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# Abdominal Aorta Diameter Among Healthy Pregnant Women: A Pilot Study in Port Harcourt, Nigeria.

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Abstract:

Background: The abdominal aorta, the largest artery in the human body, plays a crucial role in maternal and foetal well-being during pregnancy. Ultrasound is the preferred method for assessing the abdominal aortic diameter (AAD), yet there is limited data among pregnant women in Southern Nigeria. This study aims to evaluate the AAD in pregnant women in this region and its correlation with various maternal characteristics.

Methods: A descriptive, cross-sectional study was conducted at a specialist hospital in Rivers State, South-South Nigeria, over eight months. Ultrasound assessments of the abdominal aorta were performed on 559 pregnant women. Statistical analysis included descriptive statistics and Pearson product-moment correlation analysis, using SPSS version 20.1, with significance set at $p<0.05$.

Results: The mean age of the participants was 29.9 years. The study found significant positive correlations between AAD and parity, Body Mass Index (BMI), weight, and height, while a negative correlation was seen with age ($p<0.05$ for all). The mean abdominal aortic diameter was $1.36 \pm 0.16$ cm, with a range of 1.05 to 1.90 cm.

Conclusion: The findings demonstrate substantial correlations between AAD and key maternal characteristics, emphasising the necessity of establishing tailored nomograms for the local population. These custom nomograms could provide insights into pregnancy-associated vascular risks, offering a more nuanced understanding and potentially improving maternal-foetal outcomes.

Keywords: Ultrasonography; Pregnancy; Abdominal aortic diameter.

INTRODUCTION

Pregnancy expressively increases the risk of vascular challenges or incidents such as venous thromboembolism, infarction, and stroke than non-pregnant women of childbearing age.[1,2,3.] Note that these risks extend for several months into the postpartum period.[4] In addition to these relatively common vascular disorders, pregnancy may also elevate the risk of infrequent vascular events.[4.] Aortic dissection and rupture are nonetheless unusual, potentially life-threatening conditions that habitually result in death without rapid treatment.[5] Aortic complications are predominantly seen in those with connective tissue disorders and in those with a family history, but they may also occur in the absence of these risk factors[.5] Many case reports and case series over several decades suggest that pregnancy may trigger aortic dissection or rupture[.5] Aortic complications in pregnancy have been described in Marfan syndrome[,6,7] Loeys-Dietz syndrome[,8] the vascular (type 4) of Ehlers-Danlos syndrome[,9] Turner syndrome[,10] and congenital aortic malformations such as a bicuspid aortic valve.[11] Still, aortic complications have also been described in pregnant women without any other known predisposing features.[12-14]

Abdominal Aortic Aneurysms (AAA), a localised enlargement of the abdominal aorta exceeding its standard diameter by more than 50%, can pose significant health risks if not monitored carefully.[15] Diagnosis and clinical decisions concerning the management/treatment plan for abdominal aortic aneurysms (AAA) are determined by the knowledge of the standard abdominal aortic diameter.15 AAA forms vary between countries depending on geographical differences, ethnicity and the burden of risk factors.[16] The lifetime occurrence of AAA is projected between 1.3% and 8.9% in men and 1.0% and 2.2% in women in the United States of America.[17] Note that there is a lack of information on the prevalence of AAA among pregnant Nigerians. Although infrequent, ruptured AAA is disastrous with high mortality rates,[18] it is obligatory to identify individuals with this condition early enough by screening individuals at risk. Sonographic evaluation of the AAD is now the chosen screening method for AAA. The effect of factors such as age, body mass index (BMI) and gender on abdominal aortic dissection (AAD) has been considered by various researchers among the Caucasian population [19,20] Still, there are no tailored nomograms for our population, and the recommended cutoffs for screening may be unsuitable as they are based on Western demographic data. This study, however, investigates the impact of various parameters on the abdominal aorta diameter in pregnancy. Abdominal Aortic Dissection (AAD) and abdominal aortic aneurysms (AAA) are distinct conditions beyond this study's scope.

Establishing a baseline mean measurement for aortic diameter in a healthy population is a cornerstone for improving patient outcomes across multiple fronts. It is important to identify deviations that could indicate severe vascular pathologies, like aortic aneurysms. Facilitating the early detection of these conditions opens the door to timely interventions that can avert life-threatening complications such as dissection or rupture. Furthermore, this data enhances the precision of medical imaging and diagnostic criteria, ensuring that diagnostic thresholds are finely tuned to reflect normal anatomical variations, thereby improving the accuracy of patient diagnoses and care.

Beyond clinical diagnostics, the nuances captured within the range and standard deviation of aortic diameters hint at the potential influence of genetic, lifestyle, and environmental factors on vascular health. Such insights could drive targeted research, leading to tailored preventive and therapeutic strategies. On a larger scale, this information empowers the crafting of public health guidelines and interventions customised to fit specific populations' physiological profiles, streamlining healthcare delivery and maximising the efficiency of health resource utilisation. These data points underscore the multifaceted value of establishing baseline physiological metrics, laying a foundation for advancements in medical research, clinical diagnostics, and public health strategy.

This study aims to develop a baseline mean measurement of the abdominal aortic diameter in healthy pregnant women in south-south Nigeria using high-resolution B-mode ultrasonography and to evaluate the effect of factors such as age, parity, BMI, and gestational age on AAD.

MATERIALS AND METHOD:

This is an eight-month prospective cross-sectional study conducted in the Radiology department of a Specialist hospital in Port Harcourt between September 2022 and May 2023. The study was conducted at the ultrasound unit in the radiology department of the University of Port Harcourt Teaching Hospital and a free specialist hospital rendering free maternity services in Port Harcourt. The focus was on pregnant women receiving care during this period. A total number of 559 patients were recruited into the study. Demographic indices such as age, parity, gestational age, weight, height, and BMI were collected. Weight was measured in kilograms (kg), height in meters (m), and the BMI (Body Mass Index) was calculated in kg/m^2. Alongside the obstetric ultrasound scan, an ultrasound scan of the aorta was performed to measure the aortic diameter. Demographic indices such as age, parity, gestational age, weight, height and BMI were obtained. Their weight was measured in kilograms (kg), height was measured in meters(m), and their BMI (Body mass index) was calculated in $kg/m^{2.}$ An ultrasound scan of the aorta was done alongside the obstetric scan, and the aortic diameter was taken.

Inclusion criteria: Healthy pregnant women who came for ultrasound scans of the obstetric or any other part of the body were included in the study.

Exclusion criteria: Pregnant women who refused to give consent were excluded

Ethical approval for this study was obtained from the Research ethical committees of the University of Port Harcourt.

Data obtained was analysed using the SSPS 21.0 version, and statistical significance was set at <0.05.

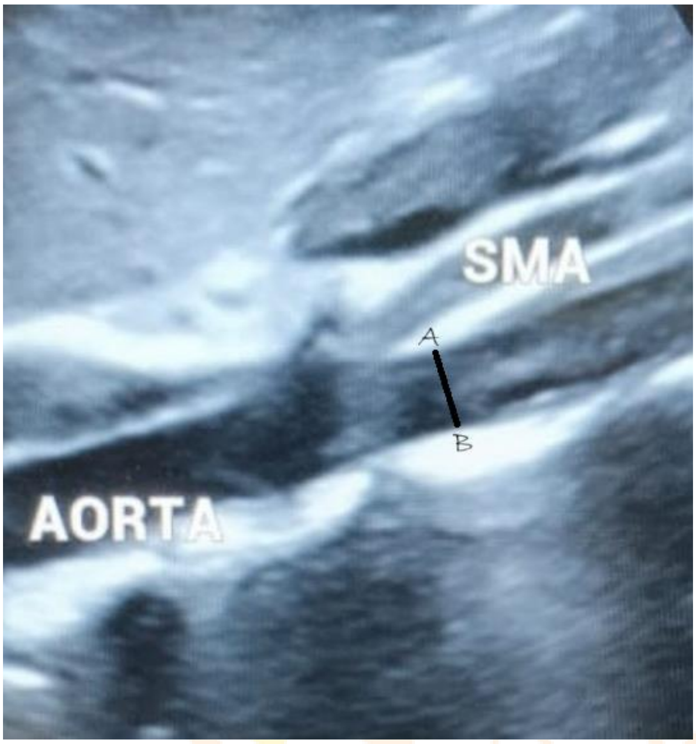


Figure 1: Sonographic diameter of the aorta (A-B)

RESULTS:

Socio-Demographic Characteristics

Table 1 shows a significant concentration in the 30-39 age group, comprising almost half of the cohort at 48.48%. The 50-59 age category is minimally represented, accounting for only 0.54% of the participants. The average age of the study population is 29.95 years, with a standard deviation indicating a wide age range of ±6.34 years, demonstrating maternal age groups ranging from 14 to 54 years. Secondary education is the most common level of education, reported by 76.92% of participants. In contrast, the proportion of participants without education is minimal at 1.25%.

Table 1: Socio-Demographic Characteristics (n=559)

| Variables | Frequency | Percent (%) |
|---|---|---|
| Age | | |
| >19 | 25 | 4.47 |
| 20-29 | 228 | 40.79 |
| 30-39 | 271 | 48.48 |
| 40-49 | 32 | 5.72 |
| 50-59 | 3 | 0.54 |

| | | |
|---|---|---|
| Mean ± SD | 29.95±6.34∞ | |
| Range | [14-54] | |
| | | |
| Educational Level | | |
| None | 7 | 1.25 |
| Primary | 60 | 10.73 |
| Secondary | 430 | 76.92 |
| University | 62 | 11.09 |

∞=Mean ± Standard Deviation

Table 2 showed that the participants had an average weight of 69.74 kg, with a standard deviation (SD) of 16.40 kg, and weights ranging from 32 kg to 121 kg. The average height was 157.93 cm, with an SD of 9.57 cm, showcasing moderate variability across a height range of 116 cm to 190 cm. Body Mass Index (BMI) averaged 28.29 with an SD of 7.94, indicating considerable diversity within the participants' body fat levels, with BMIs spanning from 11.89 to 74.32. The distribution across BMI categories showed 5.37% underweight, 35.42% with a normal BMI, 22.00% overweight, and 37.21% obese.

Table 2: Anthropometric Parameters (n=559)

| **Variables** | **Frequency** | **Percent (%)** |
|---|---|---|
| **Weight (kg)** | | |
| Mean ± SD | 69.74±16.40∞ | |
| Range | [32-121] | |
| **Height (cm)** | | |
| Mean ± SD | 157.93±9.57∞ | |
| Range | [116-190] | |
| **BMI** | | |
| Mean ± SD | 28.29±7.94∞ | |
| Range | [11.89-74.32] | |
| **BMI Category** | | |
| Underweight (<18.5) | 30 | 5.37 |
| 18.5 and 24.9 | 198 | 35.42 |
| Overweight 25 and 29.9 | 123 | 22.00 |
| Obesity ≥ 30 | 208 | 37.21 |

∞=Mean ± Standard Deviation

Table 3 revealed that 64.22% of the cohort had given birth to between 1 and 3 children. Regarding gestational age, almost all participants, 99.64%, were less than 37 weeks.

Table3: Maternal Characteristics (n=559)

| Variables | Frequency | Percent (%) |
|---|---|---|
| **Parity** | | |
| Median | 1α | |
| IQR | [0.5-2] | |
| **Parity** | | |
| 0 | 186 | 33.27 |
| 1-3 | 359 | 64.22 |
| ≥4 | 14 | 2.50 |
| **Gestational Age** | | |
| Mean ± SD | 14.09±4.80∞ | |
| Range | [6-37] | |
| **Gestational Age** | | |
| <37 | 557 | 99.64 |
| ≥37 | 2 | 0.36 |

∞=Mean ± Standard Deviation, α=Median, Inter-quartile Range

Table 4 shows the mean aortic diameter at 1.36 cm, with a standard deviation (SD) of 0.16 cm. indicating relative homogeneity within the sampled population. The range of aortic diameters spans from 1.05 cm to 1.90 cm.

Table 4: Characteristics of Aortic Diameter (n=559)

| Aortic diameter parameters | Mean ± SD |
|---|---|
| Mean ± SD | 1.36±0.16 |
| Range | [1.05-1.90] |

Table 5 showed no statistically significant relationship between AAD and age, with a Pearson correlation coefficient (r) of 0.030 and a p-value of 0.538. Parity exhibits a positive, albeit weak, correlation with AAD (r = 0.087; p = 0.028). A statistically significant negative correlation was found between AAD and weight (r = -0.042; p < 0.0001) and BMI (r = -0.155; p < 0.0001). Height positively correlates with AAD (r = 0.152; p < 0.0001).

**Table 5: To assess how age, parity, weight, height and BMI are associated with selected parameters using the Pearson correlational coefficient analysis**

| Variables | AGE, PARITY, WEIGHT, HEIGHT AND BMI | | | |
|---|---|---|---|---|
| | The Pearson correlation coefficient, r | 95.0% Confidence Interval for r | | *p-value* |
| | | Lower Bound | Upper Bound | |
| Aortic Diameter | 0.030 | -2.567 | 4.912 | 0.538 |
| Aortic Diameter | 0.087 | 0.065 | 1.112 | **0.028*** |
| Aortic Diameter | -0.042 | -6.746 | -1.918 | **0.0001*** |
| Aortic Diameter | 0.152 | 3.867 | 14.196 | **0.0001*** |
| Aortic Diameter | -0.155 | -11.192 | -4.171 | **0.0001*** |

*Statistically significant (p<0.05)

DISCUSSION:

The study delving into pregnant women's abdominal aortic diameter (AAD) encompasses a comprehensive socio-demographic and anthropometric overview of its 559 participants. A focal point of the investigation is the age distribution, with a significant concentration (48.48%) in the 30-39 years bracket and a scant representation (0.54%) in the 50-59 years category, yielding an average age of 29.95 years. This diversity is underlined by the broad age range (14-54 years) and emphasises the varied maternal age spectrum.

Additionally, educational attainment among the participants is markedly skewed towards secondary education (76.92%), highlighting a prevalent educational background with minimal participants (1.25%) having no education. This demographic profile sets the stage for a nuanced analysis of AAD's relationship with pregnancy.

Furthermore, the anthropometric data indicates a wide range of physical characteristics, with an average weight of 69.74 kg and height of 157.93 cm, portraying moderate to considerable variability. BMI analysis reveals a diverse participant body composition, with notable distributions across underweight to obese categories, providing crucial context for interpreting AAD correlations.

The parity and gestational age metrics further refine the participant demographic, primarily highlighting women in their early maternity stages with 1 to 3 children. Examining AAD's correlation with factors like age, weight, BMI, and height presents intriguing insights. Age does not significantly affect AAD, whereas parity, weight, and height display variable correlations. Specifically, higher parity is slightly associated with increased AAD, while higher weight and BMI correlate negatively, and taller stature correlates positively with larger AAD. These findings illuminate the complex interplay between physiological parameters and AAD among pregnant women, suggesting multifaceted influences converge on aortic diameter during pregnancy.

The aortic diameter in pregnant women in this study ranged from 1.05 to 1.90cm, with a mean of 1.36±0.16. These findings, which are consistent with previous studies [21-27] done in non-pregnant women, suggest that pregnancy may not significantly alter the range of the abdominal aortic diameter compared to non-pregnant women. However, it is essential to note that most measurements were taken early in pregnancy, which may have affected the measurements seen, and follow-ups throughout pregnancy may have revealed different findings. This highlights a potential limitation of the study and suggests that further research is needed to understand the relationship between pregnancy and AAD fully.

Conversely, the correlation between the abdominal aortic diameter and age is insignificant (P-value=0.538). In contrast to previous studies carried out among non-pregnant women, a significant correlation was noted [20-22, 26, 28-30]. The significance of finding an insignificant correlation between abdominal aortic diameter (AAD) and age in pregnant women in contrast to the significant correlation observed in non-pregnant women, suggests that pregnancy may influence the factors affecting AAD beyond age. This indicates that the physiological changes during pregnancy could be more pivotal in determining AAD than age in this population. Thus, more research is needed to expand on this.

The significance of the present study, which shows a statistically significant correlation between the abdominal aortic diameter (AAD) and BMI (P-value=0.0001), highlights the complexity and variability inherent in studying these variables across different populations. Despite earlier controversies, the findings align with previous studies[15, 30-31] that documented a positive correlation, underscoring a potential consistent pattern that may transcend different demographic groups. On the other hand, the contradiction presented by the studies of Ezewugo et al.[21], Stackelerg et al.[32], and Takagi et al.[33], which found no correlation, illustrates the impact of varying study populations and methodologies on research outcomes. This diversity in findings emphasises the need for further investigation to fully understand the nuances of AAD and BMI relationships, particularly considering the unique physiological changes in pregnant women.

The significance of finding a positive correlation between abdominal aortic diameter (AAD) and parity, as indicated by a P-value of 0.028, suggests that increases in parity may be associated with an increase in the AAD. This correlation could be due to the aorta undergoing structural and functional changes during pregnancy, including adjustments to cardiac output, heart rate, and circulating volume—all of which can contribute to an increase in aortic size. Hemodynamic conditions influence the aortic size and can exhibit variations in dimension in response to conditions like preeclampsia[34]. This study's observation highlights the impact of repeated pregnancies (parity) on the aortic diameter, indicating that the cardiovascular system's adaptations in pregnancy may have lasting effects on aortic dimensions.



The lack of postpartum follow-up is a significant limitation of the study on the relationship between abdominal aortic diameter (AAD) and pregnancy in Port Harcourt, Nigeria. This absence limits understanding of the long-term impact of pregnancy on AAD, including whether the observed AAD increase reverts after pregnancy or poses long-term health risks. Without longitudinal data, the study cannot definitively ascertain if pregnancy-induced AAD changes are temporary or permanent, potentially affecting the interpretation of risk for aortic pathologies. Future research should include long-term postpartum follow-up to understand the dynamics of AAD changes and their implications, enhancing research quality and clinical outcomes.



In conclusion, this pilot study conducted in Port Harcourt, Nigeria, adds crucial insights into understanding abdominal aortic diameter (AAD) dynamics among pregnant women. The aortic diameter in pregnant women in this study ranged from 1.05 to 1.90cm, with a mean of 1.36±0.16. It establishes a significant correlation between AAD and maternal characteristics such as parity, Body Mass Index (BMI), weight, and height. Contrary to expectations, age showed a negative correlation. These findings imply that pregnancy may not significantly alter the range of the abdominal aortic diameter compared to non-pregnant women but highlight the necessity to consider various factors that might influence AAD in pregnant women. Establishing tailored normative measurements for this demographic could thus enhance clinical assessments and possibly improve maternal-foetal outcomes by providing a nuanced approach to managing pregnancy-associated vascular risks.

**Limitations**

1. Selection Bias: The study's focus on a specific geographic and demographic group in Port Harcourt, Nigeria, may limit the generalisability of the findings to other populations. Participants from a single region might possess unique genetic, socioeconomic, or environmental factors influencing AAD that are not representative of the broader population.

2. Measurement Bias: Reliance on ultrasound measurements for determining AAD introduces potential variability due to operator-dependent factors and the machine's precision limitations. This may affect the consistency and accuracy of the data collected.

3. Lack of Follow-up: The absence of postpartum follow-up prevents the study from capturing long-term changes in AAD, leading to a potentially incomplete understanding of the pregnancy's impact on abdominal aortic diameter over time.

**Recommendations**

For Clinical Practice: developing region-specific nomograms for assessing AAD in pregnant women could aid in the early detection of vascular abnormalities using the available data.

Health Policy: Encourage the implementation of guidelines for regular aortic monitoring in pregnant women as part of prenatal care routines.

**Areas for Further Research**

Longitudinal Studies: Follow-up research incorporating postpartum evaluations to determine whether changes in AAD revert or persist and assess long-term impacts is necessary.

Cross-Population Studies: for more universally applicable standards, research should extend to diverse populations and compare findings across different regions and ethnic backgrounds.

Impact of Pregnancy-Associated Conditions: Further exploration into how pregnancy-specific conditions, such as pre-eclampsia, impact AAD could refine risk assessment and management strategies.

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