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Blood Pressure Measurement among Women of Reproductive Age in Southern Nepal

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Abstract

Background and objectives: Accurate measurement of Blood Pressure (BP) is crucial to the diagnosis and management of hypertensive disorders in pregnancy. Weight gain and higher Body Mass Index (BMI) is believed to increase maternal risk during pregnancy. Therefore, the present study was designed to measure the Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) among pregnant women and its association with BMI and age in Southern Nepal.

Materials and methods: This case-control study was conducted in Department of Biochemistry at Clinical Pathology Laboratory in coalition with Department of Obstetrics and Gynecology, Janaki Medical College Teaching Hospital (JMCTH), Ramdaiya in Province No.2, Nepal. Blood pressure was measured using automated digital sphygmomanometer and, also BMI was calculated.

Statistical analysis of the collected data was carried out using SPSS version 20. The p-value < 0.05 was considered as statistically significant.

Results: The mean and standard deviation for SBP (102.84 ± 5.29; 100.10 ± 5.62) and DBP (67.73 ± 3.08; 65.69 ± 3.18) from the first to the second trimester decreased while relatively higher SBP (105.85 ± 6.15) and DBP (72.76 ± 4.17) in third trimester.

BMI was negatively correlated with age and SBP but positively correlated with DBP. However, relationship for BMI with age and blood pressure was statistically insignificant.

Conclusion: SBP and DBP were found to be decreased from 1st to 2nd trimester and relatively higher in last trimester during pregnancy. Association of BMI with DBP was found statistically significant but with age and SBP was statistically insignificant.

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Introduction

The incidence of gestational hypertension in reproductive-aged women is estimated to be 7.7% [1] and is associated with increased risks of maternal and neonatal morbidity and mortality [2]. Hypertension in pregnancy has not always been standardized, but following the "National High Blood Pressure Education Program Working Group on High Blood Pressure in Pregnancy" recommendation is currently a Systolic Blood Pressure (SBP) ≥ 140 mmHg and/or a diastolic blood pressure (DBP) ≥ 90 mmHg [3].

Any values between SBP 140–159 mmHg and DBP 90–109 mmHg [4] is considered as non-severe hypertension while SBP ≥ 160 mmHg and/or DBP ≥110 mmHg as severe hypertension [5]. Hypertensive Disorders of Pregnancy (HDP) include chronic hypertension, gestational hypertension, preeclampsia, and preeclampsia superimposed on chronic hypertension [6]. Preeclampsia occurs in up to 35% of women with gestational hypertension [7] and up to 25% of those with chronic hypertension [8].

Furthermore, offspring of pre-eclamptic mothers are at risk of major health issues such as impaired motor development, [9] increased childhood blood pressure [10] and stroke in adulthood [11]. Complications of hypertension in pregnancy still account for an estimated 50,000 maternal deaths annually worldwide [12]. The associated complications with hypertension in pregnancy include posterior reversible leukoencephalopathy syndrome, [13] stroke, [14] retinal disorders, [15] cerebral white matter lesions, [16] placental abruption, preterm delivery, fetal growth restriction, stillbirth, maternal death secondary to stroke and eclampsia, as well as future risk of hypertension, diabetes mellitus, cardiovascular and metabolic disorders [17-21].

BP measurement is an important screening test used in obstetric care to detect or predict gestational hypertensive disorders [22]. Before the 21st century, BP was measured by an observer listening to sounds with a stethoscope while watching a sphygmomanometer. However, semi-automated and automated devices that use the oscillometry method, which detects the amplitude of the BP oscillations on the arterial wall, have become widely used over the past two decades [23,24].

The Association for the Advancement of Medical Instrumentation (ANSI/AAMI/ISO), British Hypertension Society (BHS), and European Society of Hypertension (ESH) have published protocols to validate BP measurement devices and ensure that their accuracy is comparable to the reference standard, a mercury sphygmomanometer [25,26]. These protocols were developed to standardize the procedures for validating BP devices, [27] and strict adherence to an individual protocol is necessary for accuracy and statistical validity [28]. However, the predictive accuracy of blood pressure measurement in early pregnancy still remains controversial [29,30].

Measurement of BP in the sitting position or left lateral recumbency (on the left arm) rather than the supine position is evidence based [31]. Over the past decades, the occurrence of overweight and obesity among women of reproductive age increase BMI and its associated complications have augmented remarkably in developed and developing countries [32].

Although, the etiology of hypertensive disorders of pregnancy (HDP) is not apparent; however, BMI is also considered as risk factor [33]. The higher risk of HDP has also been consistently linked with higher baseline BMI recorded at the first antenatal visit [34]. Pre-pregnancy BMI influences SBP and DBP levels during pregnancy [35]. Several studies reports that HDP could also increase the risk of offspring obesity, which might be partly attributed to a change in the intrauterine environment [36,37].

Nepal is a country with a very high Maternal Mortality Ratio (MMR) estimated 258 per 100,000 live births in South Asia. Despite the longstanding efforts of the Ministry of Health and Population (MOHP) in Nepal to promote Maternal and Neonatal Health (MNH) progress has been slow for MNH service use [38]. Blood pressure control and its accurate measurement are important to prevent maternal-fetal adverse outcomes [39].

Higher BMI together with high SBP are known as the leading risk factors for mortality and disability-adjusted life-years in women worldwide [40] mainly through manifestation of cardiovascular diseases and metabolic disorders [41]. There is dearth of studies examining blood pressure measurement and it's the relationship with BMI during pregnancy relating to age at Terai region of Nepal.

Therefore, the objective of this study was designed to measure the BP among women of reproductive age and its association with BMI and age in Terai of Southern Nepal.

Materials and methods

This case-control study was conducted in Department of Biochemistry at Clinical Pathology Laboratory in coalition with Department of Obstetrics and Gynecology, Janaki Medical College Teaching Hospital (JMCTH), Ramdaiya in Kshireshwarnath municipality of Province No. 2, Nepal.

The study was approved by Research Ethical Review Board of Singhania University, School of Life Sciences, Rajasthan, India. An ethical clearance letter was also obtained from the Institutional Review Board of Janaki Medical College Teaching Hospital, Ramdaiya, Nepal. Written informed consent was obtained from the participants to ensure their voluntary participation. Appropriate ethical conduct was maintained throughout the study.

The enrollment of study participants occurred between January 2015 to June 2017. As the same part of our research study, total of 336 pregnant women were recruited out of which 224 pregnant women (cases) and 112 non-pregnant healthy women (controls) were selected. Cases were selected by use of random number sequence generation from JMCTH and antenatal clinics of Janakpurdham.

Controls were selected from another health care facility at the same place Marie Stopes Centre, Janakpurdham, Nepal [42]. A higher number of cases were decided without compromising the power of study based on available literature and studies [43-45]. Pregnancy status was confirmed by a validated pregnancy test report. Cluster random sampling technique was adopted.

Pregnant and non-pregnant healthy women of reproductive age were included whereas pregnant women with gestational diabetes mellitus, hypertension, obesity, and women with other chronic diseases, drug induced abnormal liver function test and women over age 40 were excluded. The objectives of the research were clarified to the participants before conducting the formal interview.

After consent, socio-demographic information, reproductive and health history were obtained through a structured questionnaire. All anthropometric measurements were carried out

by trained healthcare professional following the recommendations of the WHO. Maternal pre-pregnancy BMI was calculated [46] and categorized into groups on the basis of WHO BMI classification [47].

Blood pressure were measured according to the manufacturers' instructions using an automated digital sphygmomanometer, Trust Check Expert, Automatic upper arm blood pressure monitor (Model no: HL888HC) manufactured by Health and Life Co., LTD , New Taipei City, Taiwan. To ensure accuracy automated blood pressure devices used for the measurement of blood pressure in pregnancy followed validation protocol [48].

Blood pressure was measured after the women had rested for at least five minutes and were seated comfortably with their back supported, their legs uncrossed and their feet flat on the floor. Clothing was removed from the arm in which the cuff was placed. The arm was supported at heart level, with the palm facing up and the elbow slightly flexed. The women were advised not to speak during the procedure and BP measurement was noted.

Statistical analysis of the collected data was carried out using SPSS version 20. Frequency distribution of BMI, systolic and diastolic BP was calculated. Correlation analyses were performed to see the association between BMI, age, SBP and DBP. The p-value < 0.05 was considered as statistically significant.

Results

Out of total 336 women, 224 were pregnant and 112 were non-pregnant. Maximum pregnant and non-pregnant women were in between the age of 20-30 years and lowest in between 30-40 years. The details about the distribution of age, obstetrics history, and BMI of study participants have been previously reported in our study [42].

Blood pressure measurement of participants

Table 1 presents the blood pressure measurement among participants. The mean systolic BP in pregnant women in 1st, 2nd and 3rd trimester was 102.84, 100.10 and 105.85 with standard deviation of 5.29, 5.62, and 6.15 respectively and in non-pregnant healthy women were 109.9 with SD of 5.45. The mean diastolic BP in pregnant women in 1st, 2nd and 3rd trimester was 67.73, 65.69 and 72.76 with standard deviation of 3.08, 3.18, and 4.17 respectively and in non-pregnant healthy women were 72.33 with SD of 3.86.

This outcome reflects that the blood pressure was relatively higher among pregnant women in third trimester as compared to 1st trimester but drops in mid trimester. The association of blood pressure in pregnant and non-pregnant healthy women was found to be statistically significant (p= 0.000).

Association of Blood Pressure with BMI and Age

BMI is negatively correlated with age and SBP but positively correlated with DBP. However, relationship for BMI with age and blood pressure is statistically insignificant as represented in Table 2.

Table 1: Blood pressure of participants

Blood pressure (mmHg)	Pregnant women (n=224)			Non-Pregnant Healthy women (n=112)	F	p-value
	1st trimester	2nd trimester	3rd trimester			
SBP	102.84±5.29	100.10±5.62	105.85±6.15	109.9±5.45	50.85	0.000
DBP	67.73±3.08	65.69±3.18	72.76± 4.17	72.33± 3.86	78.85	0.000

(SBP-Systolic blood pressure; DBP-Diastolic blood pressure)

Table 2: Correlations of Blood Pressure with BMI and Age

		BMI	SBP	DBP	Age
BMI	Pearson Correlation	1	-.077	.064	-.064
	Sig. (2-tailed)	-	.157	.242	.242
SBP	Pearson Correlation	-.077	1	.338**	.102
	Sig. (2-tailed)	.157	-	.000	.062
DBP	Pearson Correlation	.064	.338**	1	.025
	Sig. (2-tailed)	.242	.000	-	.654
Age	Pearson Correlation	-.064	.102	.025	1
	Sig. (2-tailed)	.242	.062	.654	-

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

We have previously shown that more number of study participants were in 2nd trimester of pregnancy followed by 3rd trimester. Age group between pregnant and non-pregnant healthy women was found to be statistically insignificant. The obstetric history of women with multi gravidity and multiparity constituted higher (61.61%) and 70.99% respectively [42].

Accurate blood pressure measurement is of paramount importance in the management of hypertension in pregnancy. The result of present study signifies that the blood pressure was relatively higher among pregnant women but drops in 2nd trimester of pregnancy. Earlier researcher's studies have shown alike BP pattern during pregnancy [49,50]. In current study, the mean SBP in pregnant women was 102.84, 100.10 and 105.85 mmHg in 1st, 2nd and 3rd trimester respectively and in healthy non-pregnant women were 109.9 while the mean DBP in pregnant women was 67.73, 65.69 and 72.76 mmHg in 1st, 2nd and 3rd trimester respectively and in healthy non-pregnant women was 72.33.

CamposI also depicted that the mean SBP and DBP among participants during pregnancy were 109.4 mmHg and 65.4 mmHg, respectively almost similar to our study. The possibility is that excessive gestational weight gain might be associated with higher mean systolic blood pressure values which reinforce the need for improvements in maternal care, seeking to prevent elevated blood pressure at the end of pregnancy [51].

Rebelo et al., in a Brazilian cohort study accounted SBP and DBP decreased from the first to the second trimester and in-

creased up to the postpartum period [52] is almost parallel to our study. Some authors have found different results, such as a mid-trimester BP rise instead of a drop [53-55] which is not in harmony with this study. The possibility is that in early pregnancy, usually from 5 weeks' pregnant to the middle of the second trimester, a pregnant woman's blood pressure may actually decrease. This is because pregnancy hormones can stimulate blood vessels to widen. As a result, the resistance to blood flow isn't as high.

The other possible causes for the increasing blood pressure during pregnancy may be gestational weight gain, failing to stay active, first-time pregnancy, a family history of pregnancy-related hypertension, carrying more than one child, age over 40 years and using assistive technologies such as In Vitro fertilization (IVF) during the conception process [56].

Despite a consistent finding of a mid-pregnancy drop in DBP across different ethnic backgrounds, [57] the existence of a mid-pregnancy systolic BP drop remains under debate [58,59]. Meanwhile, it is generally acknowledged that mid-pregnancy BP drops at ~20 weeks followed by an increase until term, [60] which is the basis for the current clinical guidelines for hypertensive disorders in pregnancy diagnosis.

Other similar investigations have found markedly higher values in all pregnancy trimesters [54,57,59,61]. In another comparable study, Grindheim et al., also evaluated BP variation during pregnancy in which finding reflects statistically significant drop in SBP and DBP up to mid-pregnancy [50] is in concurrence with our study. Also, Nama et al., reported a progressive increase in SBP and DBP in a sample of primiparous healthy pregnant women [55].

Other studies have also established progressive increases in SBP during pregnancy in homogeneous populations [53,54] which is in accord with current study. In another similar type of study, MacDonald-Wallis et al., in an attempt to establish BP reference values during pregnancy, have found higher mean SBP and DBP values at 12 and 37 weeks of normal pregnancies [57].

The results of 1st trimester are in accordance with our study but not for 2nd trimester. A population based prospective cohort study from early pregnancy onwards in Netherlands carried by Gaillard et al., depicted that SBP and DBP track moderately from first to third trimester.

Blood pressure tracking in pregnancy might help to early identify those women that are at high risk to develop gestational hypertensive disorders [58]. In our study, we elucidated previously the mean BMI in pregnant women was 20.24, 23.18 and 24.53 with standard deviation of 2.51, 2.36, and 2.31 in 1st, 2nd and 3rd trimester respectively and in healthy non-pregnant women was 21.10 with SD of 2.32. Weight and BMI in pregnant women increases with the trimesters of pregnancy and was statistically significant [42]. With respect to association, the present result depicts that BMI was negatively correlated with age and SBP but positively correlated with DBP. However, relationship for BMI with age and blood pressure was statistically insignificant.

In an analogous study carried by Hogan et al., on Body Mass Index and Blood Pressure Measurement during Pregnancy at Coombe Women and Infants University Hospital, Dublin, Ireland reported the mean early pregnancy BMI was 25.8 kg/m^2 (range 17.2–44.0 kg/m^2). But, when BMI is accurately measured at the start of pregnancy, women with a BMI > 34.9 kg/m^2 in early pregnancy should be assigned to a large cuff for blood pressure measurement [62].

Among 2252 pregnant women visiting Budi Kemuliaan Hospital and its branch for regular antenatal care visits at Jakarta, Indonesia reports throughout pregnancy, SBP was estimated to increase by 0.99 mm Hg/month while DBP increased by 0.46 mm Hg/month, independent of their pre-pregnancy BMI tertiles and other possible confounders. The mean blood pressures were consistently higher with higher pre-pregnancy BMI, although the pace of increase did not seem to be affected. The lines that depict the pattern of change in SBP and DBP during pregnancy appeared to be parallel in women from different pre-pregnancy BMI tertiles. In addition, no interaction was found between prepregnancy BMI and gestational age which is analogous to our study [63].

The results of current study are also in accordance with the reports from earlier studies [35,52,54, 64]. Almost similar to our findings, Thompson et al. in their study which explored the relation between blood pressure during pregnancy with gestational age and prepregnancy BMI. BMI as continuous scale measurements also found that SBP and DBP levels generally increased with higher pre-pregnancy BMI at any gestational age [49]. However, Miller et al. also showed relatively unchanged mean differences of SBP and DBP between various pre-pregnancy BMI groups in all trimesters which in not in accord with our study [54]. In contrast, a small study in Brazil Rebelo et al., showed that although women with excessive weight had higher SBP and DBP than the normal weight women throughout pregnancy [52].

Our overall finding is in accordance with a study in Sweden showing correlation between DBP during pregnancy with women's baseline BMI, but not with their gestational weight gain [65]. In addition, Savitri et al., also reported no interaction was found between prepregnancy BMI and gestational age [63] which is in similar to our study.

Preliminary research shows that excessive weight gained in the first trimester predicts excessive weight gain throughout pregnancy. Weight gain during pregnancy has also been shown to have implications for the child's future risk of being overweight [66,67]. Gestational weight gain is a strong predictor of short and long-term health outcomes for both childbearing women and their offspring [68].

Obesity during pregnancy has been associated with gestational diabetes, gestational hypertension, pre-eclampsia, birth defects, cesarean delivery, fetal macrosomia, perinatal deaths, postpartum anemia and childhood obesity [69]. Additionally, obesity may also contribute to the dysregulation of leptin function, which consequently causes hypertension, and alternatively hyperleptinaemia itself could have a direct effect on the increased level of inflammation and raise in blood pressure [70].

The pathophysiological mechanism to explain the association between pre-pregnancy BMI and blood pressure levels during pregnancy remains unclear. It has been speculated that adiposity causes a state of increased inflammation, hyperleptinaemia, hyperinsulinaemia and insulin resistance which further leads to disturbances in autonomic function such as sympathetic nervous activation.

These mechanisms appeared to be similar in pregnancy and outside of pregnancy, as has been extensively studied among

pre-eclamptic pregnant women [71] as well as in obese and hypertensive women [72]. Pre-eclampsia is approximately twice as prevalent in overweight women (BMI 25 to 30) and approximately three times as high in obese women (BMI greater than 30) [73].

Previous studies have assessed the relationships between baseline BMI, [58,63] early trimester GWG, and the occurrence of gestational hypertension and preeclampsia [58,63,74]. The higher BMI is believed to increase maternal risk of developing pre-eclampsia [74] gestational diabetes [75] including obstetrical interventions at birth such as labor induction and surgical deliveries [76,77] as well as of experiencing still-birth, neonatal, perinatal, and infant death [78].

Increased BMIs are generally associated with higher hemoglobin levels during pregnancy; they are associated with an increased risk of postpartum anemia. Indeed, a lower BMI and suboptimal weight gain during pregnancy are long-recognized risk factors for the delivery of infants too small for gestational age [79].

Conclusion

This study provides new data about the pattern of BP variability throughout pregnancy which is a concern of great interest in Southern Nepal.

Systolic BP and diastolic BP decreased from 1st to 2nd trimester and were relatively higher in last trimester during pregnancy. The findings also emphasize the association of BMI with BP and age highlighting that BMI was negatively correlated with age and SBP but positively correlated with DBP. Also, relationship for BMI with age and blood pressure was statistically insignificant.

Weight reduction in obese and overweight women of reproductive age should be encouraged to practice a healthy lifestyle prior to pregnancy. High BMI should be monitored more closely in women who enter pregnancy for development of hypertensive disorders during pregnancy. Further, more research is needed and should be focused on blood pressure measurement and their associations with BMI and other factors during pregnancy to prevent maternal and perinatal morbidity and mortality.

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