ASSOCIATION BETWEEN DIETARY CALCIUM AND PREGNANCY INDUCED HYPERTENSION

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ABSTRACT

Background: Pregnancy induced hypertension (PIH) is one of the major complications of pregnancy. Inadequate calcium (Ca) intake is considered a public health problem in some vulnerable groups, especially pregnant women. A balanced diet during pregnancy with adequate Ca should be the ideal solution, and to proceed in this direction, evidence is required on the nature and extent of Ca deficiency in the diet of PIH mothers. **Objectives:** To assess the dietary intake of Ca in PIH (compared to non-PIH) mothers and to explore the factors affecting the intake of those nutrients. **Methods:** Under an observational case-control design, we recruited 300 Bangladeshi pregnant women in two groups (150 with and 150 without PIH), aged between 20-40 years (from 3 hospitals in Dhaka) at the 3rd trimester of pregnancy. A pre-tested questionnaire was used to collect the data. The first part of the questionnaire was allocated to general socio-demographic and clinical characteristics. Secondly, a food frequency questionnaire was used to estimate individual dietary Ca intake. **Results:** The dietary Calcium intake [(mg/day), median (range)] was significantly lower [265(111-487)] ($p<0.001$) in the PIH compared to the non-PIH [350(201-984) ;($p<0.001$)] group. On bivariate analysis, the dietary Calcium intakes had a significantly negative correlation with mean blood pressure which was considered an indicator of the severity of PIH ($r=-0.276$; $p<0.001$) for Ca. On regression analysis, PIH was found to be significantly associated with a lower intake of Ca ($\beta=-0.009$; $p<0.001$) when the effects of age, family history of HTN and family income were adjusted. **Conclusion:** Dietary consumption of Calcium during pregnancy is much lower than those recommended in our population, PIH seems to have an association with dietary deficiency of Calcium in pregnant women.

KEYWORDS: Pregnancy induced hypertension, PIH, PE, Ca

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Introduction

Pregnancy induced hypertension (PIH) is one of the major complications of pregnancy which includes both gestational hypertension (GH) and preeclampsia (PE). Gestational hypertension is characterized by an abnormal rise in blood pressure that usually develops after the 20th week of pregnancy [1]. Preeclampsia is defined as the combination of high blood pressure, swelling of the face and hands and protein in the urine (albuminuria, proteinuria) [2]. A Woman with PE, of seizures that cannot be attributed to other causes have potentially life-threatening consequences for both mother and child. If the condition progresses to eclampsia, life-threatening convulsions and comas can occur. The incidence of PIH in developing countries is particularly high due to the lack of proper care of the mother during pregnancy. Geographic, social, economic and racial differences are responsible for an incidence that is up to three times higher in some populations [3]. The worldwide incidence of the disease is still high in spite of the significant improvements in motherhood and childcare over the last decades. Mortality from hypertensive disorders is much higher reaching rates of 70-120 per 100,000 maternities.[4] It is the main cause of maternal mortality in these countries and is associated with a 5- fold increase in perinatal mortality [3]. PE and GH (together considered as pregnancy induced hypertension or PIH) are thus highly important public health problems. PIH is a multi-system syndrome characterized by vasoconstriction, metabolic changes, endothelial dysfunction, activation of coagulation cascade and increase inflammatory response. PIH contributes to (MMR) maternal mortality rate, prenatal mortality rate and stillbirth with variations due to geographical location and race [5].

In a study it was stated that in most countries, PIH is the single largest cause of maternal mortality. WHO (2000), stated that maternal mortality is said to be an indicator of social inequity and discrimination against women [6]. Globally, pre-eclampsia or PIH, is a condition that affects up to 80% of pregnancies every year and is among the leading causes of maternal and fetal illness worldwide. Hypertension disorders during pregnancy are the most common and direct cause of maternal deaths in South Africa. 19.1% of maternal deaths in a three-year period (2002-2004) were associated with hypertensive disorders of pregnancy [7]

At the national level and in developing countries like India, the maternal and prenatal mortality rates are still high. It is of great concern to suggest mothers, improve the health status of the mother and the child. It is well accepted that only a healthy mother can give birth to a healthy baby [8].

Although a fairly good degree of knowledge has now been accumulated on the etiopathogenesis of PIH, the exact biochemical events leading to the disorder remain unclear. The disease is known to have a genetic, environmental and nutritional basis [3]. Many different factors, i.e. lack of nutrients, poverty, dietary habits, and a lack of exercise or many other lifestyle changes, might play an important role in the development of this disease. The cause of PIH is unknown, although several factors have been shown to contribute. PIH is more common in women during their first pregnancy, as well as in women who have diabetes, or who have had preeclampsia during a previous pregnancy are also at increased risk.

Recent studies have emphasized that the possible role of general nutritional deficiency or an imbalance of several specific nutrients in the etiology of the disease. Prescription medications to reduce high blood pressure may be used. The categories of prescription drugs known as are commonly used to treat hypertension.[9]

Dietary changes that may be helpful for preventing PIH. Unlike the conditions that cause and use of salt can worsen PIH by reducing blood flow to the kidneys and placenta [10]. In preeclampsia, unrestricted use of salt and increased consumption is needed to maintain normal blood volume and circulation to the placenta [11]. Data from one preliminary study suggest that high trans-fat diets are associated with an increased risk of PIH [12]. Foods that have been deep-fried (e.g., French fries) are rich sources of Trans fatty acids.

Deficiency of a variety of nutrients like Calcium (Ca) and Magnesium (Mg) has been reported in patients with PIH. Ca and Mg are known to play major roles in modulating insulin secretion and sensitivity. Ionized Ca plays a central role in the secretion of insulin from pancreatic β cells [13]. On the other hand, Ca as well as Mg have critical roles in mediating insulin action in peripheral tissues. Thus, the relationship of these ions with the distal process of insulin secretion and action is linear. There are reports of decreased Mg and Ca in the serum of PIH patients, and it has been claimed that serum calcium deficiency and increased intracellular Ca concentration during late pregnancy contribute to the pathogenesis of PE [14]. There is a correlation between intracellular Ca and arterial tension (Pereyra, 1991). Some authors reported an inverse association between Ca intake and maternal BP and the incidence of PE [15]. Results from epidemiologic studies and clinical trials of non-pregnant adults suggest that dietary calcium may play a role in the etiology, prevention, and treatment of primary hypertension [16]. In the above perspective the present study has been undertaken to investigate the role of dietary calcium intake in PIH subjects.

Subjects and Methods

Study design

It was an observational analytic study with a group comparison design.

Study Population

A total of 300 Subjects were included, on the basis of availability, pregnant mothers from, within last 12 weeks (3rd trimester) of gestation, attending the outpatient departments of the selected hospitals, were the study population. All the potential subjects were included at their last prenatal visit on the basis of availability. a. Subjects were categorized in the 2 following groups:

- Healthy pregnant Women (Non-PIH): (n = 150)
- Pregnant women with Pregnancy Induced Hypertension: (n = 150)

Place and duration of the Study

It was a collaborative study conducted in the Institute of Nutrition and Food Science (INFS), University of Dhaka and the Bangladesh Institute of Health Sciences (BIHS), Mirpur Darussalam. The study subjects were collected from the Outpatient Departments of some tertiary level hospitals in Dhaka city i.e. Dhaka Medical College Hospital, Bangabandhu Sheikh Mujib Medical University Hospital, Bangladesh Institute of Health Sciences Hospital, Monowara Hospital etc. after the approval of institutional heads and the Ethical Review Committee as appropriate. The study subjects were referred to the Bangladesh Institute of Health Sciences (BIHS). The study was carried out over a period of 1 year and 4 months.

Diagnostic criteria for detection of PIH

PIH was diagnosed by hypertension, with or without proteinuria and/or edema (William, 1994).

Hypertension was defined following the criteria of the American College of Obstetrics and Gynecology (ACOG).BP equal to or greater than 140/90 mm of Hg, Rise of systolic BP 30 mm/Hg or more and Rise of diastolic BP (point of muffling i e point IV) 15 mm of Hg or more.

Edema was defined as per William (1994): Dependent edema greater than 1+ pitting after 12 hours of rest in bed/or weight gain in excess of 2 pounds per week, or particularly sudden weight gain over 1or2 days. **Proteinurea** was defined as per William (1994):Excretion of 0.3 g/l in 24 hour urine collection or greater than 1 g/l in a random sample or two random clean catch urine specimen with 2+ or more on reagent strip.

The Exclusion criteria of the study were pregnancy with diabetes mellitus, multiple pregnancies, and pregnancy with chronic renal disease. Pregnancy with chronic hypertension, neurological disorders, thyroid dysfunction, and pregnancy with other medical diseases.

Methods

The study was explained to each individual subject, and informed consent was obtained. Detailed sociodemographic data, family history and medical history, and dietary history were taken on a predesigned interviewer-administered questionnaire. A pre-test was conducted. The dietary history of normal pregnant and PIH subjects was taken by a food frequency questionnaire. Energy expenditure of the subjects was calculated by the factorial method (WHO/FAO/UNU1985). Anthropometry was recorded and the biochemical reports of the patients were collected from the patient's guidebook.

Development of Questionnaire

A pre-designed, pre-tested questionnaire was developed to obtain relevant demographic and socio-economic data. All interviews were conducted in the hospital. The dietary history

was taken by food frequency questionnaire and anthropometric measurements (height, weight), BMI of each subject were taken and recorded in a pre-designed checklist form. Obstetric examination was performed and recorded for every patient. The data were collected from DMCH, BIHS, BSMMU and Monowara hospital.

Measurement of Blood Pressure as per ACOG (Fernando, 1993):

BP was measured with the sphygmomanometer at the level of the heart.

Dietary Assessment Technique

Assessment of Ca rich dietary intake

- Ca rich dietary practices of the respondents were assessed through food frequency method.
- There were about 100 questions in the questionnaire regarding intake of Ca rich vegetables, green leafy vegetables, fruits, cereals, legume and animal foods etc.
- By using food frequency method, dietary history (daily/weekly/monthly/1st 6 months of pregnancy/never) and frequency of Ca rich foods intake among the pregnant women were assessed.
- In order to estimate the amount of usual Ca intake during pregnancy, the fractional portion size of each food consumed per day was multiplied by its Ca content, obtained from the national food composition table (Gopalon, Helen Keller; Swaminathan).
- The value was then summed up to obtain an estimate of an individual's total daily Ca intake.

Statistical analysis

- Data were expressed as M±SD for parametric values and median (range) for non-parametric values. Comparisons between groups were done using an independent t-test to compare means and a Mann-Whitney U test for skewed data. To test the association between two variables was examined using Spearman's coefficient correlation (r) analysis. Logistic regression was calculated for association with another confounding variable. Multiple regression analysis was done to better assess the relationships within the variables and the influencing variables. A P value of <0.05 was considered sufficient to reject the null hypothesis of no difference among groups. All statistical analysis was performed with the software SPSS 16 for Windows (SPSS, Inc. Chicago. IL. USA).

Results

Out of 300 subjects enrolled in this study, a total number of PIH subjects were 150 (who had pregnancy induced hypertension) and 150 subjects were normotensive as non-PIH.

Sociodemographic characteristics of the study subjects (Table: 1):

There is a significantly higher group of PIH (50%) subjects come from rural areas compared to non-PIH (32.7%). Majority (61.3%) of the non-PIH subjects live in urban areas compared to PIH (37.3%). Most of the respondents of both groups were housewives. Others included service holders, businessman, students and maidservant. There is no significant difference between the two groups (p=0.622). According to income level of the respondents, PIH (24%) subjects are lower class groups than the non-PIH (12%). Positive family history of HTN is significantly higher in the PIH (44%) compare to the non-PIH (22%) group (p<0.001).

Table 1. Sociodemographic characteristics of the study subjects (n=300)

Characteristics	Non-PIH	PIH	P value
Location			
Urban	92(61.3)	56(37.3)	<0.001
Rural	49(32.7)	75(50)	
Semi Urban	9(6)	19(12.7)	
Educational status			
Illiterate	7(5)	10(6.7)	0.288
Primary	31(21)	28(18.7)	
6-10 class	38(25.3)	34(22.7)	
Secondary	42(28)	37(24.7)	
Higher secondary	18(12)	20(13.3)	
Graduate	14(9.4)	21(14)	
Occupation			
House wife	130(86.7)	136(90.7)	0.622
Service Holder	6(4)	5(3.3)	
Business	6(4)	3(2)	
Student	5(3.3)	2(1.3)	
Maidservant	3(2)	4(2.7)	

Monthly income			
Low income	18(12)	36(24)	0.022
Middle	92(61.3)	89(59.3)	
Upper middle	34(22.7)	22(14.7)	
Upper	6(4)	3(2)	
Family history of HTN			
Yes	33(22)	66(44)	<0.001
No	104(69.3)	48(32)	
Don't know	13(8.7)	36(24)	

Results are expressed as number (%), the results calculated by cross tab analysis, n= number of subjects, PIH=Pregnancy Induced Hypertension, HTN=Hypertension

The Clinical characteristics of the total study subjects (Table:2)

The age (in years; M±SD) of the different study groups are as follows: Non-PIH 25±5 vs PIH 26±5. There are no significant differences in age (p=0.299). The BMI (Mean±SD) significantly higher in PIH groups (34±3.7) as compared to non-PIH subjects (26± 3.5) (p<0.001). There is also significant difference of Gestational weeks between the two groups (p<0.001). Gestational weeks [in weeks; median (range)] of the study subjects are as follows: Non-PIH 36(26-40) vs PIH 35(20-40).

The median (range) of systolic blood pressure (mmHg) is significantly higher in 150(130-230) PIH groups as compared to 120(58-130) non-PIH groups (p<0.001). Similarly, the median (range) of diastolic blood pressure (mmHg) is significantly higher in 100(80-140) PIH groups as compared to 70(62-90) non-PIH groups (p<0.001). The median (range) of mean blood pressure (mmHg) is also significantly higher in 120(105-170) PIH groups to compared to 86(70-100) non-PIH groups (p<0.001).

Table 2. The Clinical characteristics of the total study subjects (n=300)

Characteristics	**Non-PIH**	**PIH**	**P value**
Age (yrs)	25±5	26±5	0.299
BMI (kg/m^2)	26±3.5	34±3.7	<0.001
Gestational wks	36(26-40)	35(20-40)	<0.001
SBP (mm of Hg)	120(58-130)	150(130-230)	<0.001
DBP (mm of Hg)	70(62-90)	100(80-140)	<0.001
MBP	86(70-100)	120(105-170)	<0.001

Results are expressed as Mean±SD and median (range) as appropriate; n= number of subjects; Independent t-test, Mann-Whitney 'U' test were done as tests of significance, according to the nature and distribution of variables. BMI=Body Mass Index, SBP=Systolic Blood pressure, DBP=Diastolic Blood Pressure, MBP=Mean blood pressure.

The daily dietary Ca intake of the study subjects (Table:3)

The dietary Ca intake (gm/day), (Mean±SD) and [median (range)] are significantly lower in PIH (272.9±69) as compared to non-PIH, [(390.8±160). (p<0.001).

Table 3. The daily dietary Ca intake of the study subjects (n=300)

Variables	**Non-PIH** (n=150)	**PIH** (n=150)	**P value**
Dietary intake Calorie (kcal)	1584±355	1658±394	0.073
	1587(1000-3048)	1622(1027-2895)	0.054
Dietary intake of Ca (mg/day)	390.8±160	272.9±69	0.001
	350(201-984)	265(111-487)	0.001

Results are expressed as Mean±SD and median (range) as appropriate; n= number of subjects; Independent t-test, Mann-Whitney 'U' test were done as tests of significance, according to the nature and distribution of variables

The main sources of Ca intake of the study subjects (Table:4)

This table shows the main dietary sources of Ca among the Non-PIH and PIH groups. Intake of Ca from GLV [mg/day, median (range)] 5.7(.08-38.3) and 5.7(0.21-33.7); from Veg, [mg/day, median (range)] 17.1(6.38-75.4) and 17.8(3.02-63.9); from fruits [mg/day, median (range)] 9.5(2.62-143.9) and 9.1(2.96-43.4); and from some other foods (like betel leaves, Kathaler Bichi, lemon, orange, Fast food, Bakery products) [mg/day, median (range)] 1.3(0.00-66.9) and 1.8(0.00-20.3), there are no significant differences of Ca intake from those foods between the groups.

Significant differences of Ca intake from cereals, fish, legume sources. From cereals [mg/day, median (range)] 47.7(19.45-95.9) in non-PIH and 45.5(19.47-79.7) in PIH, (p=0.008); fish [mg/day, median (range)], 138.1(41.49-345.9) and 128.9(24.35-376.2), (p=0.008) and from legume [mg/day, median (range)] 33.4(1.64-194.2) in Non-PIH and 27.5(0.57-85.5) in PIH, (p=0.011).

But, intake of Ca from meat and poultry [mg/day, median (range)] 43.8(2.45-603) in non-PIH and 15.6(1.06-345.7) in PIH there are highly significant differences between Non-PIH and PIH groups (p<0.001).

Table 4. The main sources of Ca intake of the study subjects (n=300)

Variables	**Non-PIH** (n=150)	**PIH** (n=150)	**P value**
Cereal	47.7(19.45-95.9)	45.5(19.47-79.7)	0.008
Legume	33.4(1.64-194.2)	27.5(0.57-85.5)	0.011
GLV	5.7(.08-38.3)	5.7(0.21-33.7)	0.839
Veg	17.1(6.38-75.4)	17.8(3.02-63.9)	0.890
Fruits	9.5(2.62-143.9)	9.1(2.96-43.4)	0.672
Fish	138.1(41.49-345.9)	128.9(24.35-376.2)	0.008
Meat & Dairy	43.8(2.45-603)	15.6(1.06-345.7)	<0.001
Others	1.3(0.00-66.9)	1.8(0.00-20.3)	0.017

Results are expressed as median (range); n= number of subjects; Mann-Whitney U test were done as tests of significance, GLV-Green leafy vegetables; Veg-vegetables

The correlation coefficient of Ca intake with other variables in the Non-PIH and PIH groups (Table:5)

The (Table:6) shows that correlation coefficient of Dietary Ca intake with other variables in the Non-PIH and PIH group. There is significantly positive correlation find out between dietary intake of Ca with family income (r-0.246, p<0.001) and MBP (r=0.276, p=0.001) in PIH group.

Also find out significantly positive correlation of dietary intake of Ca with family income (r-0.430, p=0.002)

Table 6. The correlation coefficient of Ca intake with other variables in the Non-PIH and PIH groups (n=300)

Parameter	**Non-PIH** (n=150)		**PIH** (n=150)	
	r	**P**	**r**	**p**
Age (yrs)	0.046	0.580	0.025	0.763
BMI (kg/m^2)	-0.112	0.476	-0.030	0.733
Gestational week	-0.154	0.060	0.036	0.666
FHHTN	0.061	0.459	0.081	0.323
Family Income	0.430	0.002	0.246	<0.001
SBP	-0.056	0.498	0.075	0.361
DBP	-0.056	0.496	-0.051	0.536
MBP	0.045	0.638	0.276	0.001

Spearman's correlation coefficient's test was done as a test of significance. FHHTN=Family history of hypertension, SBP=Systolic Blood pressure, DBP=Diastolic Blood Pressure. MBP=Mean Blood Pressure

Association of PIH with various parameters as explored by binary logistic regression (Table:7)

The (Table:8) shows that logistic regression analysis, when the PIH group is dependable variable and other risk factors are adjusted then the significant association shows with Family history of HTN (p<0.001), and lower Ca intake are strongly associated with PIH subjects (p<0.001).

Table 7. Association of PIH with various parameters as explored by binary logistic regression (n=300)

Variable	**β Value**	**P value**	**Exp(B)**	**95% CI**	
				Lower	**Upper**
Age	0.026	0.384	1.026	0.968	1.088
Family history of HTN	0.187	0.000	1.206	1.095	1.328
Family Income	0.178	0.460	1.195	0.745	1.918
Dietary intake of Ca	-0.009	<0.001	0.991	0.988	0.995

β for standardized regression coefficient. PIH was taken as dependent variable whereas other variables were taken as independent variable; n = number of subjects

Discussion

A deficiency of calcium has been implicated in the etiopathogenesis of PIH. A Few interventional studies have also provided evidence that supplementation with Ca and Mg may help in preventing and managing the disorder. There is, however, paucity of data on the dietary origin of Ca and Mg deficiency and also on the association between PIH and dietary deficiency of these minerals. Dietary imbalance and inadequacy is fairly common among Bangladeshi pregnant women. On the other hand, around 10-20% of the pregnant women in our country suffer from PIH. It is thus rational to hypothesize that dietary deficiency of Ca is associated with PIH in our population.

The daily Ca intake of the non-PIH women in the present study ranged from 201 to 984 mg/day (with a median of 350mg). The recommended dietary allowance (RDA) during pregnancy is 1000 mg/day (Source: Institute of Medicine, 2010). Thus, the dietary calcium intake is 20%-98% with most

subjects taking much lower than even 50% of RDA. In the PIH Group the ranges were even lower without supplementation (ranging from 111 to 487 mg a day and these intakes are 11%-48.7% of the recommended dietary allowance (RDA) of 1000 mg) and the median value was 265 mg/day. It is thus evident that Ca intake is in general grossly inadequate in our pregnant women and it is further inadequate in the group of women who develop PIH. The data corresponds with the study by Zamzam et. al., (2007) done on an Iranian population where PIH women had significantly lower Ca intake compared to non-PIH groups.

The main focus of the present study was to explore the association of dietary Ca deficiency with PIH. The data shows that the calorie intake of PIH women, compared to their non-PIH counterparts, is not significantly different (and even has a higher tendency). The dietary intake of Ca was grossly low (table-3). This may depict that a lack of consciousness regarding food diversity (to ensure adequate intake of macro and micro-nutrients) rather than a shortage of food in general is related to a deficient intake of calcium, which seems to have an association with PIH.

An attempt was made in the present study to identify the particular food types that may be related to the dietary deficiency in the present population, Legume, fish , meat and dairy products were consumed at a much lesser amount by the PIH Group and particularly deficient intake of fish, meat and dairy products and seem to have a link with a much lower intake of Ca in PIH subjects(Table 4-6).Since calcium intake was found to have a strong association with family incomes(Table 6 and 7) it may be indirectly inferred that due to the relatively high price of fish, meat and dairy products, financial constraints may be a determinant of the dietary deficiency of that minerals in pregnancy. These factors, particularly in relation to the PIH, need to be investigated further.

Conclusions

In conclusion the present data indicate that, 1. Dietary consumption of Ca during pregnancy is much lower than that recommended in our population. 2. PIH seems to have an association with dietary deficiency of calcium in our pregnant women. 3. Inadequate dietary intake of ca are related to low intake of fish, meat and dairy products, which, in turn, may have a linkage with the family income of a woman.

References

1. Gudeta T A and Regassa T M. Pregnancy Induced Hypertension and Associated Factors among Women Attending Delivery Service at Mizan-Tepi University Teaching Hospital, Tepi General Hospital and Gebretsadik Shawo Hospital, Southwest, Ethiopia.
2. Solomon CG, Seely EW. 2001 ‘Hypertension in pregnancy: a manifestation of the insulin resistance syndrome? Hypertension; 37:232.
3. Lopez Jaramilleo P, Casas JP, Serrano N. 2001 ‘Preeclampsia: from epidemiological observations to molecular mechanisms.’ Braz J Med Biol Res; 34: 1227-35.
4. Robson SC. 1999 ‘Hypertension and renal disease in pregnancy.’ In, Edmonds K (Editor): Dewhurst’s Text Book of Obstetrics and Gynecology for Post-graduates, (6th edition). London: Blackwell Science Publication: PP-166-169.
5. Duckitt K, Harrington D. 2005 ‘Risk factors for pre-eclampsia at antenatal booking: systematic review of controlled studies.’ BMJ. Mar 12 ;330(7491):565.
6. Chang J, Elam-Evans LD, Berg CJ, Herndon J, Flowers L, Seed KA, et al. Pregnancy-related mortality surveillance--United States, 1991--1999. MMWR Surveill Summ. Feb 21 2003;52(2):1-8
7. Lopa Banerjee, 2010 ‘The Dangers of Preeclampsia and Eclampsia,’Jan 22, pp 14
8. Dutta, D.C. 2001, ‘Textbook of Obstetrics’, Jan.81 (1):25-30 New Central Agency (p) Calcutta.
9. Chong, R Q., Gelissen, I., Chaar, B., et al. Do medicines commonly used by older adults impact their nutrient status? Explor Res Clin Soc Pharm. 2021 Sep; 3: 100067.Published online 2021 Sep 3. doi: 10.1016/j.rcsop.2021.100067
10. Franx A, Steegers EA, de Boo T, et al. 1999 ‘Sodium-blood pressure interrelationship in pregnancy’. J Hum Hypertens; 13:159–66
11. Moutquin JM, Garner PR, Burrows RF, et al.: Report of the Canadian Hypetension Society Consensus Conference 2: nonpharmacologic management and prevention of hypertensive disorders in pregnancy. Can Med Assoc J 1997, 157:907–919.
12. Williams MA, King IB, Sorensen TK, et al. 1998 ‘Risk of preeclampsia in relation to elaidic acid (trans fatty acid) in maternal erythrocytes. Gynecol Obstet Invest; 46:84–7.
13. Grapengiesser E, Berts A, Shaha S, Lund PE, Gylfe E and Hellman B. 1993 ‘Dual effect of Na + /K+ pump inhibition on cytoplasmic Ca++ oscillations inpancreatic b cells. Arch Biochem Biphys; 300; 372-3
14. Hojo M, Suthanthiran M, Helseth G, Augustp. (1999) ‘Lymphocyte intracellular free Ca++ concentration is increased in pre-eclampsia’ Am-J-Obstet -Gynaecol,; 180: 1209-14.
15. Paolisso G, Scheen A, Onofrio FD, and Lefebvre P. 1990 ‘Magnesium and glucose homeostasis’. Diabetologia; 33: 511-514.
16. Hamet P. 1995 ‘The evaluation of the scientific evidence for a relationship between calcium and hypertension.’ J Nutr; 125:311S–400S.