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Effect of Pregnancy and Fasting on Arterial Blood Pressure Among Healthy Sudanese Women at Khartoum State

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Abstract: Pregnancy is a dynamic process characterized by multiple physiological changes in the cardiovascular system. These changes are adaptive mechanisms to face the high metabolic demand for both fetus and mother. Measurement of arterial blood pressure is important in each Ante-Natal Care (ANC) visit to categorize pregnant ladies for early detection and management of Pregnancy Induced Hypertension (PIH) cases. There are no reference values of arterial blood pressure among healthy Sudanese pregnant ladies and the values of blood pressure were obtained from international studies also fasting Ramadan can affect the blood pressure, blood glucose and body mass index. This study aimed at determining the effect of Fasting on the arterial blood pressure among healthy pregnant and non-pregnant Sudanese ladies living in Khartoum state. A case control study was conducted in Khartoum state during May-October, 2019 on (105) healthy Sudanese ladies who were randomly selected, their age range between 17-40 years. About 20 of them served as control group (non pregnant and not fasting) and (55) of them were pregnant not fasting and (30) fasting pregnant ladies as cases. All participants were assessed by questionnaire after filling an informed consent. Blood pressure was measured 3 times at resting state according to WHO criteria. In the fasting groups the blood pressure was measured before 3 pm. Data was analyzed using the Statistical Package for the Social Sciences (SPSS) Version 25 with significant $p \leq 0.05$, comparing the fasting pregnant blood pressures with the non fasting. The blood pressure was found to be 100.6/67.8 mmHg in pregnant women, not fasting, 114.2/75 mmHg in non pregnant and 103.6/67.9 mmHg in fasting pregnant ladies. In the pregnant not fasting group the blood pressure was found to be 94.7(±7.5)/63(±5.9 mm Hg) for first trimester, 100.4 (± 9.2)/67.2(±7.9 mmHg)for second trimester and 105.4 (± 13.2)/72.2(±7.3 mmHg) for the third trimester. While

for the fasting group the blood pressure was found to be 104.6 (±15.1)/70.4(±14.2 mmHg) in the first trimester, 96.4 (±6.7)/63.8(±4.6 mmHg) in the second trimester and 109.7(±13.2)/69.4 mmHg (±9.7) in the third trimester. The results of this study showed that the pregnancy affects blood pressure significantly and the BP is lower in the first trimester than second trimester and the BP in the second trimester is lower than the third trimester. The mean of systolic and diastolic blood in the fasting group were higher than the mean systolic and diastolic blood pressures in non fasting group. The highest mean systolic blood pressure was recorded at the third trimester and the highest mean diastolic blood pressure recorded at the first trimester. Antenatal care follow up according to reference values for Sudanese ladies is important for the early detection and management of pregnancy induced hypertension. Further confirmatory studies are needed.

INTRODUCTION

Pregnancy is a dynamic process characterized by multiple physiological changes in the cardiovascular system. These changes are adaptive mechanism to face the high metabolic demand for both fetus and mother; insufficient hemodynamic changes can result in maternal and fetal morbidity like intrauterine growth restriction and preeclampsia with subsequent maternal cardiovascular disorders[1]. Pregnancy is associated with splanchanic, especially, renal vasodilatation occurring as early as 5 weeks of gestation[2]. This vasodilatation induces a drop in peripheral resistance until middle of the second trimester (decrease by 35-40%) then either unchanged or paradoxically increased for the remainder of the pregnancy and 2 weeks after delivery, maternal hemodynamic return to non pregnant level[3] Vasodilatation of the kidneys results in a 50% increase in renal plasma flow and glomerular filtration rates by the end of the first trimester, this decreases serum creatinine, urea and uric acid values[4].

Cardiac output increases throughout pregnancy[5]. The sharpest rise in cardiac output occurs at the beginning of the first trimester and this increase continues in the second trimester[6]. After that the cardiac output is either decreased or increased or unchanged. There is up to 45% rise in cardiac output at the 24th week gestation of singleton pregnancy and it is 15% higher in a twin pregnancy[7]. The stroke volume increases, gradually in pregnancy until the end of the second trimester and then remains constant or decreases late in pregnancy, so it is responsible for rising of cardiac output in early gestation while in late gestation rising of the cardiac output is mediated by the increased heart rate[8]. Heart rate increases progressively by 20-25% over base line, maximum heart rate recorded at the third trimester[9-11].

The vasodilatation in pregnancy is mainly related to the level of estrogen and progesterone and also Relaxin has avasodilator role[12, 13]. In a Swedish observational study of pregnant women, the effects of serum concentrations of progesterone, relaxin and estradiol on arterial blood pressure were studied. Higher serum concentrations of relax in and progesterone early in pregnancy were related to lower mean SBP in the second and third trimesters. Furthermore, those women with DBP >90 mmHg late in pregnancy had lower relax in concentrations earlier in pregnancy compared with those with lower DBP[14]. There is high estrogen level during pregnancy which stimulate angiotensinogen production so pregnancy induced rennin angiotensin aldosterone stimulation occur early in pregnancy with increased plasma volume starting at 6-8 weeks and rising progressively until 28-30 weeks[15, 16] but this is not associated with sodium retention and potassium loss due to Progesterone which is a potent aldosterone antagonist when acting on the mineral ocorticoid receptor[4]. Myocardial contractility and left ventricular and right ventricular ejection fractions do not appear to change during pregnancy[17,18].

The blood pressure changes during pregnancy has been studied at different aspects. A Chinese study was done among ladies who planned to have a baby within six months, arterial blood pressure was measured prior pregnancy and during pregnancy and found that the BP decreased significantly in early pregnancy and increased thereafter. Pre-gravid BP level was inversely associated with the BP drop in early pregnancy such that women with higher pre-gravid BP had greater BP drop at the beginning while women with the lowest pre-gravid BP level demonstrated no obvious BP drop throughout the entire pregnancy[19].

Between January, 2010 and December, 2012 a total of 578 pregnant ladies in Portugal were recruited to participate in a study to determine the correlation between weight and blood pressure during pregnancy and found that overweight is associated with both higher Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) during pregnancy and increased risk of gestational hypertensive disorders also found that both normotensive and hypertensive ladies mean arterial blood pressures were influenced by their body mass index[20].

In Jakarta, 2252 pregnant ladies were recruited to participate in study to evaluate if pre-pregnancy Body Mass Index (BMI) determines blood pressure throughout pregnancy and to explore the role of gestational weight

gain in this association and found regardless pre-pregnancy BMI the SBP and DBP increased by 0.99 and 0.46 mmHg/month, respectively. Higher pre-pregnancy BMI was associated with higher pregnancy SBP (0.25 mmHg/kg/m^2[21].A Brazilian cohort study was done at April 2015 to describe the changes in Diastolic Blood Pressure (DBP) and Systolic Blood Pressure (SBP) levels during pregnancy according to early pregnancy Body Mass Index (BMI) and found that DBP and SBP decreased from the first to the second trimester and then increased up to the postpartum period. Women with early pregnancy high BMI had higher SBP and DBP than their normal-weight in all stages of pregnancy but not in the postpartum period[22]. A study was done among pregnant ladies aimed to examine the correlation between risk of preeclampsia and obesity and found that the mainstay of prevention of hypertension is preconception counseling, entering pregnancy with lower Body Mass Index (BMI), limiting weight gain and taking low dose aspirin to prevent preeclampsia before 16 weeks gestation[23]. In a French study done among healthy pregnant women (both nulliparous and multiparous) with no history of hypertension or obesity (BMI<30 kg m^{-2}) who could measure their BP at home and found that diastolic BP was significantly lower during the first two trimesters of the pregnancy, systolic and diastolic blood pressure increased during the third trimester also found that heart rate increased significantly during pregnancy[24].

The World Health Organization (WHO) performed a study which aimed at examining the correlation between rising of arterial blood pressure and risk of preterm birth and found out that rising in systolic or diastolic blood pressures from early pregnancy to the second trimester is associated with spontaneous preterm birth[25].

A study was done at a center for Obesity Research and education in Philadelphia and found that higher maternal gestational weight gains are associated with abnormalities in maternal b lood sugar, hypertensive disorders of pregnancy and delivery complications[26].

Another study published at July, 2019 on 457 pregnant women attending Primary Health (PHC) center in Cruzeiro do Sul and found that weekly gestational weight gain was associated with higher blood pressure readings at the beginning of the third trimester[27]. Overweight and obese ladies when they become pregnant they have significantly higher readings SBP, DBP and MAP at any point during the pregnancy and postpartum than women with lower body mass[28]. Fasting during the holy month Ramadan is a religious activity for all adult healthy Muslims but it is not obligatory for pregnant ladies and some ladies prefer to fast. During this month Muslims are allowed to eat and drink between sunset and dawn. The length of fasting duration may vary in Ramadan depending on the geographical location of each specific country and the season in which Ramadan falls. Muslims who practice fasting usually have two meals per day: Breakfast at sunset and sahor before dawn[29] Knowing whether Ramadan fasting affect blood pressure among pregnant ladies has implications for health advice to the Muslim community.

Fasting Ramadan has many effects on health as weight reduction, reduction of total cholesterol and triglycerides in men but high density lipoproteins in ladies was increased. There is no impact on kidney function and urine output[30]. A study was done in Iran and showed that Ramadan fasting caused weight loss and fat-free mass reductions and body composition changes variation depend on sex and age. At October, 2018 a published study showed that Ramadan fasting does not adversely affect birth weight[31]. Another study was done among pregnant Muslim women residing in the UK who fasted during Ramadan and found there was fasting not be associated with adverse birth outcomes[32]. A study was done among Iraqi women pregnant fasting ladies and found that fasting during the second trimester of the pregnancy decreased the risk of gestational diabetes and excessive weight gain during pregnancy[33]. Another study was done to determine effect of maternal fasting during Ramadan on preterm delivery and found the fasting does not increase the risk of preterm delivery in pregnant women[34].

A Serbian study was done to measure effect of three-week fasting diet in extremely obese patients and found that there is significant reduction and even normalization of blood pressure (both systolic and diastolic blood pressure significantly declined (143±2 vs. 132±2 mmHg, 92±2 vs. 85±2 mmHg[37]. The general objective of this study is to determine the effect of pregnancy and fasting on arterial blood pressure among ladies living in Khartoum state.

MATERIALS AND METHODS

This is an analytical, case control hospital based study performed in Khartoum state capital of Sudan during the period of May-October, 2019 in Sudanese healthy pregnant ladies who were not diabetics or hypertensive, not anemic have no endocrine or renal problems and not suffering from any chronic illness attending antenatal care visits in maternity hospital, El-Sheikh Ali Fadul hospital, National Ribat University hospital and Wad-Nubawi primary health center. 105 volunteer were included (20 non pregnant ladies, 15 pregnant ladies in first trimester, 20 pregnant ladies in second trimester, 20 pregnant ladies in third trimester, 4 fasting in first trimester, 11 fasting in second trimester,

15 fasting in the third trimester) after taking their informed consent. Questionnaire Interviews with all participants were done covering information about age, family history of DM, HTN, smoking, alcohol history, obstetrical history and physical activity. Physical examination of the blood pressure (3 readings), pulse rate, height-weight and calculation of body mass index was done. Ethical Approval of this study was obtained from the National Ribat University NRU. The objectives of the study were explained to all individuals participating in the study. Data was analyzed using Statistical Package for the Social Sciences (SPSS) Version 25. The $p \leq 0.05$ considered to be significant.

RESULTS

Regarding the association between the arterial blood pressure and the gestational age of the surveyed ladies ; we observed that tracking correlation for SBP and DBP was stronger between first and third trimester with significant P value for SBP and DBP (0.008 and 0.00), respectively.

There is no significant variation between first and second trimester with insignificant p value in both SBP and DBP (0.53 and 0.81), respectively also between second and third trimester with insignificant p value in both SBP and DBP (0.174 and 0.45), respectively. Regarding the association between the arterial blood pressure and fasting state in the surveyed ladies; we observed that there is no significant variation between fasting and non fasting in the first trimester with insignificant p value in both SBP and DBP (0.73 and 0.107), respectively also in the second trimester with insignificant p value in both SBP and DBP (0.212 and 0.207), respectively and in the third trimester with insignificant p value in both SBP and DBP (0.354 and 0.343), respectively.

There is significant correlation between body mass index and systolic and diastolic blood pressure in non fasting group at the third trimester with (p = 0.002) and 0.004) respectively, no significant correlation in fasting group at third trimester, also no significant correlation in first and second trimester for both fasting and non fasting ladies.

There is no significant correlation between number of parity and systolic and diastolic blood pressure in all trimesters among fasting and non fasting ladies (Fig. 1-4). There is significant correlation between systolic blood pressure and maternal age among non fasting ladies at third trimester also between non fasting ladies and systolic blood pressure. There is no significant correlation between systolic blood pressure in all fasting and all non fasting ladies with p values (0.196 and 0.871),

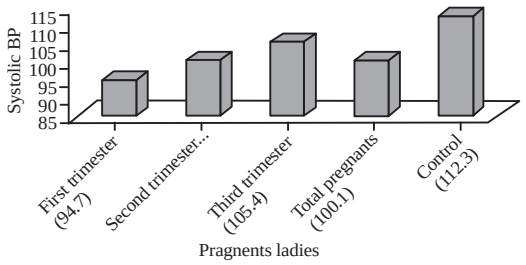

Fig. 1: Shows the mean Systolic blood pressure (mmHg) in pregnant ladies and control (n = 75); Systolic BP (mmHg)

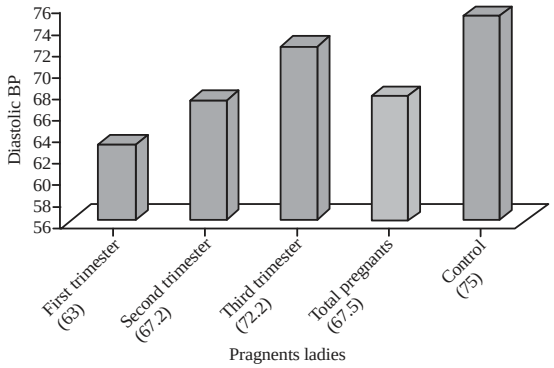

Fig. 2: Shows the mean diastolic blood pressure (mmHg) in pregnant ladies and control (n = 75); Diastolic BP (mmHg)

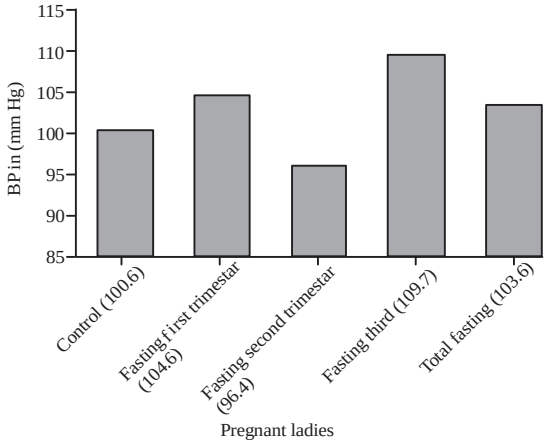

Fig. 3: Shows the mean systolic blood pressure (mmHg) in fasting pregnant ladies and control non fasting (n = 30); Systolic BP

respectively. There is significant correlation between BMI and SBP and DBP of non fasting ladies with p values (0.002) (0.004), respectively (Table 1 and 2). There is no significant correlation between arterial blood pressure and number of parity among fasting and non

Table 1: Shows the mean of systolic and diastolic blood pressure during all trimesters (n = 55)and in control non-pregnant group (n = 20)

Pregnant in third trimester	Pregnant in second trimester	Pregnant in first trimester	Total pregnant	Non pregnant
(N = 20)	(N = 20)	(N = 15)	(N = 55)	(N = 20)
BP+/- (SD)	BP+/- (SD)	BP+/- (SD)	BP+/- (SD)	BP+/- (SD)
SBP 105.4 (13.2)	100.6(11.2)	94.7(7.5)	100.4(9.2)	114.2(7.5)
DBP 72(7.3)	67.8(8.00)	63(5.9)	67.2(7.9)	75(4.7)

Table 2: Shows the mean of systolic and diastolic blood pressure in fasting during all trimesters (n = 30)and in control non fasting group (n = 55)

Fasting pregnant in third trimester (N=15)	Fasting pregnant in second trimester (N = 11)	Fasting pregnant in first trimester (N = 4)	Non fasting (N = 55)	Total fasting (N = 30)
BP (SD)	BP (SD)	BP (SD)	BP (SD)	BP (SD)
SBP 109.7(13.2)	96.4 (6.7)	104.1 (15.1)	104.6 (12.7)	100.6 (11.2)
DBP 69.4(9.7)	63.8 (4.6)	70.4 (14.2)	67.5 (9.1)	67.8 (8.00)

Table 3: Shows the correlation of arterial blood pressure and gestational age among fasting (n = 30) and non fasting pregnant ladies (n = 55) during all trimesters

Pragnents ladies	SBP* gestational age	DBP* gestational age
First trimester		
Total	0.993	0.358
Fasting	0.969	0.590
Not fasting	0.766	0.832
Second trimester		
Total	0.179	0.201
Fasting	0.728	0.693
Not fasting	0.237	0.282
Third trimester		
Total	0.008	0.220
Fasting	0.845	0.839
Not fasting	0.002	0.010
Total fasting	0.293	0.322
Total not fasting	0.003	0.020

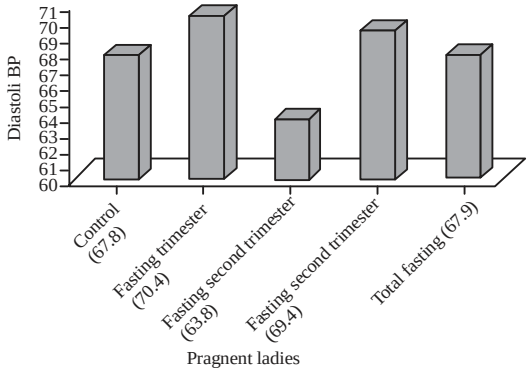

Fig. 4: Shows the mean diastolic blood pressure (mmHg) in fasting pregnant ladies and control non fasting (n = 30); Diastolic BP

fasting pregnant ladies during all trimesters. There is no significant correlation between blood pressure and maternal age among fasting and non fasting pregnant ladies during all trimesters (Table 3).

DISCUSSION

The results obtained from this study showed that the arterial blood pressures are significantly lower in pregnant ladies than non pregnant ladies. In the pregnant group we observed that the BP was lower in the first trimester than the second trimester and in the third trimester was higher than the second trimester. This finding is combatable with Tan[22], Farias[25] and Savitri[27] studies.

The mean of diastolic blood pressure in the first trimester was found to be lower than non pregnant (control group) and this is explained by the vasodilatation which occurs as early as 5th weeks of gestation which induces a drop in peripheral resistance[4].

Systolic and diastolic arterial Blood pressure was found to be highest in the third trimester and this is explained by the increase in the cardiac output mediated by increasing heart rate. This finding is most likely due to physiological changes during pregnancy[9-11].

No statistical difference was reported between first trimester and second trimester also between second trimester and third trimester as the physiological changes need more time to change blood pressure level. The results obtained from this study showed that the mean of systolic and diastolic blood pressures in the first trimester in fasting ladies was found to be higher than non fasting ladies.

The mean of systolic and diastolic blood pressure in the second trimester in fasting ladies was found to be lower than non fasting ladies. The mean of systolic blood pressure in third trimester in fasting ladies was found to be higher than non fasting ladies, but the reverse for diastolic. Eating habits in Ramadan as Sahour and Dinner may contribute to these variations in arterial blood pressure.

CONCLUSION

Arterial Blood pressure in pregnant ladies was found to be lower than non pregnant ladies with significant statistical differences. Arterial blood pressure in fasting pregnant ladies was found to be higher than non fasting ladies with significant statistical differences. Encouragement of more studies about BP and fasting is recommended with more sample size and states of Sudan. Diagnosis of Pregnancy Induced Hypertension (PIH) is recommended to be revised according these values.

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