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# Effects of Anthropometric and Parity Factors on Blood Pressure (BP) Pattern of Third Trimester Pregnant Women in Sokoto, North-West, Nigeria

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## Abstract

This study examined the blood pressure (BP) patterns, anthropometric and parity factors that can affect the BP pattern among third trimester normal, singleton pregnant women in Sokoto.

A total of 129 subjects were recruited for the study including 88 pregnant women and 41 non-pregnant, age matched controls. The age ranges were 18-40 years and 19-40 years and the mean ages were 27.0+6.0 years and 28.1+6.8 years for the pregnant and non-pregnant groups, respectively (p=0.580). Majority (82%) of the pregnant women unlike the non-pregnant group, (44%) were parous. Most subjects of both groups fell in the BMI range 18.5-24.9 Kg/m$^2$ (normal); 37.5% and 53.7% for the pregnant and non-pregnant groups, respectively. The mean BP of the pregnant women was 109.1 ± 10.4/67.8 ± 8.0mmHg and the non-pregnant controls was 113.8 ± 11.7/71.7 ± 9.5 mmHg.

Also the mean BP of the various categories of BMI and the mean for the parous and nulliparous sub-groups for both pregnant and non-pregnant controls were recorded separately and their means compared for statistical significance. Blood pressures in normal singleton third trimester pregnant women tend to fall as the pregnancy age advances, especially the systolic BP. But BP tends to increase as the BMI increases from underweight, normal weight, through over weight to obesity in both pregnant and non-pregnant groups. Also BP values appear to be higher among the parous sub-groups in both pregnant and non-pregnant groups.

**Keywords:** Pregnancy; Parity; Anthropometric factors; Blood pressure; Trimesters

## Introduction

The changes that occur in the pregnant women can be physiological, pathological or a modification of the pre-existing conditions [1-4]. The desirability of blood pressure and other haemodynamic changes in pregnancy is informed by the need to compensate for the dilutional anaemia, increased need for oxygen delivery to tissues, and the blood losses during labour [3-9]. These changes are characteristics of the various stages of the normal pregnancy. Meanwhile, studies have shown that blood pressure disorders in pregnancy especially from mid-pregnancy (20$^{th}$ week) contribute significantly to maternal and perinatal morbidity and mortality worldwide [10-15]. Although there are studies on pregnant women in Sokoto State on variable such as gestation age at Antenatal Care (ANC) clinic booking [6] birth weight and placenta weight [16,17] but information on blood pressure (BP) patterns of pregnant women and the factors that affect such pattern to the best of our knowledge is scanty in the literature.

Studies elsewhere have established separately the relationship between anthropometry, parity and BP during pregnancy. Thus, [18,19] found in Abakaliki, South-East Nigeria that parous pregnant women had significantly higher Body Mass Index (BMI) and [15] in Ibadan, South-West Nigeria have shown that higher BP problems are commoner among nulliparous pregnant women. In Benin, South-South Nigeria, [4] in a different but related study on peripheral blood pressure to ascertain among normotensive pregnant women in the third trimester the effect of parity on the hitherto known decrease in Intraocular Pressure (IOP) dur ing pregnancy and found that parous women have lower IOP compared to their nulliparous counterparts. However had a contrary finding earlier when they worked in Ile-Ife, South-West Nigeria and found no significant correlation of BP with parity [16]. These earlier researchers explained their findings to be due to surge in serum levels of oestrogens and pregestrone which is also the physiological mechanism behind the changes in any normal pregnancy [3,10].

We speculate from our results that probably the parous sub-group was less sensitive to the effects of the pregnancy hormones, a form of 'resistance' or the result of their higher BP expected to be associated with advancement in age [1,11]. Similarly, we also err on the side that the higher BP among the sub-group with higher BMI is a result of higher BPs opined to be associated with increase in BMI [11]. These however, require further research. None of the above mentioned studies to the best of our knowledge considered the effect of anthropometry on BP in Sokoto or elsewhere in Nigeria. Also, a need to generate a data base in this environment that will be used to manage our pregnant women instead of using data from studies carried out in other locations is pertinent, this may be explained by the variations shown above. We believe also, that our study will not only serve in Sokoto State as an addition to our body of knowledge on the BP pattern of normal third trimester pregnant women and parity and anthropometric factors affecting it but will elicit further studies on our pregnant women in third trimester in particular and the pregnant women, in general for optimal feto-maternal outcomes.

## Materials and Methods

The study was carried out in six months among pregnant women attending ANC in the state specialist hospital and their non-pregnant match controls was drawn from the Sokoto metropolis, which includes five local Goverments of the state viz: Sokoto North, Sokoto South, Kware, Dange-Shuni and Wamakko LGs [5]. Sokoto metropolis has a total population of about 937,471 (National Population Commission, 2011).

### Study design and population

It was a cross-sectional study to assess the BP pattern and anthropometric and parity factors affecting such BP pattern among normal singleton 3rd trimester pregnant women attending ANC in the State Specialist Hospital and apparently healthy non-pregnant volunteer controls who are age matched and resident in same metropolis.

### Eligibility/Inclusion criteria

Pregnant women resident in the metropolis and in the age bracket 18-40 years, in their early third trimester, carrying singleton pregnancy and free of systemic illnesses like hypertension and diabetes. Also, apparently healthy non-pregnant age matched female volunteer controls resident in the metropolis were also considered.

### Exclusion criteria

Pregnant women, who smoke during the pregnancy, consume alcohol or regular on some medications different from the normal haematenics and reside outside the metropolis. And no volunteer control was considered if she was pregnant or in her puerperal period.

### Sample size estimation

The study being a cross-sectional descriptive study and since the population of pregnant women residing in Sokoto metropolis is not known with certainty the formula for calculating the sample size for infinite population was used to calculate the minimum sample size for the study [14]. We therefore used the formula $n = Z^2 pq/d^2$

Where n= minimum required sample size in population>10,000

Z=Standard normal deviate

P=proportion of success or prevalence

q=proportion of failure (=1-p)

d=precision

Given that prevalence (proportion of success), p of pregnant women with normal BP was 92.5% (0.925) [15]. And adjusting sample size for non-response and attrition, the minimum sample size selected, ($n_s$) at 90% response was $n_s= n/0.9$ [18]. The required sample size was 119. But we used a total of 129 subjects including 88 pregnant subjects and 41 non-pregnant controls.

### Sampling techniques

Proportionate stratified random sampling method was employed.

### Stage 1

A list of the five (5) secondary health facilities in Sokoto metropolis was made and a systematic sampling of three of them after alphabetical arrangement; (Maryam Abacha Hospital, Noma Children Hospital, State Specialist Hospital, University Health Centre and WCWC) and eventually a health facility was selected randomly among the three.

### Stage 2

Screening tools (Appendices I and II) were used to classify subjects or controls into eligible and ineligible. But for subjects who could not read to understand the screening tool and the structured questionnaire, the lead investigator who has a good command of Hausa, Yoruba and some Igbo languages took time to explain to them. The study sample consisted of 88 eligible pregnant women seen at the antenatal clinic of the selected secondary health facility and 41 non-pregnant eligible controls seen in Sokoto metropolis, spread over the study period. A proportional allocation of number of subjects to the metropolitan Local Governments was adapted to arrive at the required 129 sample sizes for both the pregnant and non-pregnant controls in accordance with their contribution to the total metropolitan population. Thus the following numbers of subjects for each category were drawn from these respective Local Governments;

-Sokoto North: 22 pregnant and 10 non-pregnant

-Sokoto South: 19 pregnant and 9 non-pregnant

-Wamakko: 17 pregnant and 8 non-pregnant

-Dange-Shuni: 18 pregnant and 8 non-pregnant

-Kware: 12 pregnant and 6 non-pregnant

### Procedure protocol

-A check list (Appendix VII) was scrutinized before setting out to the field, every morning

-Contact with subjects were by appointment at 2 weekly interval

-At each visit, the following were carried out on each woman with the assistance of a female chaperon, in this order;

1. Subjects/volunteer control were recalled by their numbers, SN/CN

2. The BP, MAP (derived), PR and Body temp measured and recorded

3. Weight (kg) measurement and recording

4. Height (m) measurement and recording (1st visit)

5. BMI derived ($kg/m^2$)

## Measurements

### Blood pressure (BP), Pulse rate (PR) and Mean arterial pressure (MAP)

During each visit a subject or volunteer control's BP, PR were measured and MAP derived.

An Omron (Japanese M2 basic) digital upper arm blood pressure monitor was used throughout the study to measure systolic, diastolic BP and PR. The machine has the advantage of having an adaptable, easy to wrap medium (22 cm-32 cm) cuff for average size women or large (32 cm-42 cm) cuff for overweight women. During each procedure the subject sits upright and quietly too with back straight, the arm placed on the table so that the cuff made same level as her heart so that the brachial artery is at the level of the tricuspid valve to neutralize the effect of gravity [1].

## Weight

During each contact time, a subject's weight (kg) was measured on bare feet and in light clothing, using a simple, mechanical, portable weighing scale (Camry, China, ISO 9001: 2008 certified by SGS, model: BR 9012), with the following accuracy; 0-60 kg ± 1.2 digits, >60 kg ± 2.0 digits. It was standardized each day using a known weight. The knob at the rear makes it possible that the reader on the calibration is adjusted to the zero point before each weight taking procedure.

## Height

Mobile standiometer, Seca 217 was used to measure height. It has a robust base plate which guarantees a sturdy stance. The measuring range is 20-205 cm, the graduation is 1 mm, dimension 328 × 2145 × 574 mm and it weighs 6 kg.

## Body Mass Index (BMI)

At each visit and for each subject and volunteer control that had her weight and height recorded, the Body Mass Index (BMI) was calculated as follows;

BMI = Weight (kg) / Height ($m^2$)

## Statistical analysis

Data was entered into and analyzed using Statistical Packages for Social Sciences (SPSS), version 20. All values were expressed as the mean ± S.D. of either the pregnant group (n = 88) or the non-pregnant control group (n=41).

Data were presented using graphs, charts and tables for frequencies and percentages of variables. T-test was used for comparison of sample mean. The level of statistical significance (α) for the test was set at $p \leq 0.05$.

## Ethical clearance

Before the commencement of the study, ethical approval was obtained from the ethical committee of the Usmanu Danfodiyo University and the ethical committee of State Specialist Hospital, Sokoto and informed consents were obtained from each woman that were enrolled in the study.

## Results

A total of 129 subjects were recruited for the study including 88 pregnant women and 41 non-pregnant age matched controls. The age range of the pregnant subjects was 18-40 years and the non-pregnant controls was between 19-40 years. The mean age for the pregnant group was 27.8 ± 6.0 yrs and has no statistically significant difference with the non-pregnant control group with mean age of 28.1 ± 6.8 yrs (p-value 0.580) (Table 1 and Figure 1).

| Class interval | Frequencies | | Percentage | |
|---|---|---|---|---|
| | Pregnant | Non-pregnant | Pregnant | Non-pregnant |
| 25-34 | 49 | 16 | 55.70% | 39% |
| 35-44 | 14 | 9 | 15.90% | 22% |
| Total | 88 | 41 | 100% | 100% |

**Table 1:** Age distributions of respondents

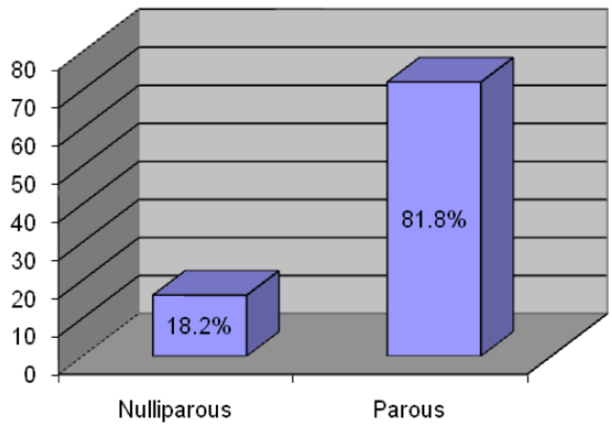


**Figure 1:** Distribution of pregnant women into parous and nulliparous

| | Pregnant, n=88 | | | Non-pregnant, n=41 | |
|---|---|---|---|---|---|
| Parameter | 1st visit | 2nd visit | 3rd visit | 1st visit | 2nd visit |
| Systole | 111.9 ± 11.9 | 109.8 ± 10.2 | 105.6 ± 7.6 | 114.3 ± 11.7 | 113.3 ± 11.9 |
| Diastole | 68.5 ± 9.9 | 68.3 ± 7.3 | 66.6 ± 6.3 | 70.8 ± 9.4 | 72.5 ± 9.7 |
| MAP | 82.7 ± 9.7 | 82.2 ± 7.2 | 82.4 ± 7.1 | 84.8 ± 10.4 | 86.1± 10.0 |
| PR | 95.2 ± 9.5 | 95.2 ± 10.0 | 98.5 ± 9.6 | 82.5 ± 11.2 | 83.2 ± 10.8 |
| Mean BP=109.1 ± 10.4/67.8 ± 8.0 mmHg; Mean. BP=113.8 ± 11.7/71.7 ± 9.5 mmHg; Mean MAP= 81.1 ± 9.0; Mean MAP=85.5 ± 10.2 | | | | | |

**Table 2:** Patterns of mean systole, diastole, MAP and PR of pregnant women during the 1st, 2nd and 3rd visits in their 3rd trimester and that of age matched Non-pregnant women during the 1st and 2nd visits

Our results showed a serial drop in BP in the third trimester of pregnancy this pattern was not seen in the non-pregnant group (no particular pattern was seen) and the results are also generally lower than the corresponding non-pregnant controls; mean systole for the pregnant was 109.1 ± 10.4 which showed statistically significant difference with that of the non-pregnant with mean systole of 113.8 ± 11.7 (p-value 0.001).

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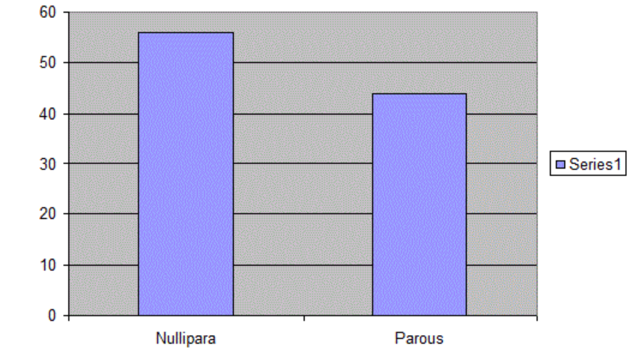


**Figure 2:** Showing distribution of non-pregnant controls as Nulliparous (56%) and parous (44%).

| BMI Class (kg/m$^2$) | Mean BP, Non-pregnant | | Mean Bp, Pregnant | | |
|---|---|---|---|---|---|
| | 1st visit | 2nd visit | 1st visit | 2nd visit | 3rd visit |
| <18.5(Under Weight) | (106.5 ± 0.7)/(66.0 ± 1.4) | (109.0 ± 1.4)/(68.0 ± 2.8) | | | |
| 18.5-24.9 (Normal Weight) | (113.2 ± 11.7)/(68.5 ± 8.3) | (110.0 ± 11.4)/(69.2 ± 8.4) | (108.7 ± 11.7)/(65.5 ± 7.8) | (107.3 ± 9.3)/(66.5 ± 8.0) | (103.7 ± 8.8)/(65.1 ± 7.6) |
| 25-29.9 (Over Weight) | (116.5 ± 12.5)/(73.2 ± 10.0) | (116.3 ± 118)/(75.8 ± 10.2) | (112 .0 ± 10.6)/(65.9 ± 10.2) | (110.2 ± 11.3)/(69.1 ± 6.8) | (105.4 ± 6.2)/(66.9 ± 5.3) |
| ≥ 30(Obese) | (116.7 ± 12.5)/(76.2 ± 11.8) | (120.3 ± 13.2)/(79.2 ± 10.5) | (121.5 ± 10.6)/(76.5 ± 10.9) | (115.1 ± 8.2)/(71.0 ± 5.7) | (109.7 ± 6.6)/(68.8 ± 4.9) |

**Table 3:** Distribution of pregnant subjects and non-pregnant controls according to BMI and associated mean BPs

Mean diastole for the pregnant was 67.8 ± 8.0 which showed statistically significant difference from the non-pregnant controls with mean diastole of 71.7 ± 9.5 (p-value 0.000) and the mean MAP for the pregnant, 81.1 ± 9.0 was significantly lower than the non-pregnant controls with mean MAP of 85.5 ± 10.2 (p-value 0-000) (Table 2 and Figure 2). None of the pregnant women has BMI<18.5 kg/m$^2$ (underweight), but 33 (37.5%) of the Pregnant women fell in the BMI range of 18.5-24.9 kg/m$^2$ (normal). Majority of the pregnant women, 37 (42.1%) were found in the BMI range of 25-29.9 kg/m$^2$ (overweight) and 18 (20.4%) were in the category ≥ 30 kg/m$^2$ (obese) (Figure 3). The mean BP of both the pregnant group and non-pregnant controls increases with increase in BMI. Thus, the pregnant women with normal BMI had mean BP of 105.8 ± 8.2/69.2 ± 8.7 mmHg, which is significantly lower than those in the overweight category, 112.1 ± 11.9/72.7 ± 5.7 mmHg and was significantly lower than those obese with mean BP of 115.7 ± 11.3/70.6 ± 5.1 mmHg (p-values<0.05) (Tables 3,4 and Figure 4). Among the non-pregnant controls, one of them (2.4%) had BMI<18.5 kg/m$^2$ (under weight), 22 (53.7%) had normal BMI, 12 (29.3%) were overweight while 6 (14.6%) of them were obese.

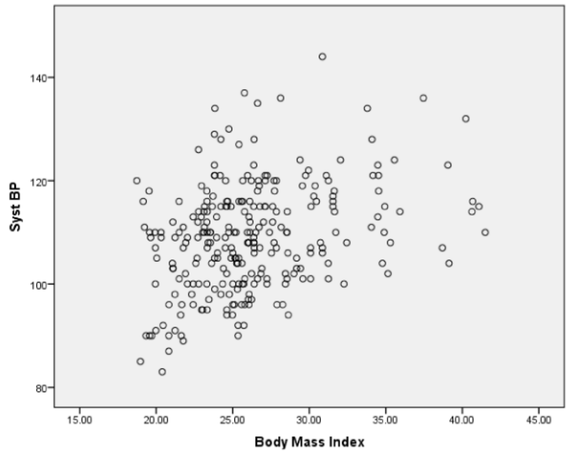


**Figure 3:** Relationship between Systolic Blood Pressure and BMI among Pregnant Women

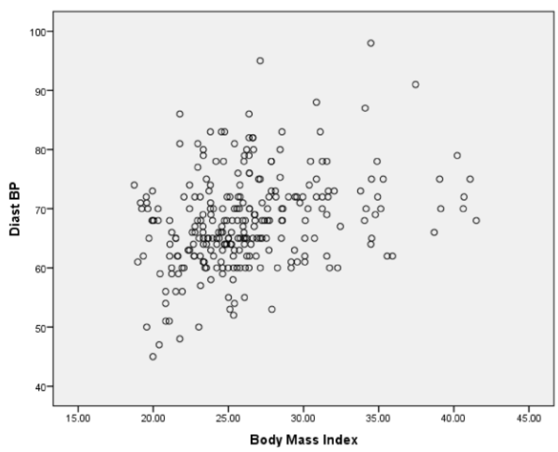


**Figure 4:** Relationship between Diastolic Blood Pressure and BMI among Pregnant Women

| | Mean BP, Pregnant | | | Mean BP, Nonpregnant | |
|---|---|---|---|---|---|
| Parity | 1st visit | 2nd visit | 3rd visit | 1st visit | 2nd visit |
| Nulliparous | 110.8 ± 8.6/70.1 ± 7.9 | 107.5 ± 8.1/68.8 ± 6.7 | 107.1 ± 7.3/67.8 ± 6.8 | 112.2 ± 11.2/67.3 ± 6.6 | 109.2 ± 10.1/68.6 ± 7.1 |
| Parous | 112.2 ± 12.6/68.1 ± 10.3 | 110.3 ± 10.6/68.3 ± 7.5 | 105.3 ± 7.7/66.3 ± 6.1 | 116.9 ± 12.0/75.2 ± 10.7 | 118.6 ± 12.2/77.5 ± 10.5 |

**Table 4:** Distribution of Pregnant subjects and non-pregnant controls according to Parity and associated mean BPs.

-Mean BP for the parous pregnant women was 114.1 ± 11.6/68.1 ± 7.0 mmHg

- Mean BP for the nulliparous pregnant was 107.9 ± 6.7/69.1 ± 7.1 mmHg

-Mean MAP for the parous pregnant 82.8 ± 10.3

-Mean MAP for the nulliparous pregnant 83.7 ± 7.7

-Mean BP of the parous control was 123.1 ± 10.9/83.7 ± 8.8 mmHg

-Mean BP of nulliparous control was 112.4 ± 6.9/67.3 ± 5.3 mmHg.

-Mean MAP for parous controls was 89.1 ± 10.8

-Mean MAP for the nulliparous control was 81.5 ± 8.9

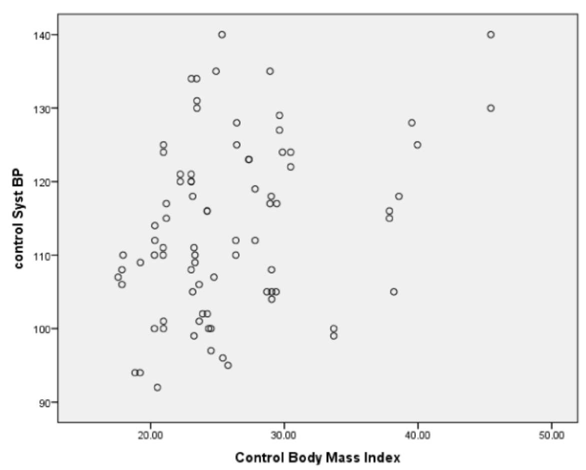


**Figure 5:** Relationship between Systolic Blood Pressure and BMI among Non-Pregnant Women

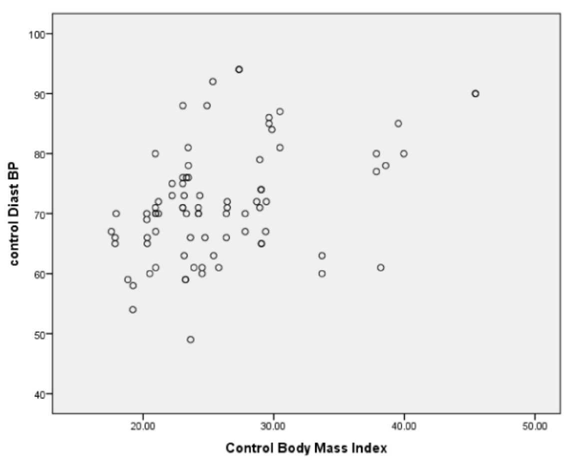


**Figure 6:** Relationship between Diastolic Blood Pressure and BMI among Non-Pregnant Women

Their mean BPs increased significantly with increase in BMI (p-values <0.05); 108.5 ± 10.1/68.5 ± 9.8 mmHg for the underweight, 114.3 ± 9.9/68.9 ± 7.6 mmHg for the normal weight, 124.9 ± 5.2/78.0 ± 5.7 mmHg for the overweight controls but was 118.5 ± 11.6/77.7 ± 5.2 mmHg for the obese (Figure 5). Among the pregnant women 16(18%) of them were primpara (nulliparous), while 72(82%) were multipara. In the non-pregnant control category, 23(56%) were nulliparous while 18 (44%) were parous. The mean BP for the parous pregnant women was 114.1 ± 11.6/68.1 ± 7.0 mmHg and the mean for the nulliparous pregnant was 107.9 ± 6.7/69.1 ± 7.1 mmHg. The mean BP of the parous control was 123.1 ± 10.9/83.7 ± 8.8 mmHg while that of nulliparous control was BP of 112.4 ± 6.9/67.3 ± 5.3 mmHg (Figure 6).

## Discussion

Our study revealed significant drop in the mean Systolic, Diastolic and Mean Arterial Blood Pressures (BPs) among normal, third trimester pregnant women ($p<0.05$). A similar decline was observed with statistical significance in a study carried out by [8] at Sabon-Gari Local Government of Kaduna, State, North-West Nigeria. This was also the finding of [3] in the United Kingdom. These results further explain the position of [7], in Essex, United Kingdom where he wrote that blood pressure does not increase in normal pregnancy. The drops in blood pressures could probably be explained by the Oestrogen and Progesterone mediated disproportionate systemic vasodilatation [2] and increased capacitance of peripheral vessels posited [12]. This phenomenon which Kenneth and colleagues sought to explain as been due to underfilled vascular system, supporting it with rise in plasma rennin level with reduced atrial nitriuretic peptide levels in pregnancy. They corroborated their work with the observation that increasing Sodium intake does not lead to further volume expansion in pregnancy. Their work however entails further explanation as the amount of Sodium loaded was not specified.

However [16] studied all the trimesters of pregnancy and found an initial decline in the mean systolic, diastolic and mean arterial pressures during mid-trimester but contrary to our finding they found later a progressive increase towards term in their study at OAU, Ile-Ife, South-West Nigeria.

In our non-pregnant controls, no particular pattern of mean Systolic, Diastolic or mean Arterial BPs changes were observed and may not be unconnected with the daily physiological instances of blood pressure changes including; time of the day, meal, emotions and exercise [1] depending on which of the factor is dominating.

Our results revealed a lower mean BPs among pregnant women (109.1/67 mmHg) comparable with values obtained in the industrialized countries, but differ from the finding of [16] when they found a mean BP of 130/80 mmHg. Whether environmental or lifestyle differences between the average pregnant women of the North-West and South-West Nigeria could explain this difference need further studies.

We noticed a general higher mean systolic, diastolic and mean arterial blood pressures among the parous women (pregnant and non-pregnant) compared to the nulliparous women. On one hand and expectedly, the parous women are older in age and on the other hand probably also the parous group responds less to the effects of oestrogen and progesterone which earlier researchers have cited to orchestrate the changes seen in this stage of pregnancy. These entails further studies.

We also noticed an increase in the mean BP from normal weight to overweight and obesity in both pregnant and non-pregnant women but noticed a drop at the cut-off point for obesity (≥ 30 kg/m$^2$) among the non-pregnant control. This is in tandem with the fact that body constitution can affect the blood pressure values up to 10 – 15 mmHg for the obese compared to the non-obese [1].

## Conclusion

The parous pregnant woman initially tends to exhibit the physiological effects of pregnancy less than the nulliparous pregnant woman probably an 'acquired higher threshold' due probably to 'previous experience' with pregnancy hormones. This may be seen from our results that the parous pregnant woman have higher mean BP than the nulliparous during the initial visits but declines with subsequent visits until it falls below the mean obtained for the nulliparous.

The anthropometric (BMI) factor on the other hand appears to be a stronger factor in positively increasing the mean BP regardless of the advancement in the age of pregnancy in the third trimester. This is shown in our results where the mean BPs (systole and diastole) consistently increased with increase in BMI.

## Recommendation

Blood pressure changes in normal pregnancies are inevitable but the acceptable values in the various trimesters of pregnancy need to be ensured by monitoring it at least during every fortnight in the third trimester when the effects of the pregnancy hormones are more pronounced so that excesses can be forestalled.

Both parity and anthropometric factors have positive correlation with mean BPs in the third trimester of normal pregnancies. But the pregnant woman with BMI outside the normal (≥ 25) requires closer monitoring of their BPs as it may be unabated by the 'overriding' effects of advancement in pregnancy age. This is unlike parity factor which effect on BP in pregnancy appears to be mitigated with advancement in pregnancy age in the third trimester.

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