fluid volume at each gestational week, the average amniotic fluid volume did not change significantly between 22 weeks and term. This may also partly explain why there was no statistically significant difference in AFI of preterm and term gestations in this study.

In the present study, subjects with an amniotic fluid index of less than 4.17cm at fifteen weeks gestation to term may be regarded as having oligohydramnios while those with a value of greater than 22.05 at any gestational age may be regarded as having polyhydramnios. These values, though not too different from the normal range in present use (5 – 20), however provide a wider range of normal values than the present reference range. This is probably due to the trend observed in our study where the amniotic fluid index tends to remain relatively stable for a longer period of gestation before eventually declining after 40 weeks.

## V. Conclusion

This study has established the range of amniotic fluid index in this environment which will be a useful guide in the assessment of amniotic fluid volumes. The values are comparable to those found in south western Nigeria but at variance with that in Northern Nigeria. We have also shown that, in this environment, the

amniotic fluid index does not change much from about the 25th gestational week to term and it does not correlate with the GA as in other studies in literature.

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