Results

This prospective study included 100 pregnant females chosen from those attending Tokh Central Hospital Antenatal Care Unit, depending on the development of GH during pregnancy after 20 weeks' gestational age (GA).

Table (1): Study group characters

Character		
Number	Total	100
	Primigravida	82
	Multigravida	18
Mean age(years)	Total	22.7±5.5
	Primigravida	21.3±4.1
	Multigravida	29.4±6
Obstetric history	Recurrent Hypertension	10
Family history of hypertension with pregnancy		17

Patients had mean age of 22.7±5.5; range 17-41 years. There were 82 primigravida and 18multigravida, the mean age of primigravida was 21.3±4.1, range 17-41 years, whereas the mean age of multigravida was 29.4±6; range 20-41 years, (Fig.1).

There were 18multigravida with a mean gravidity of 2.5±0.7, range 2-4 gravida and mean parity of 1.4±0.6; range 1-3. Three patients had previous abortion, (Fig. 2).

Ten patients had a history of recurrent hypertension and 17 patients had a family history of gestational hypertension, (Table 1). There were 94 pregnant had singleton fetus, whereas the other six had twin pregnancy.
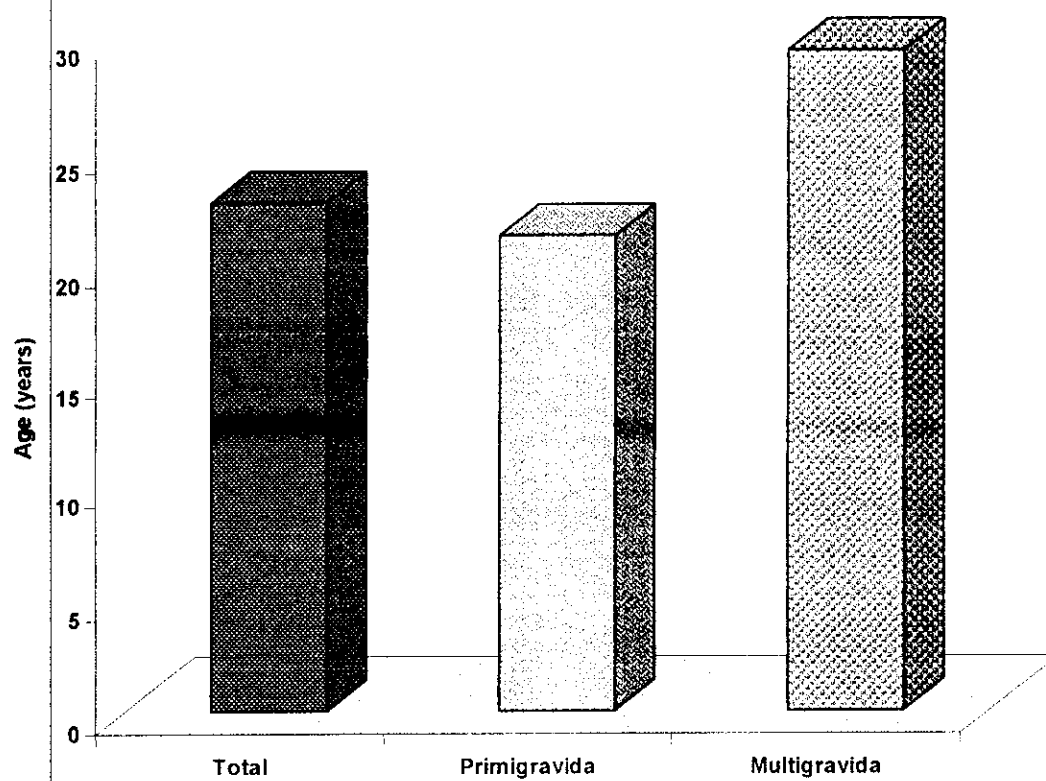
Fig. (1): Mean age of study group

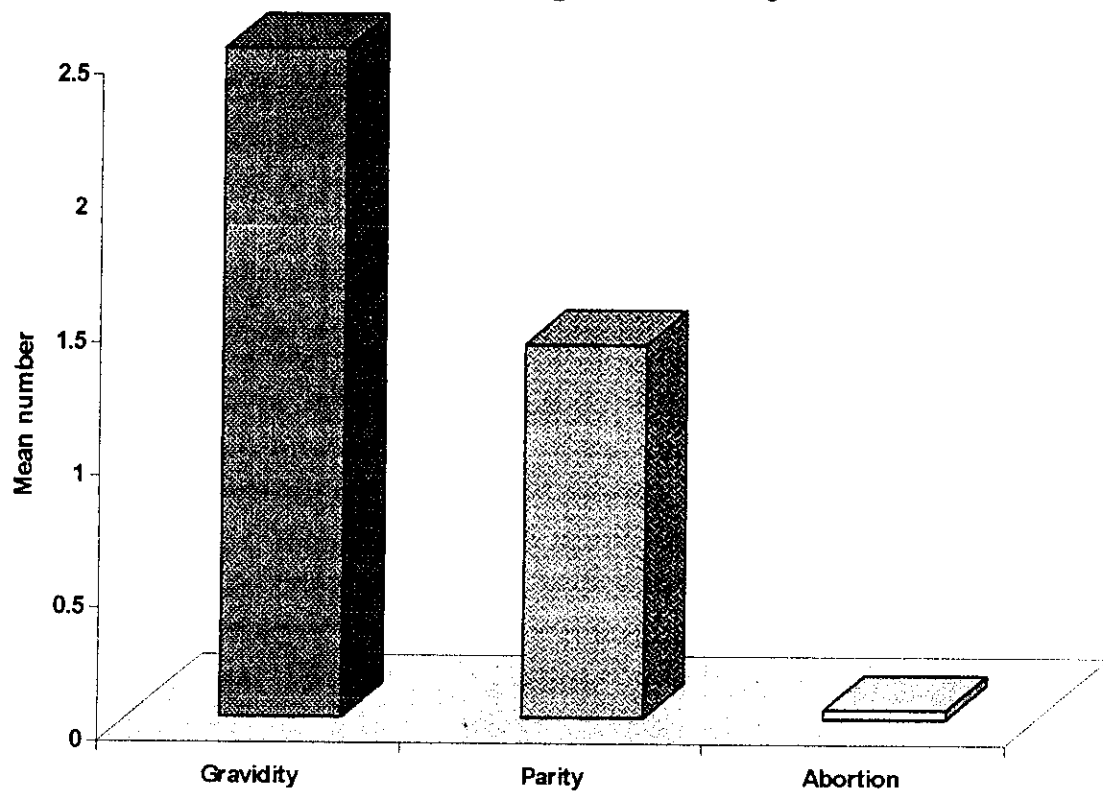# Fig. (2): Obstetric data of multigravida participating in the study

Table (2): First trimester data of study group defined retrospectively

	SAP (mmHg)	DAP (mmHg)	S. Creatinine (mg/dl)	S. Uric acid (mg/dl)	S. Albumin (mg/dl)
Total	114.4±6.8 (100-125)	74±4.3 (65-85)	1±0.18 (0.75-1.2)	3.8±0.85 (2.2-5.5)	3.32±0.52 (2.2-4.5)
Primigravida (n=82)	114.2±7.1 (100-125)	74±4.4 (65-85)	1±0.18 (0.75-1.2)	3.8±0.83 (2.2-5.5)	3.3±0.52 (2.2-4.5)
Multigravida (n=18)	115±5.4 (105-125)	73.9±3.7 (70-80)	0.98±0.19 (0.8-1.2)	3.8±1 (2.8-5.5)	3.3±0.36 (2.8-4)

First trimester data recorded for patients included in the study were revised retrospectively and this showed that systolic blood pressure (SAP) ranging between 100 and 125, mean=114.4±6.8 mmHg; diastolic blood pressure (DAP) was ranged between 65 and 85, mean=74±4.3 mmHg; mean serum creatinine was 1±0.18, range 0.75-1.2 mg/dl, mean serum uric acid was 3.8±0.85, range 2.2-5.5 mg/dl and mean serum albumin was 3.32±0.52 range 2.2-4.5 mg/dl. No patient presented with proteinuria. There was a non-significant difference between primi- and multigravida as regards preliminary data determined at time of inclusion in the study, (Table 2, Fig. 4 & 5).

Fig. (3): Mean GA of study group according to gravidity at time of development of GH
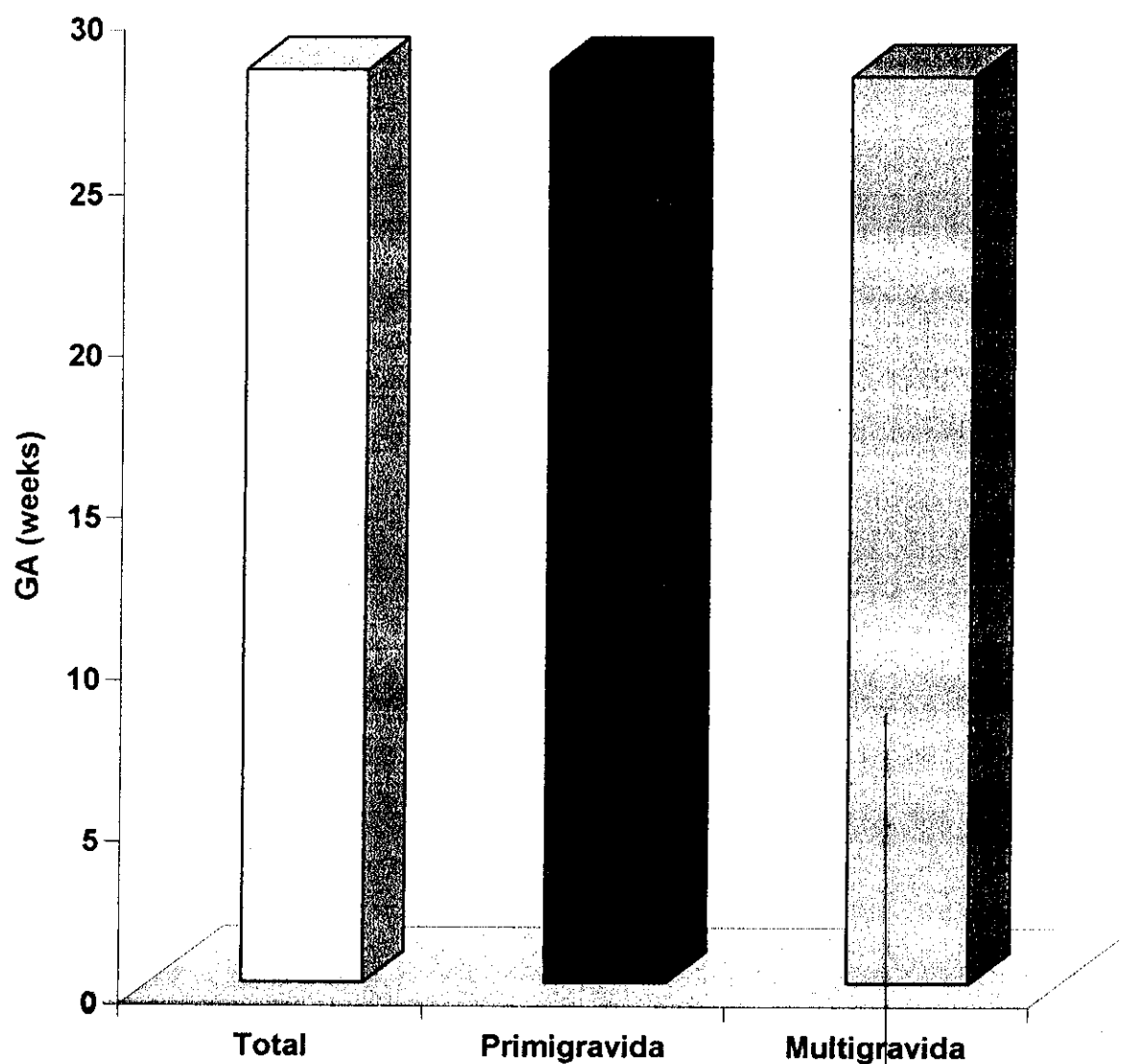
Patients had mean GA of 28.1±4.3; range 20-36 weeks, at time of development of gestational hypertension (GH). The mean GA of primigravida was 28.1±4.4, range 20-36 weeks whereas the mean GA of multigravida was 28±4; range 20-35 weeks. There was a non-significant (P>0.05) difference between multi- and primigravida as regards the GA at which they developed GH, (Fig. 3).

Fig. (4): Mean systolic and diastolic blood pressures estimated at first trimester
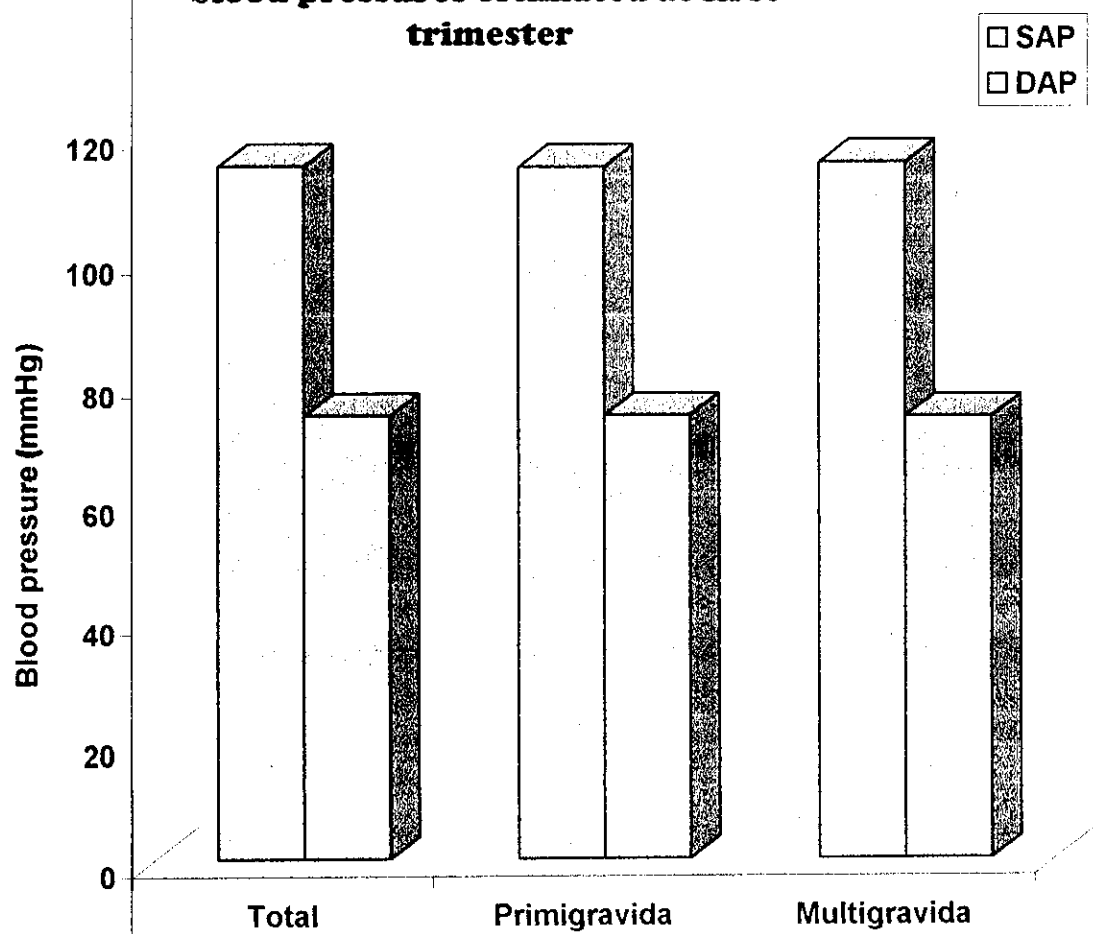

Legend: □ SAP □ DAP

X-axis: Total, Primigravida, Multigravida

Y-axis: Blood pressure (mmHg)

Fig. (5): Mean serum levels of creatinine, uric acid and albumin estimated at first trimester
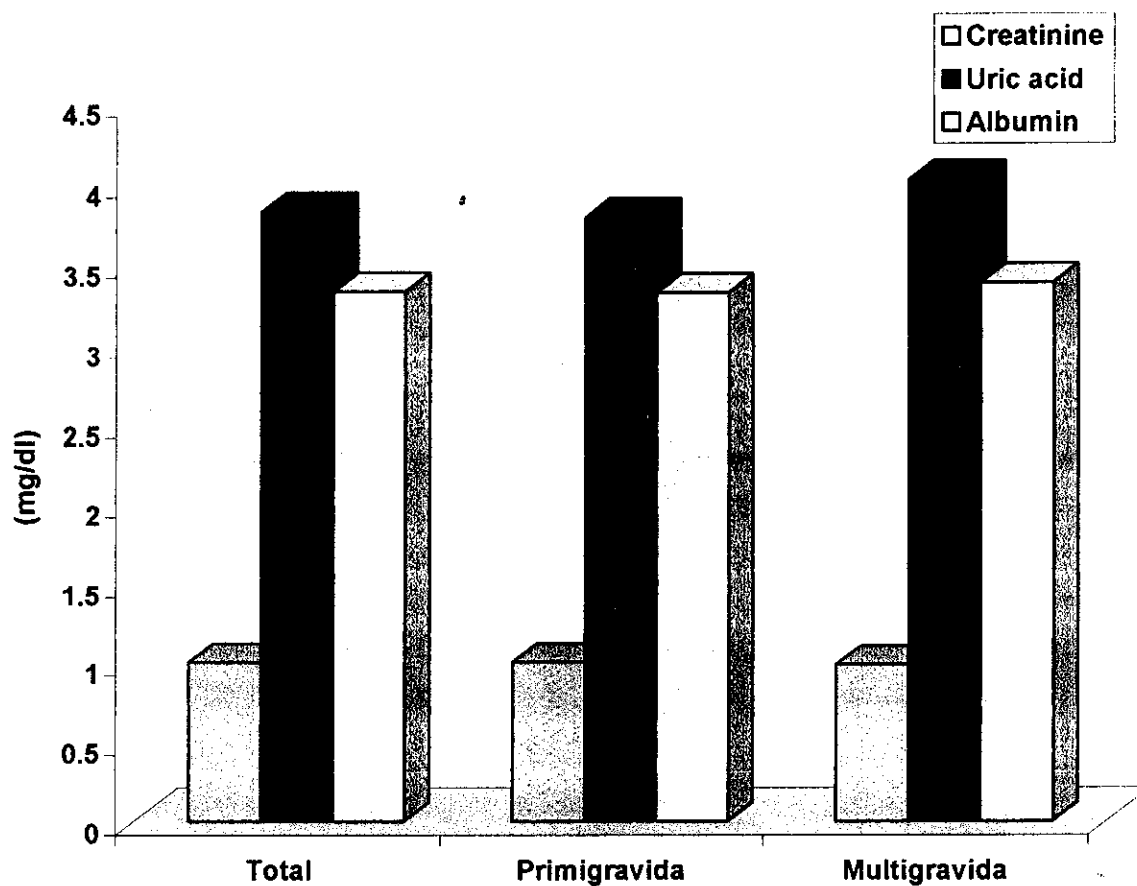
Table (3): Preliminary data of study group defined at the time of inclusion in the study

	SAP (mmHg)	DAP (mmHg)	S. Creatinine (mg/dl)	S. Uric acid (mg/dl)	S. Albumin (mg/dl)
Total	142.4±3.9 (135-150)	89±3.7 (90-100)	1.02±0.19 (0.8-1.2)	4.15±1.05 (2.8-6)	3.5±0.5 (2.7-4.6)
Primigravida (n=82)	142.5±4 (135-150)	89±3.8 (90-100)	1.01±0.16 (0.8-1.2)	4.24±1.05 (2.8-6)	3.5±0.52 (2.7-4.6)
Multigravida (n=18)	142.2±3.1 (140-150)	89.2±3.1 (90-100)	1.03±0.18 (0.8-1.2)	4±0.96 (2.8-5.5)	3.4±0.51 (2.7-4.5)

Data determined at time of inclusion in the study included SAP ranging between 135 and 150, mean=142.4±3.93 mmHg; DAP was ranged between 90 and 100, mean=89±3.7 mmHg; mean serum creatinine was 1.02±0.17, range 0.8-1.2 mg/dl, mean serum uric acid was 3.9±0.96, range 2.2-5.5 mg/dl and mean serum albumin was 3.32±0.52, range 2.2-4.5 mg/dl. No patient presented with proteinuria. There was a non-significant difference between primi- and multigravida as regards preliminary data determined at time of inclusion in the study, (Table 3, Fig. 6 & 7).

Fig. (6): Mean systolic and diastolic blood pressures estimated at time of inclusion in the study
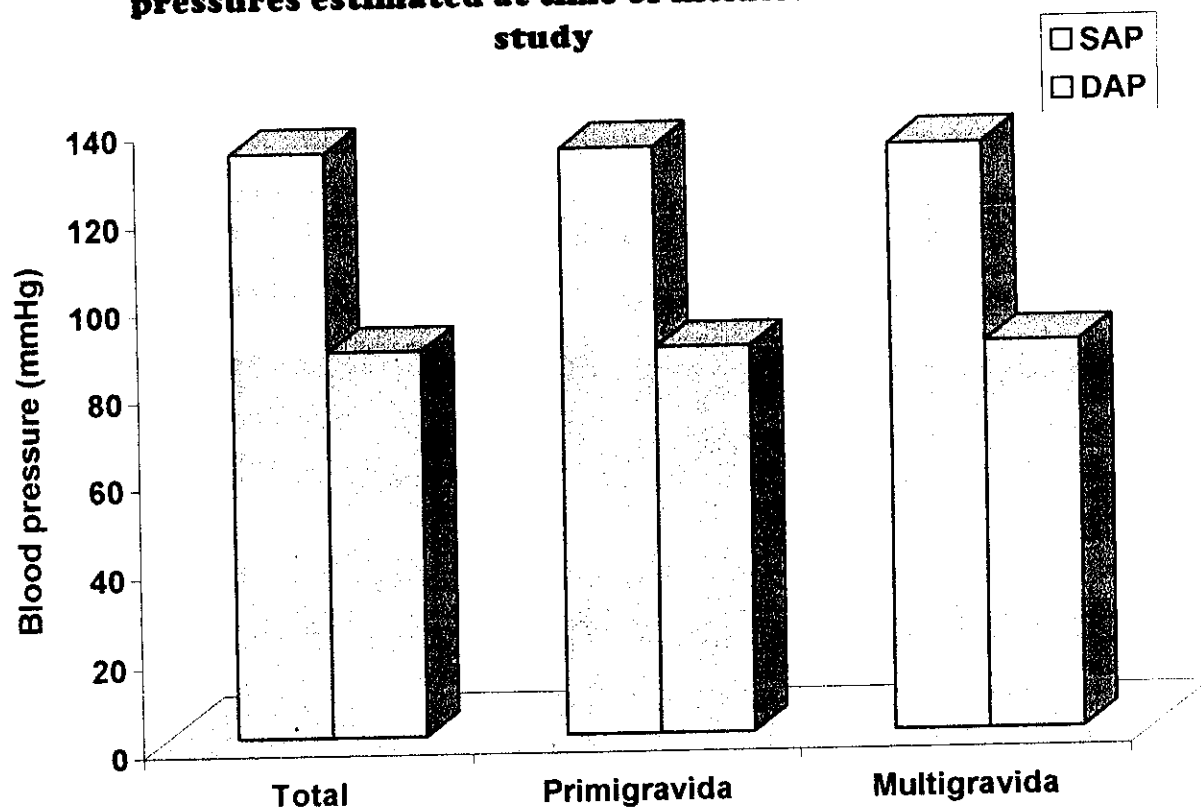
Fig. (7): Mean serum levels of creatinine, uric acid and albumin estimated at time of inclusion in the study
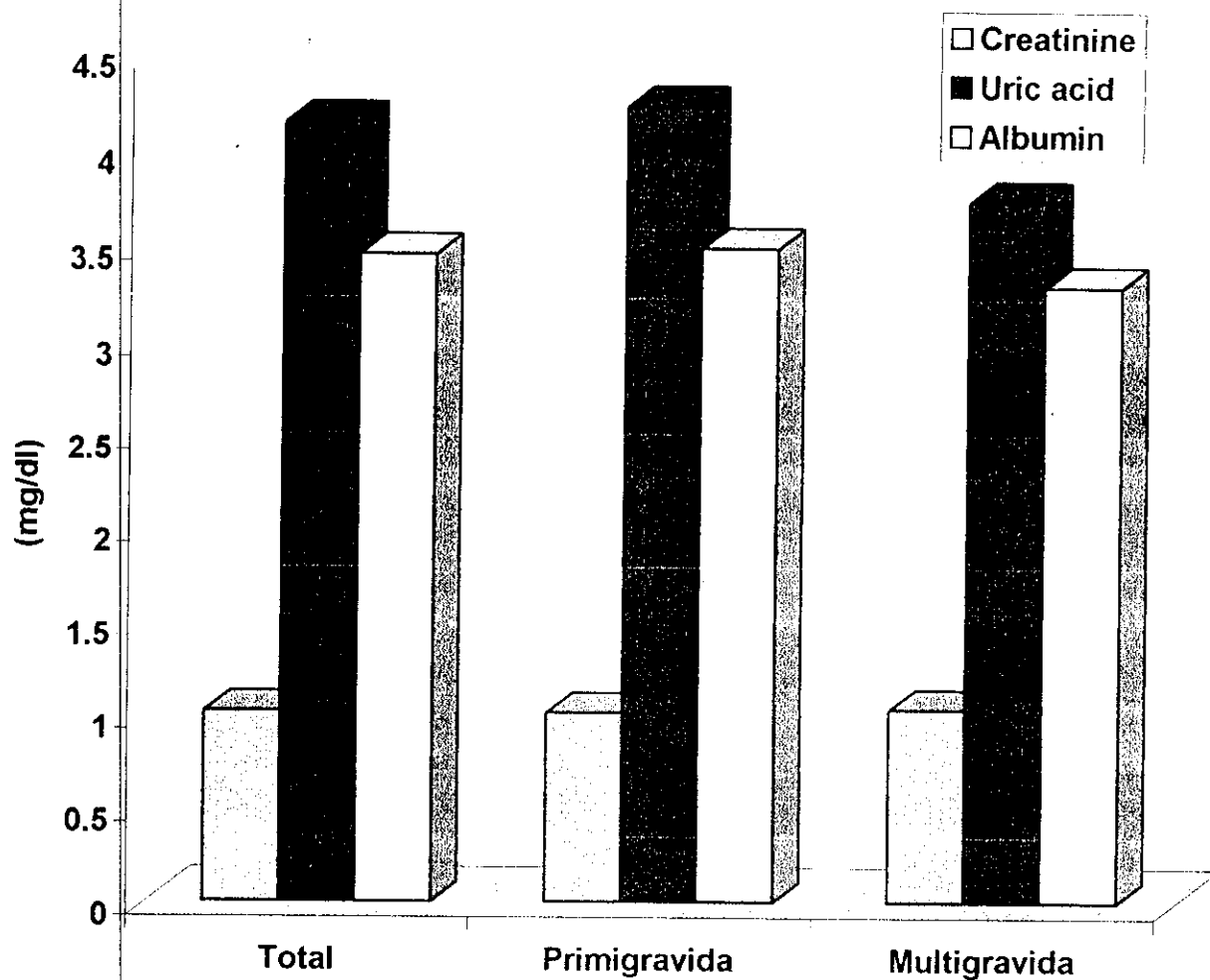
Table (4): Comparison between blood pressure measures obtained at 1st trimester versus that obtained at time of inclusion in the study

Parameter	Time of estimation	Total (n=100)	Primigravida (n=82)	Multigravida (n=18)
SAP (mmHg)	1st trimester	115±5.4 (105-125)	114.2±7.1 (100-125)	114.4±6.8 (100-125)
	Inclusion in study	142.4±3.9* (135-150)	142.5±4* (135-150)	142.2±3.1* (140-150)
DAP (mmHg)	1st trimester	74±4.3 (65-85)	74±4.4 (65-85)	73.9±3.7 (70-80)
	Inclusion in study	89±3.7* (90-100)	89±3.8* (90-100)	89.2±3.1* (90-100)

*: Significant versus measures determined at first trimester

Comparison of data determined at first trimester versus that obtained at time of inclusion in the study revealed significant (P<0.05) elevation of both systolic and diastolic blood pressures, (Fig. 8 & 9) both in primi and multigravida patients at inclusion in the study, despite the non-significant (P>0.05) difference between primi- and multigravida at both times of estimation, (Table 4).

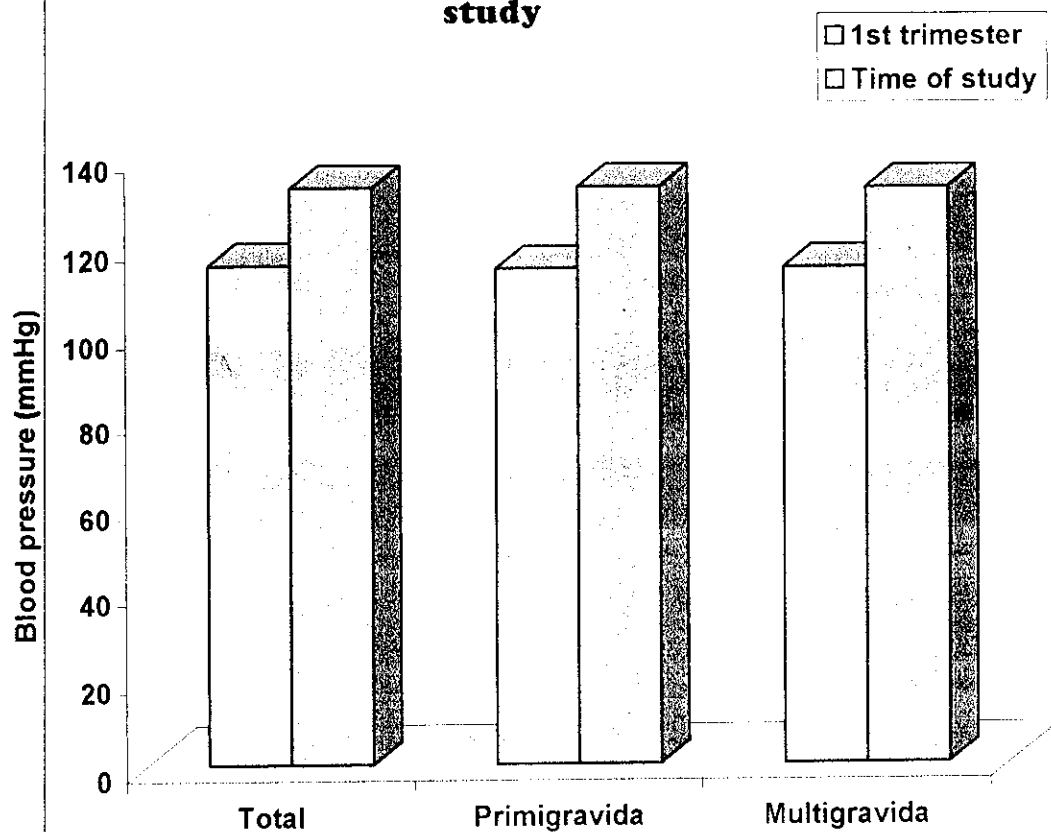## Fig. (8): Mean systolic blood pressure estimated at 1st trimester and at time of inclusion in the study

☐ 1st trimester
☐ Time of study

Fig. (9): Mean diastolic blood pressure estimated at 1st trimester and at time of inclusion in the study

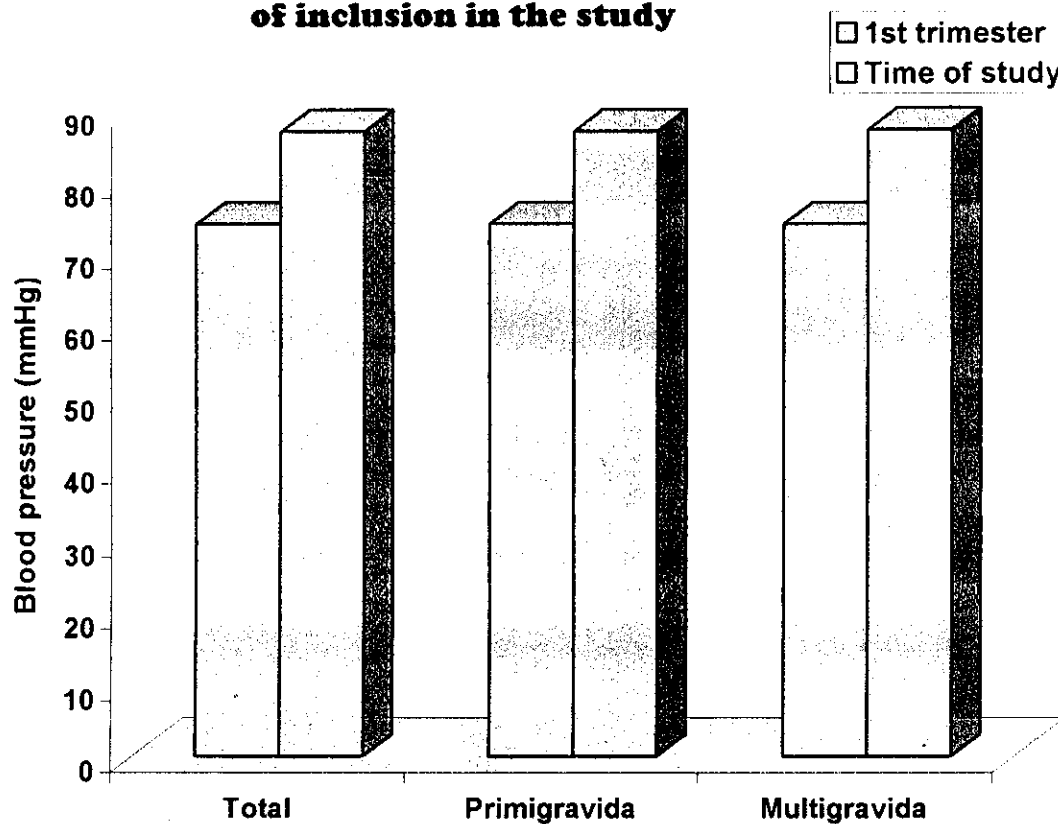
Legend: □ 1st trimester □ Time of study

Table (5): Comparison of laboratory findings obtained at 1st trimester versus that obtained at time of inclusion in the study

Parameter	Time of estimation	Total (n=100)	Primigravida (n=82)	Multigravida (n=18)
S. Creatinine (mg/dl)	1st trimester	1±0.18 (0.75-1.2)	1±0.18 (0.75-1.2)	0.98±0.19 (0.8-1.2)
	Inclusion in study	1.02±0.19 (0.8-1.2)	1.01±0.16 (0.8-1.2)	1.03±0.18 (0.8-1.2)
S. Uric acid (mg/dl)	1st trimester	3.8±0.85 (2.2-5.5)	3.8±0.83 (2.2-5.5)	3.8±1 (2.8-5.5)
	Inclusion in study	5.4±1.38* (3.6-7.8)	5.48±1.39* (3.6-7.8)	5.07±1.35 (3.6-7.15)
S. Albumin (mg/dl)	1st trimester	4.4±0.45 (3.7-5.3)	4.39±0.63 (3.7-5.3)	4.1±0.91 (3.8-5.3)
	Inclusion in study	4.27±0.65 (3.5-5.2)	4.23±0.71 (3.5-5.04)	4.19±0.87 (3.6-5)

*: Significant versus measures determined at first trimester

There was a significant increase of serum uric acid, (Fig. 10) at time of inclusion in the study compared to first trimester levels. On the other hand, there was a non-significant (P>0.05) increase and non-significant (P>0.05) decrease in serum levels of creatinine and albumin, respectively, at time of inclusion in the study in comparison to first trimester levels, (Fig. 11 & 12). Similarly, there was a significant (P<0.05) increase in serum uric acid and a non-significant (P>0.05) increase in serum creatinine levels determined at time of inclusion in the study compared to levels estimated at first trimester in primigravida patients, whereas the increase was non-significant (P>0.05) in multigravida patients with a non-significant (P>0.05) increase in levels determined in primi- compared to that determined in multigravida at both times, (Table 5).

Fig.(10): Mean serum uric acid estimated at 1st trimester and at time of inclusion in the study
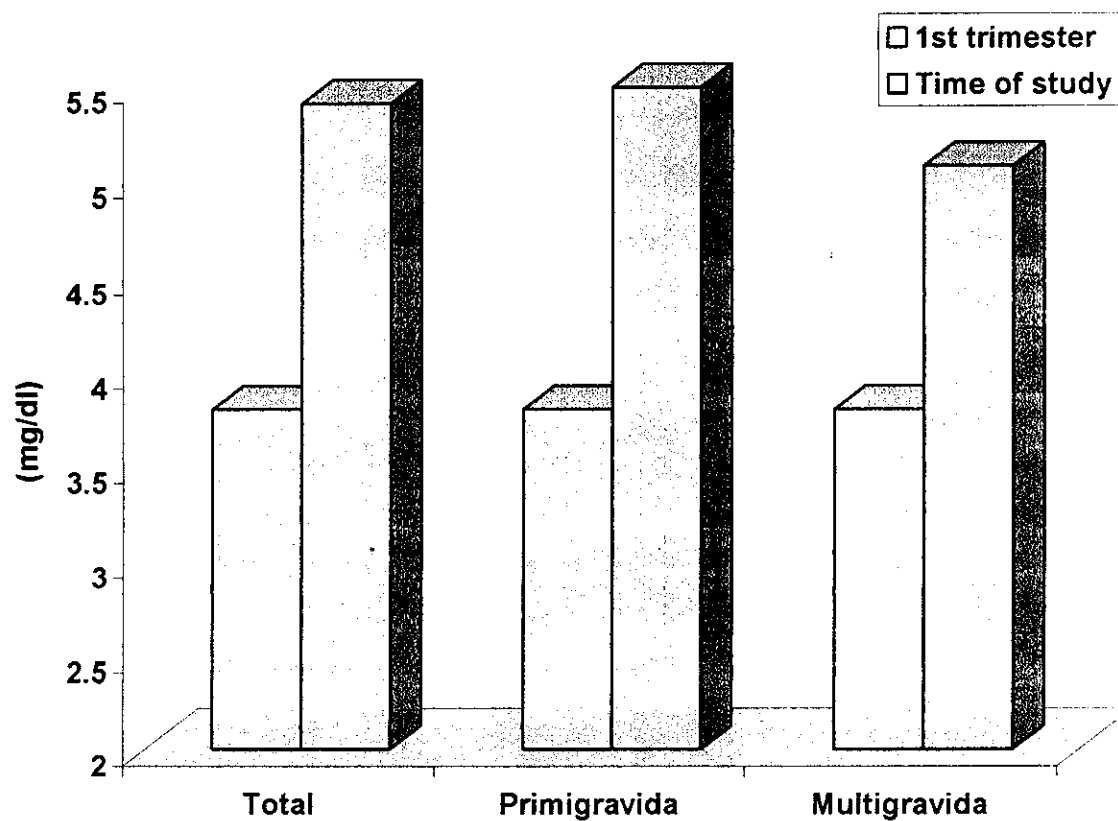
Fig. (11): Mean serum creatinine estimated at 1st trimester and at time of inclusion in the study
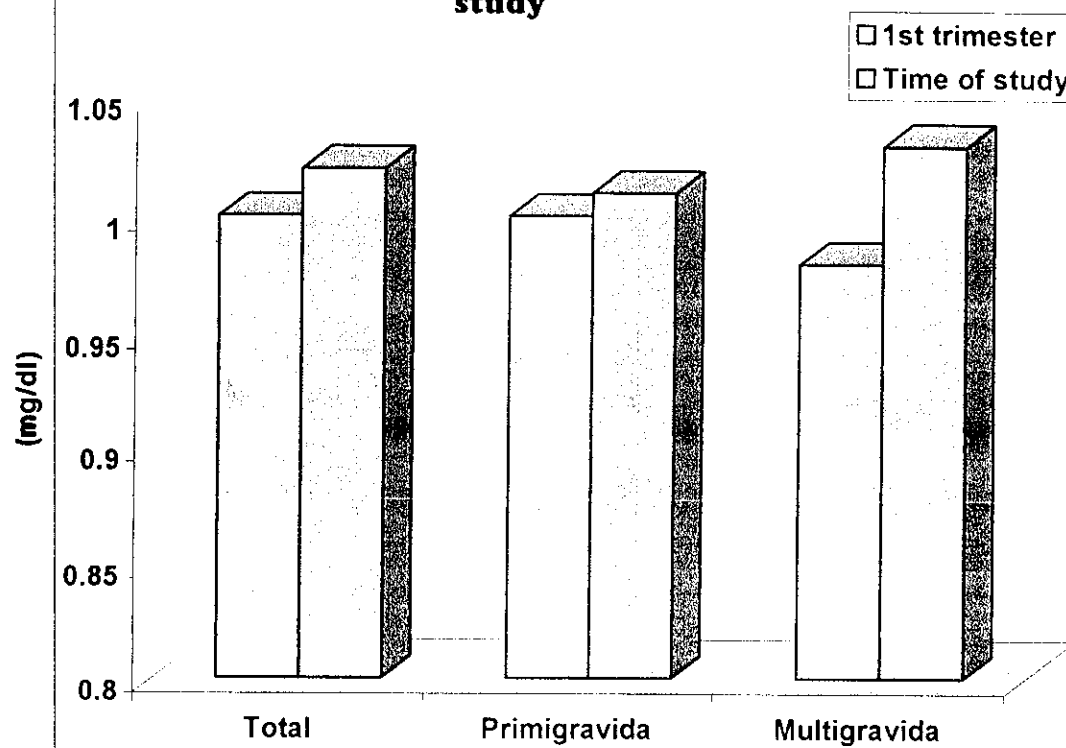
**Fig. (12): Mean serum albumin estimated at
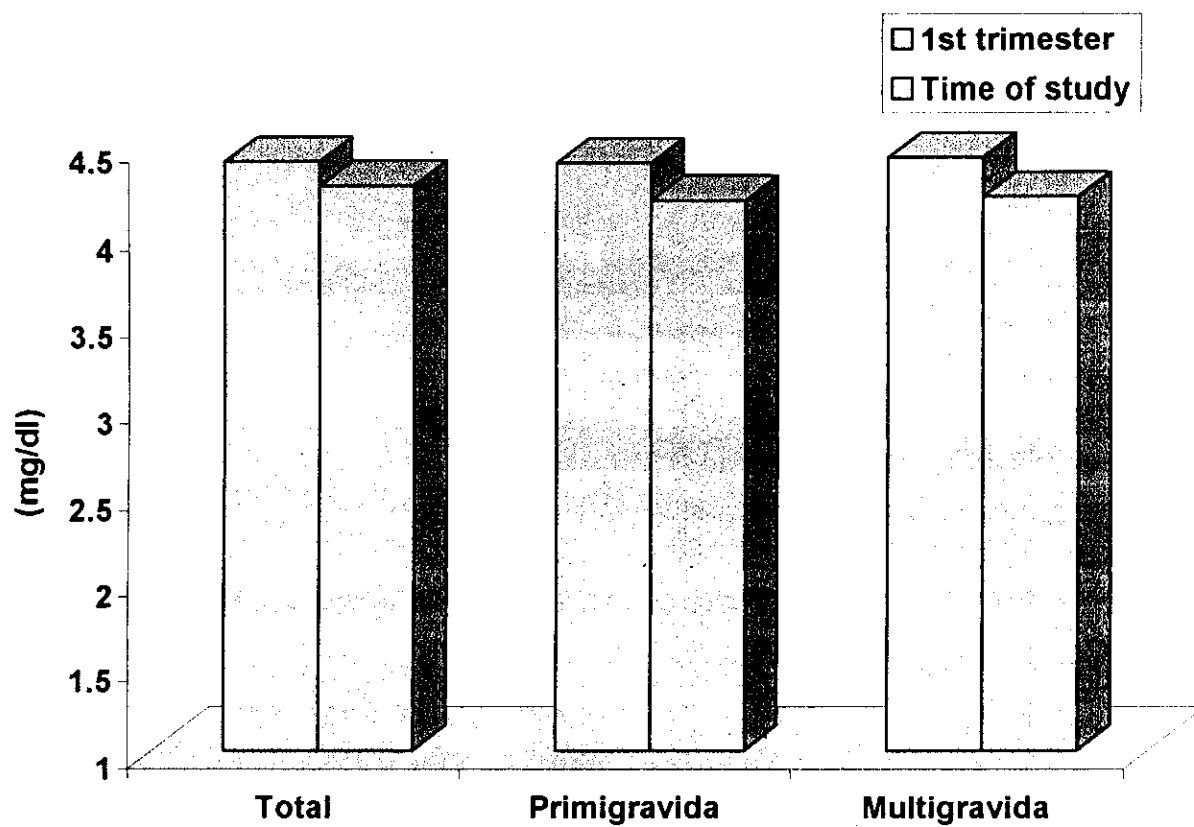1st trimester and at time of inclusion in the**

Table (6): Comparison between blood pressure measures obtained at 1st trimester versus that obtained at time of inclusion in the study of patients who developed pre-eclampsia and those with maintained GH only

		SAP (mmHg)		DAP (mmHg)	
		1st trimester	At inclusion in study	1st trimester	At inclusion in study
Total (n=100)	GH (n=82)	114.3±6.9 (100-125)	141.7±3.5* (135-150)	74±4.4 (65-85)	89.7±3.1* (90-100)
	PEc (n=18)	114.7±6.3 (100-125)	145.6±4.2*† (140-150)	73.9±3.9 (65-80)	98.3±2.4*† (90-100)
Primi (n=82)	GH (n=67)	114.3±7.3 (100-125)	141.6±3.6 (135-140)	74.2±4.6 (65-85)	89.7±2.9* (90-100)
	PEc (n=15)	114±6.3 (100-125)	146±4.3*† (140-150)	73.3±3.6 (65-80)	99.3±1.7*† (90-100)
Multi (n=18)	GH (n=15)	115±5.7 (105-125)	142±3.2* (140-145)	73.7±3.5 (70-80)	89±3.2* (90-100)
	PEc (n=3)	115±5 (110-120)	143.3±2.9* (140-150)	75±5 (70-80)	98.3±2.9* (95-110)

*: Significant versus measures determined at first trimester

†: Significant versus measures determined in patients wit'h GH

Through follow-up 18 (18%); 15 primi and 3 multigravida progressed to preeclampsia. The mean GA at time of being preeclapmtic was 31.6±2.1 weeks, range 28-35 weeks. The mean time elapsed since inclusion in the study (time of getting GH) till progress to preeclampsia was 4.7±3.1weeks; range 2-12 weeks. Four preeclamptic patients were found to have multiple pregnancies, whereas the other 14 patients had singleton fetus

Retrospective analysis of blood pressure measurements and laboratory findings at 1st trimester and at time of inclusion in the study of patients developed pre-eclampsia revealed a significant (P<0.05) increase of both systolic and diastolic pressures in patients developed pre-eclampsia in comparison to those developed GH, moreover, there was a significant increase (P<0.05) of both systolic and diastolic pressures in preeclamptic primigravida compared to primigravida developed GH. On the other hand, systolic and diastolic pressures showed a non-significant (P>0.05) increase in pre-eclamptic multigravida compared to those developed GH, (Table 6).

Fig. (13): Mean systolic blood pressure estimated in patients developed pre-eclampsia versus those with GH
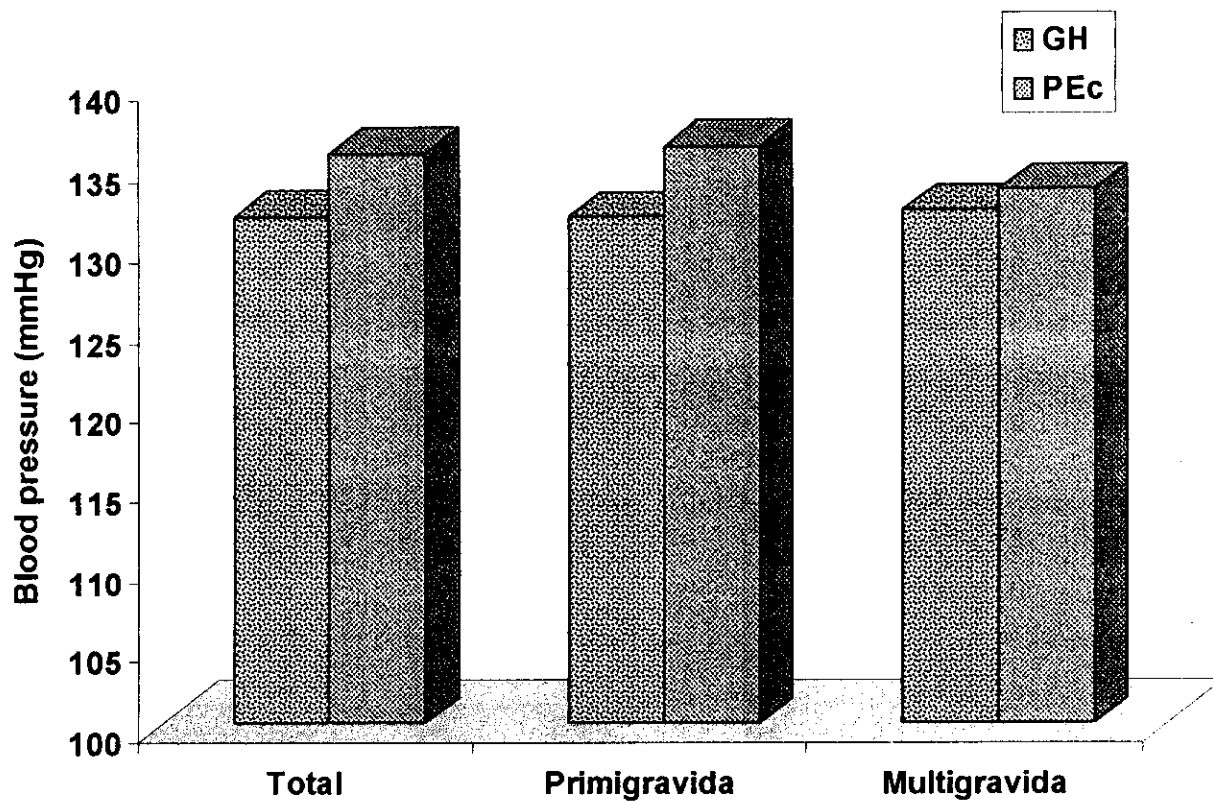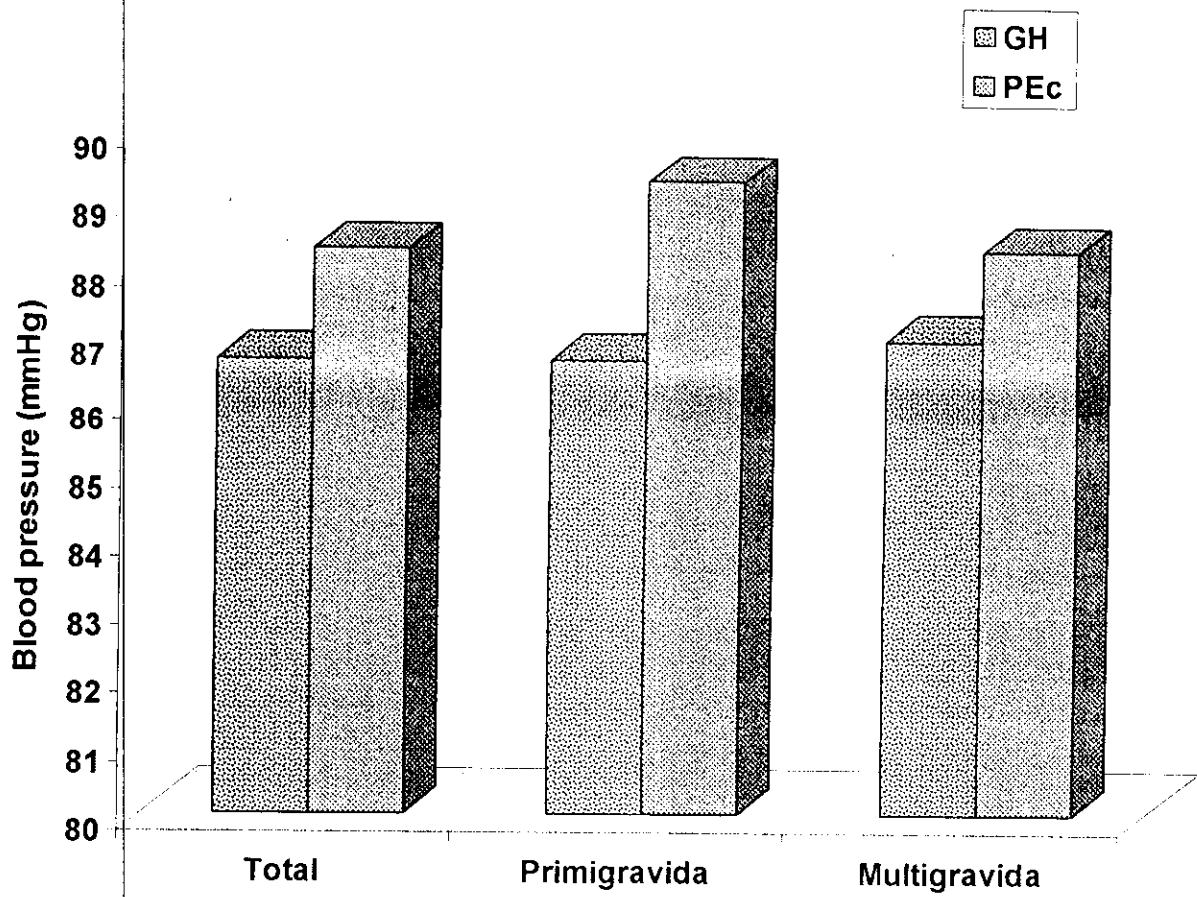
Fig. (14): Mean diastolic blood pressure estimated in patients developed pre-eclampsia versus those with GH

Serum uric acid showed a significant (P<0.05) increase at development of both GH and pre-eclampsia compared to levels detected at first trimester, furthermore, serum uric acid showed a significant (P<0.05) increase in patients developed pre-eclampsia compared to those with GH either at 1st trimester estimates or at time of development of pre-eclampsia. However, these changes were significant (P<0.05) in primigravida and non-significant (P>0.05) in multigravida women, (Fig. 15). On contrary, serum creatinine showed a non-significant (P>0.05) increase in all study participants compared to the estimates determined at 1st trimester, with a non-significant increase in serum creatinine levels determined in women developed pre-eclampsia compared to those maintained with GH, either primi or multipara, (Fig. 16). Similarly, serum albumin showed a non-significant (P>0.05) decrease at time of development of GH and pre-eclampsia compared to measures determined at 1st trimester with a non-significant (P>0.05) decrease in pre-eclamptic women compared to those with GH.

Table (7): Comparison between laboratory findings obtained at 1st trimester versus that obtained at time of inclusion in the study of patients who developed pre-eclampsia and those maintained GH only

		S. Creatinine		S. Uric acid		S. Albumin	
		1st trimester	At study inclusion	1st trimester	At study inclusion	1st trimester	At study inclusion
Total (n=100)	GH (n=82)	0.98±0.19 (0.75-1.2)	1±0.17 (0.8-1.2)	3.5±0.91 (2.2-5.5)	5.17±1.28* (3.6-7.8)	4.5±0.45† (3.8-5.2)	4.4±0.44 (3.7-5.1)
	PEc (n=18)	1.03±0.17 (0.8-1.2)	1.07±0.14 (0.8-1.2)	4.14±0.98† (2.2-5.5)	6.5±1.37*† (3.7-7.8)	4.4±0.5 (3.7-5.3)	4.2±0.65 (3.5-5.3)
Primi (n=82)	GH (n=67)	0.99±0.18 (0.75-1.2)	1±0.17 (0.8-1.2)	3.55±0.8 (2.2-5.5)	5.24±1.32* (3.6-7.8)	4.66±0.43 (3.8-5.2)	4.54±0.41 (3.6-4.9)
	PEc (n=15)	1.03±0.17 (0.8-1.2)	1.08±0.13 (0.8-1.2)	4.07±0.7† (2.2-5.5)	6.54±1.29†* (3.9-7.8)	4.36±0.43† (3.7-5.3)	4.14±0.61† (3.5-5.04)
Multi (n=18)	GH (n=15)	0.97±0.17 (0.8-1.2)	1.03±0.18 (0.8-1.2)	3.76±0.9 (2.8-5.5)	4.89±1.19 (3.6-7.15)	4.44±0.51 (3.8-5.3)	4.22±0.49 (3.6-5)
	PEc (n=3)	1.03±0.21 (0.8-1.2)	1.04±0.21 (0.8-1.2)	4.5±1.48 (2.8-5.5)	6±1.99 (3.7-7.15)	4.3±0.52 (4-4.9)	4.09±0.5 (3.8-4.7)

†: *Significant versus measures determined in patients with GH*

Fig. (15): Mean serum creatinine estimated in patients with GH versus those developed pre-eclampsia
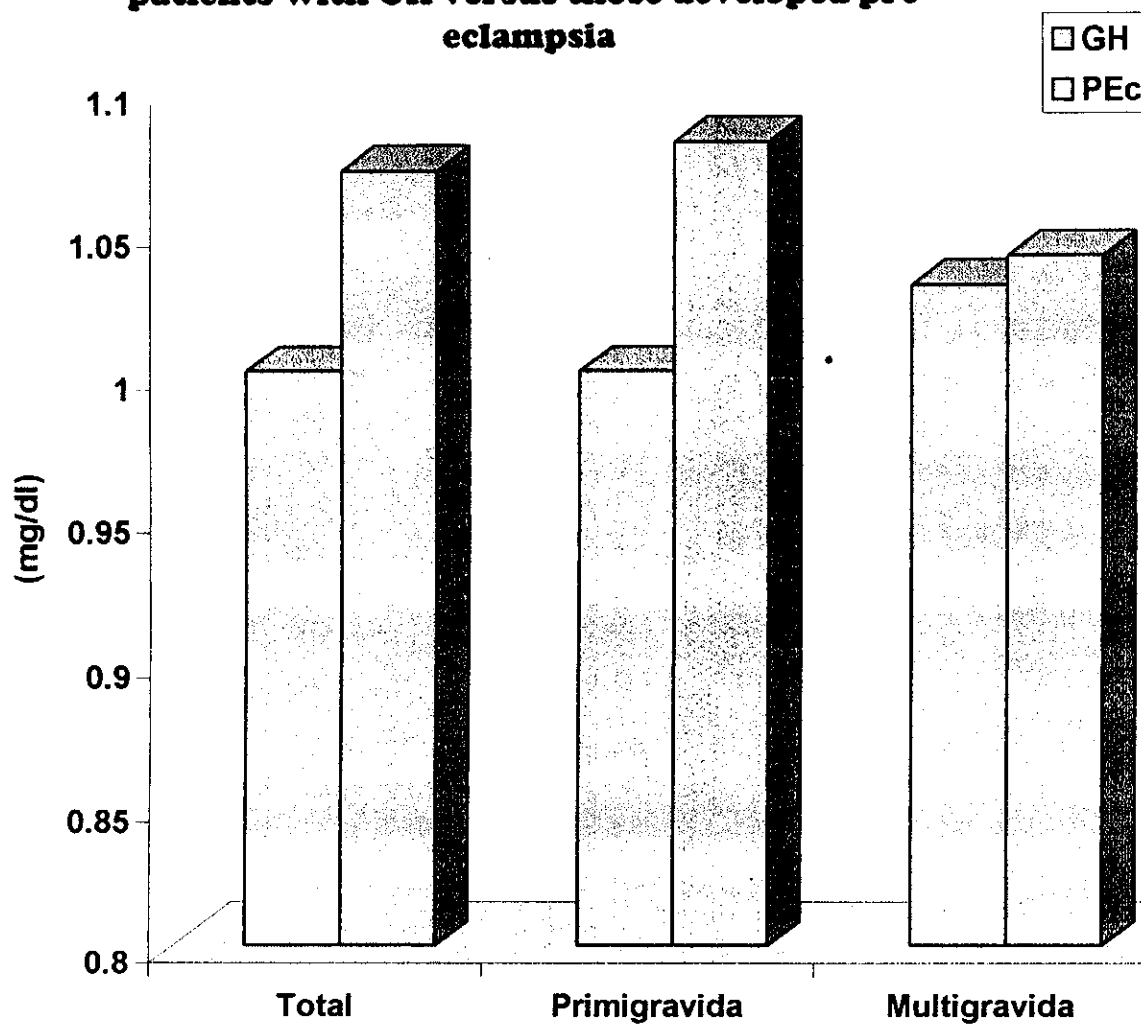
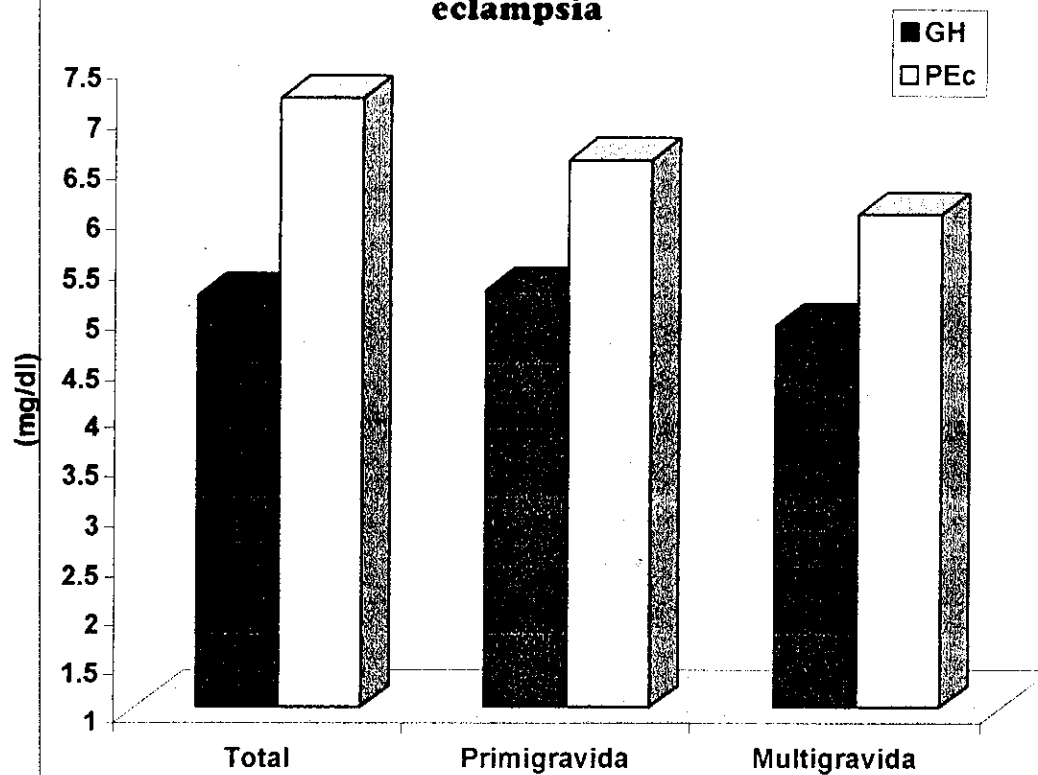**Fig. (16): Mean serum uric acid estimated in patients with GH versus those developed pre-eclampsia**

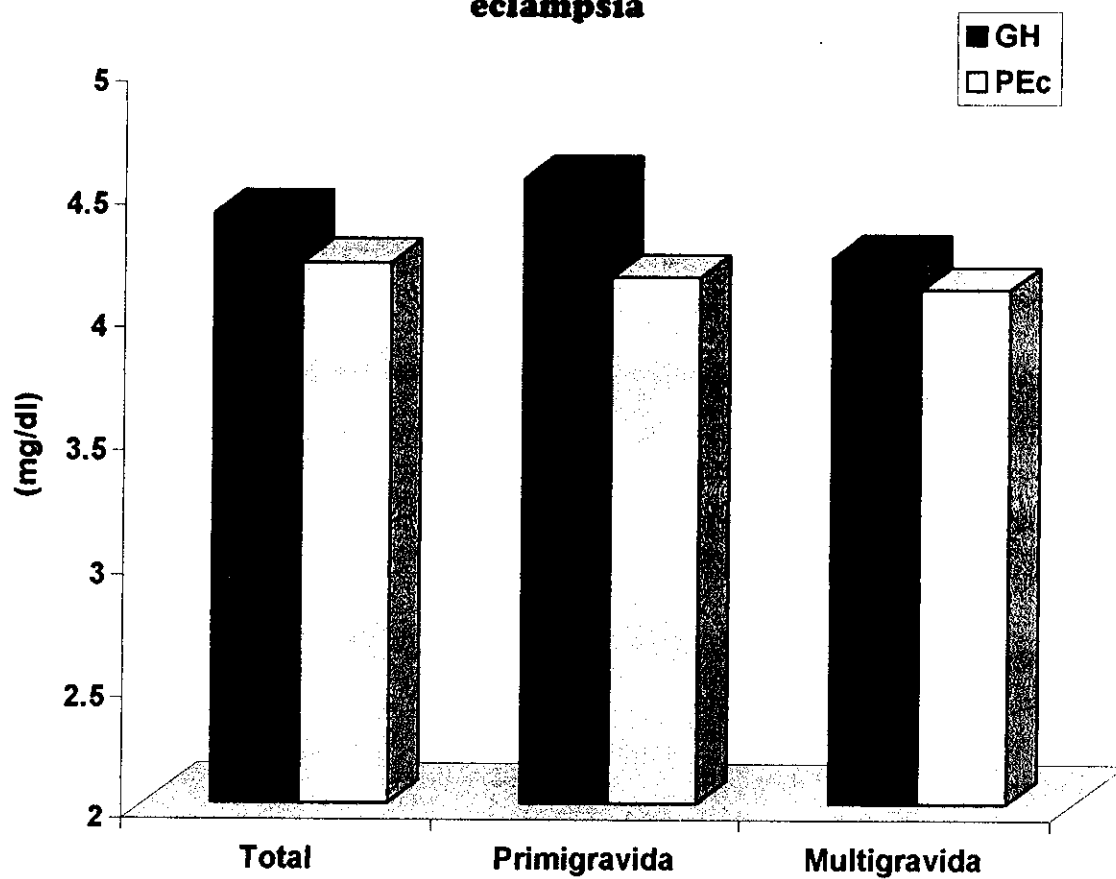**Fig. (17): Mean serum albumin estimated in patients with GH versus those developed pre-eclampsia**

Table (8): Pre-eclamptic patients' distribution according to the severity of proteinuria

	No	Severity
Total (n=18)	9	+
	6	++
	3	+++
Primi (n=15)	7	+
	5	++
	3	+++
Multi (n=3)	2	+
	1	++

All pre-eclamptic patients had proteinuria, 9 patients (7 primi and 2 multi) had mild (+) proteinuria, 6 patients (5 primi and 1 multi) had moderate (++) proteinuria and only 3 primi had severe (+++) proteinuria, (Table 8, Fig. 18).

Fig. (19): Mean serum levels of uric acid and albumin in preeclamptics according to number of fetuses
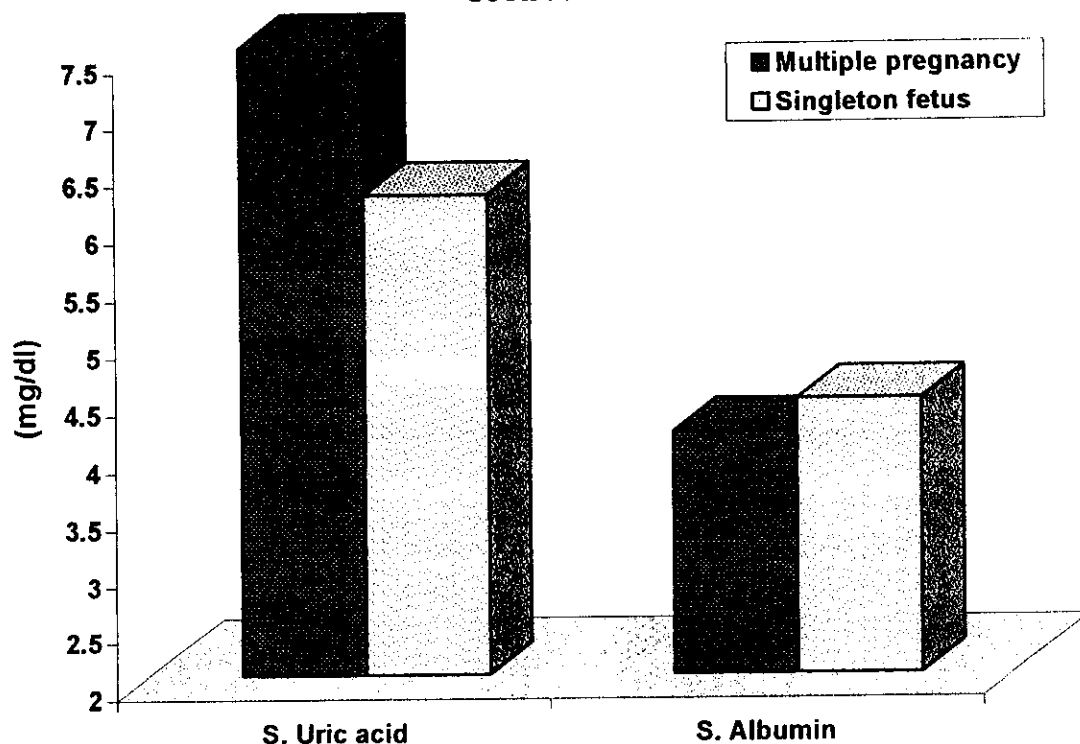
There was a significant increase (P<0.05) in serum uric acid in preeclamptics with multiple pregnancy, (7.5±0.38; range 7.15-7.8 mg/dl) in comparison to preeclamptics with singleton fetus, (6.2±1.4; range 3.7-7.8 mg/dl). However, serum albumin showed a non-significant decrease (P>0.05) decrease in preeclamptics with multiple pregnancy, (4.12±0.46; range 3.2-4.6 mg/dl) in comparison to those with singleton fetus, (4.4±0.39; range 3.8-4.6 mg/dl), (Fig. 19).

Table (9): Correlation coefficient between the occurrence of pre-eclampsia and clinical and laboratory findings

	r	P
Systolic blood pressure	0.517	<0.001
Diastolic blood pressure	0.345	=<0.001
Mean blood pressure	0.407	<0.001
Serum uric acid	0.357	=0.001
Gestational age	-0.331	=0.001
Serum creatinine	0.148	>0.05
Serum albumin	-0.131	>0.05

There was a positive significant correlation between the occurrence of pre-eclampsia and the following parameters recorded at time of inclusion in the study:

1. Systolic blood pressure, (r=0.517, P<0.001), (Fig. 20).
2. Diastolic blood pressure, (r=0.345, P=0.001), (Fig. 21).
3. Mean Blood pressure, , (r=0.407, P<0.001), (Fig. 22).
4. Serum uric acid levels, (r=0.357, P=0.001), (Fig. 23).

Whereas there was a negative significant correlation between the occurrence of preeclampsia and gestational age at presentation with gestational hypertension, (r=-0.331, P=0.001), (Fig. 24).

On the other hand, there was non-significant correlation between occurrence of pre-eclampsia and serum creatinine levels, (r=0.148, P>0.05) and serum albumin levels and (r=-0.131, P>0.05), (Table 9).

Fig. (20): The correlation between the occurrence of preeclampsia (PE) and systolic arterial pressure (SAP) at time of enrollment in the study
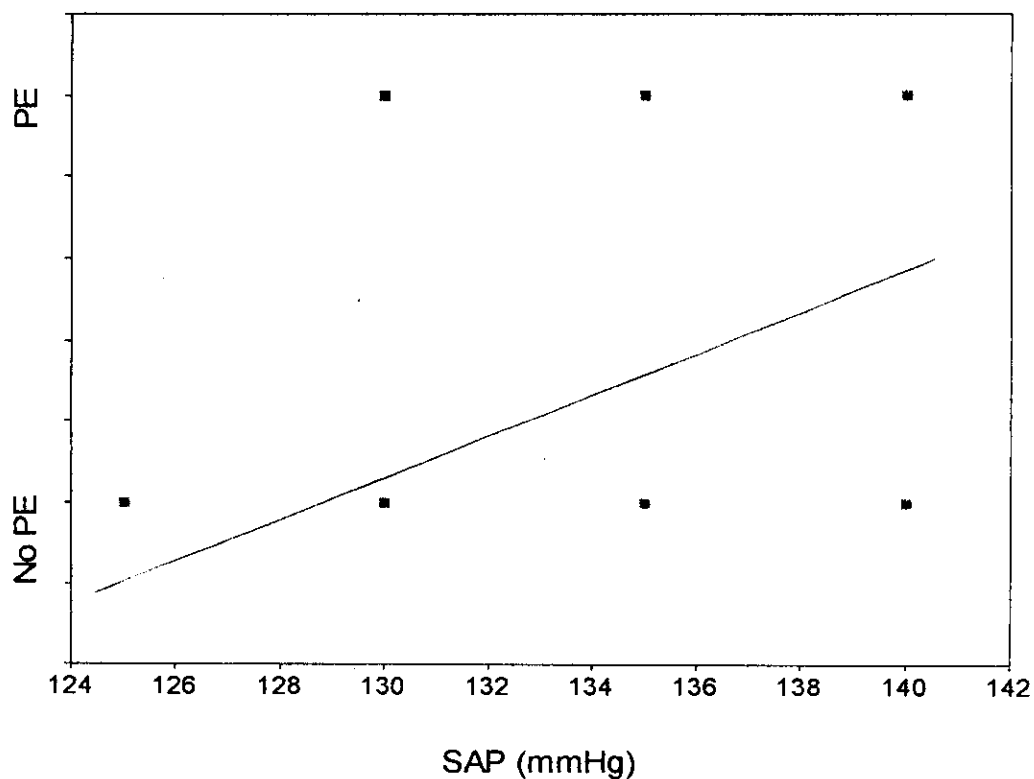

SAP (mmHg)

Fig. (21): The correlation between the occurrences of preeclampsia (PE) and diastolic arterial pressure (DAP) at time of enrollment in the study
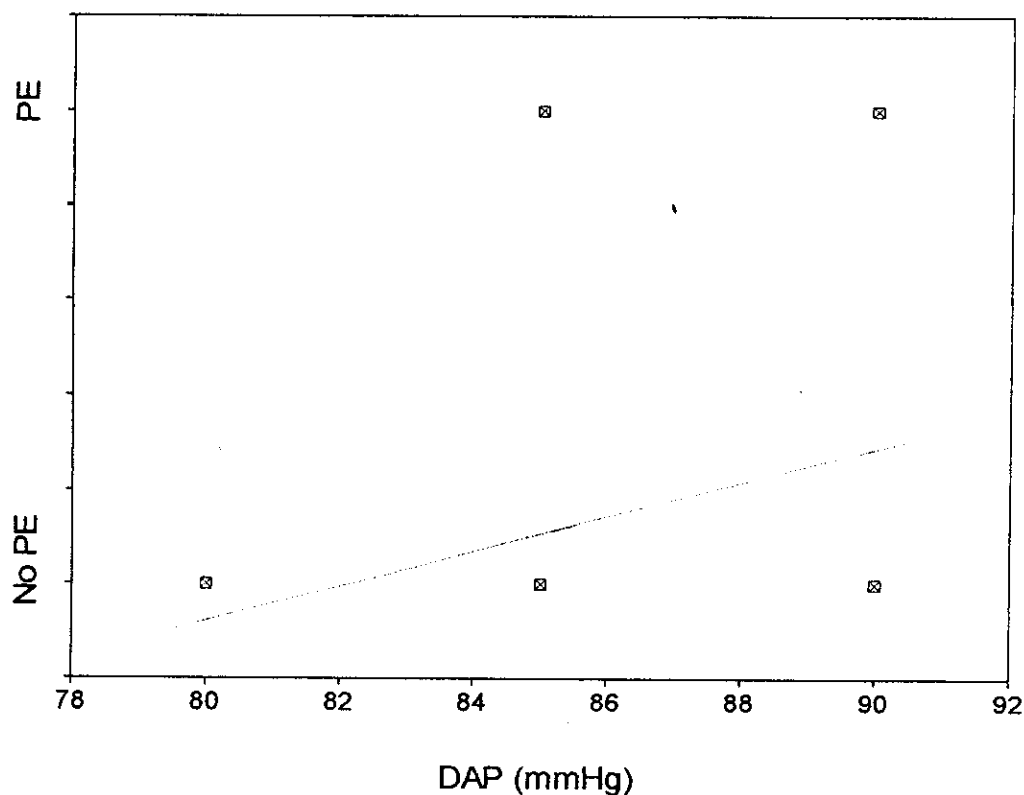

DAP (mmHg)

Fig. (22): The correlation between the occurrences of preeclampsia (PE) And mean arterial pressure (MAP) at time of enrollment in the study
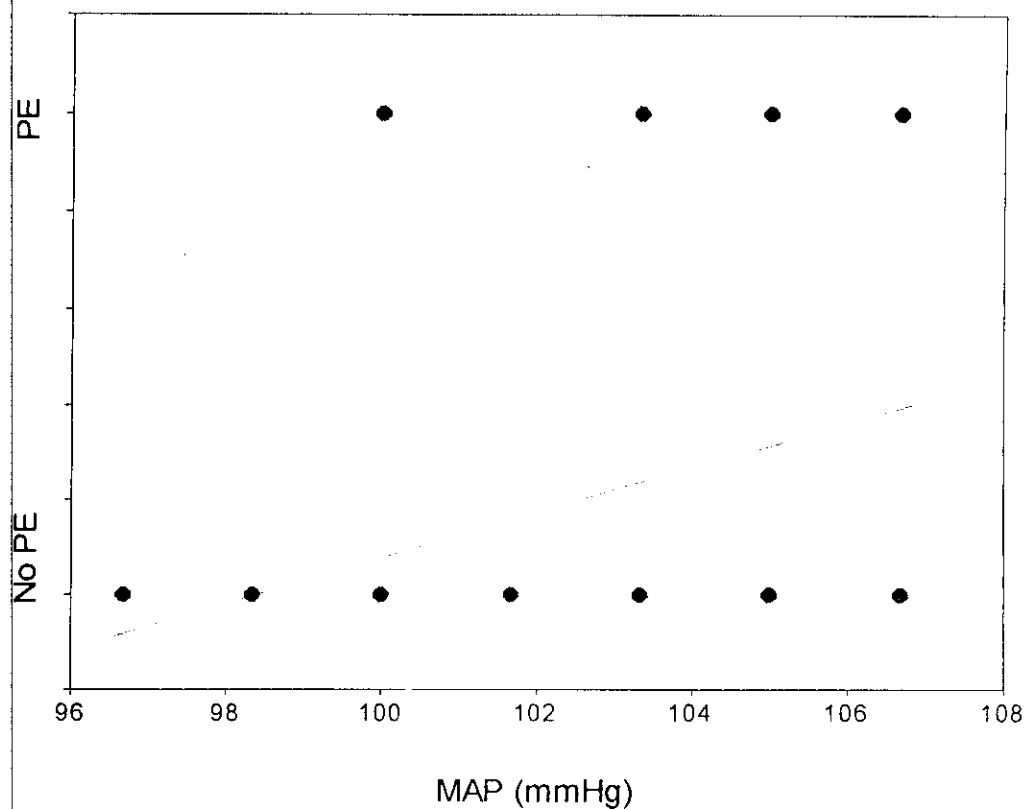

MAP (mmHg)

Fig. (23): The correlation between the occurrences of preeclampsia (PE) and mean serum uric acid (mg/dl) at time of enrollment in the study
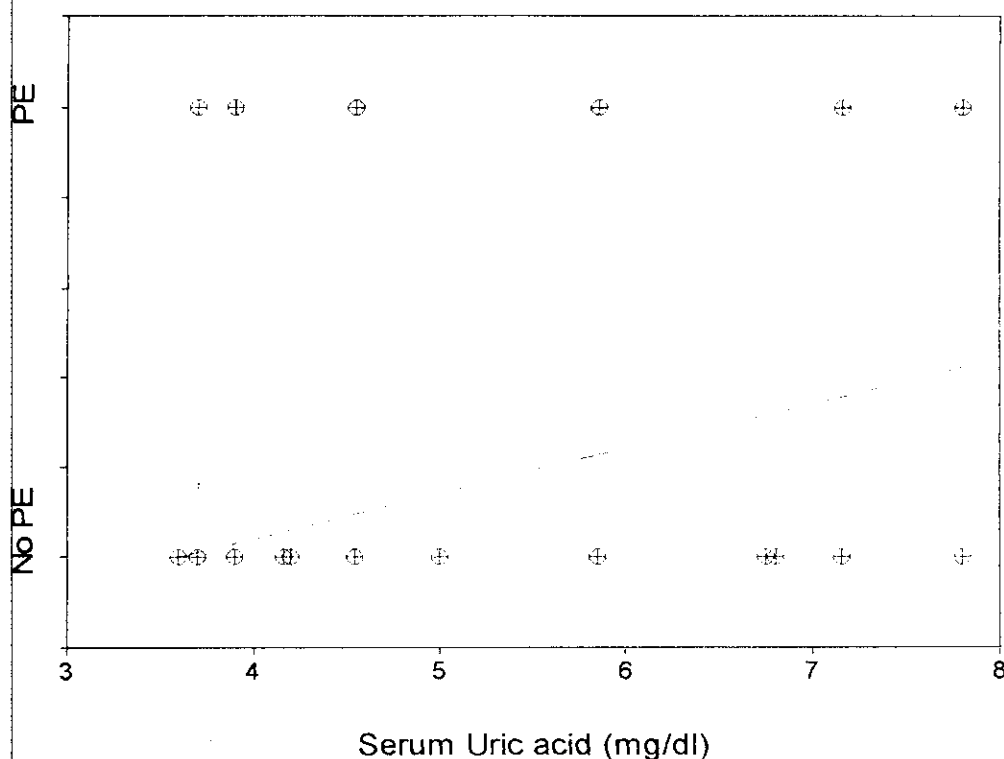

Serum Uric acid (mg/dl)

Fig. (24): The correlation between the occurrences of preeclampsia (PE) And gestational age (GA) at time of enrollment in the study
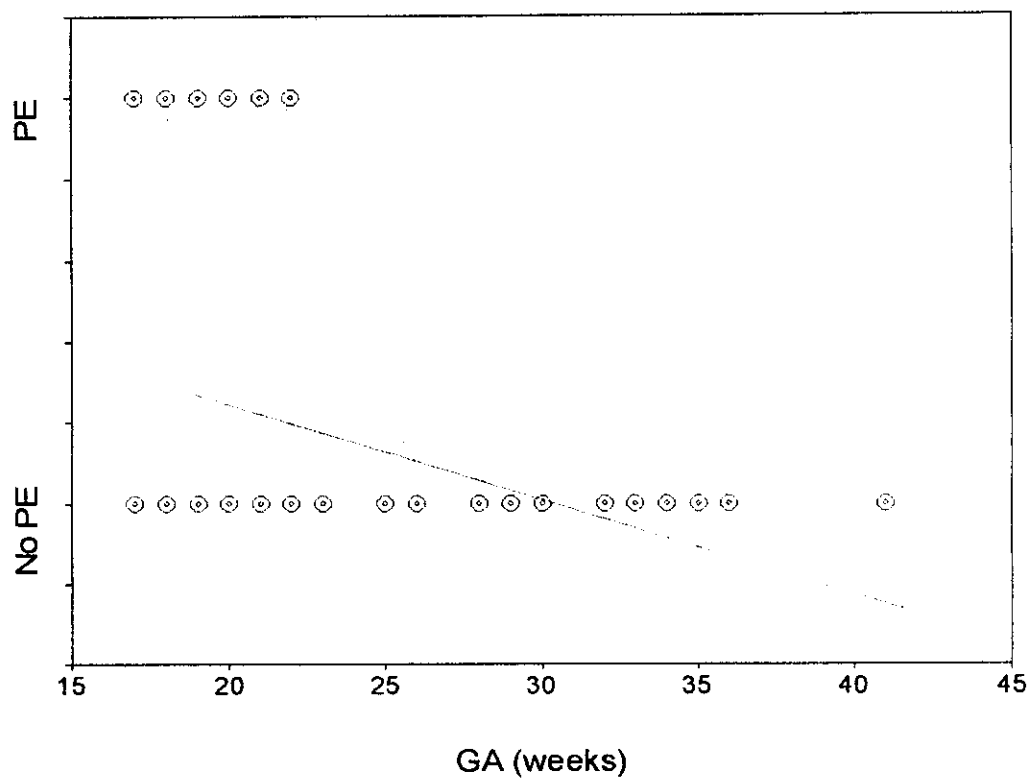
Table (10): The most significant predictors of occurrence of PE as defined by the logistic stepwise regression analysis

Model	Predictors	Standardized Coefficient (β)	t	P
Model I	SAP (mmHg)	0.430	4.991	<0.001
	GA (weeks)	-0.200	-2.323	=0.022
	S. Uric acid (mmHg)	0.189	2.149	=0.034
Model II	SAP (mmHg)	0.472	5.525	<0.001
	GA (weeks)	-0.244	-2.854	=0.005
Model III	SAP (mmHg)	0.517	5.948	<0.001

Application of logistic regression (stepwise exclusion method) revealed that the most significant predictors of occurrence of pre-eclampsia are the estimation of systolic blood pressure, gestational age and serum uric acid level at time of enrollment, (Table 10).

Table (11): GH cases distribution according to GA cutoff points

	Value	Total		Preeclampsia	
		No.	Value	No.	Value
P_1 at 50th percentile	<29 W	43	30.6±1.2	9	30.4±1.3
P_2 at 75th percentile	≥31 W	25	29.7±0.56	6	29.7±0.52
P_3 at 90th percentile	≥34 W	11	35±0.45	4	34.7±0.5
P_1-P_2	29-<31 W	29	33±1.7	7	33.6±1.62
P_1-P_3	29-<34 W	46	24.2±2.4	5	24.2±1.9

P: cutoff point

Table (12): Preeclampsia diagnostic yield at 3 cutoff points of GA

	Value	Sensitivity	Specificity	NPV	Accuracy
P_1 at 50th percentile	<29 W	22.2	76.8	84.2	79
P_2 at 75th percentile	≥31 W	38.9	73.1	84.2	76
P_3 at 50th percentile	≥34 W	27.8	50	75.9	46

Comparison of multiple cutoff points for various parameters revealed the following: Gestational age at time of inclusion in the study, considering P_1 at the 50th percentile (P_1<29 W), P_2 at the 75th percentile (P_2≥31 W) and P_3 at the 90th percentile (P_3≥34 W), there were 43 patients had developed GH at GA at P_1, 25 patients developed GH at GA at P_2 and 11 patients developed GH at GA at P_3, moreover, there were 29 patients developed GH at GA in range between P_1 and P_2 and 46 patients developed GH at GA in range between P_1 and P_3. Depending on GA at presentation with GH, preeclampsia could be predicted at P_1 with sensitivity rate of 22.2% and accuracy rate of 79% and could exclude the possibility of getting preeclamptic with NPV of 84.2%, whereas depending on GA at P_2 preeclampsia could be predicted with sensitivity of 38.9%, specificity rate of 73.1% and accuracy rate of 76% and could exclude that possibility with NPV of 84.2%. On the other hand, depending on GA at P_3 the possibility of being preeclamptic could be predicted with sensitivity 27.8%, specificity 50%, and accuracy rate 46% and could exclude that possibility with NPV of 75.9%, (Table 13, Fig. 20). Comparison of diagnostic yield at the three cutoff points showed that there was a significant difference between the diagnostic yield at P_2 compared both to that defined at P_1 (X^2=5.42, P<0.01) and to that determined at P3, (X^2=4.95, P<0.01), (Table 11, Fig. 21).

Fig. (25): GH patients distribution according to cutoff values of GA

Fig. (25): GH patients distribution according to cutoff values of GA

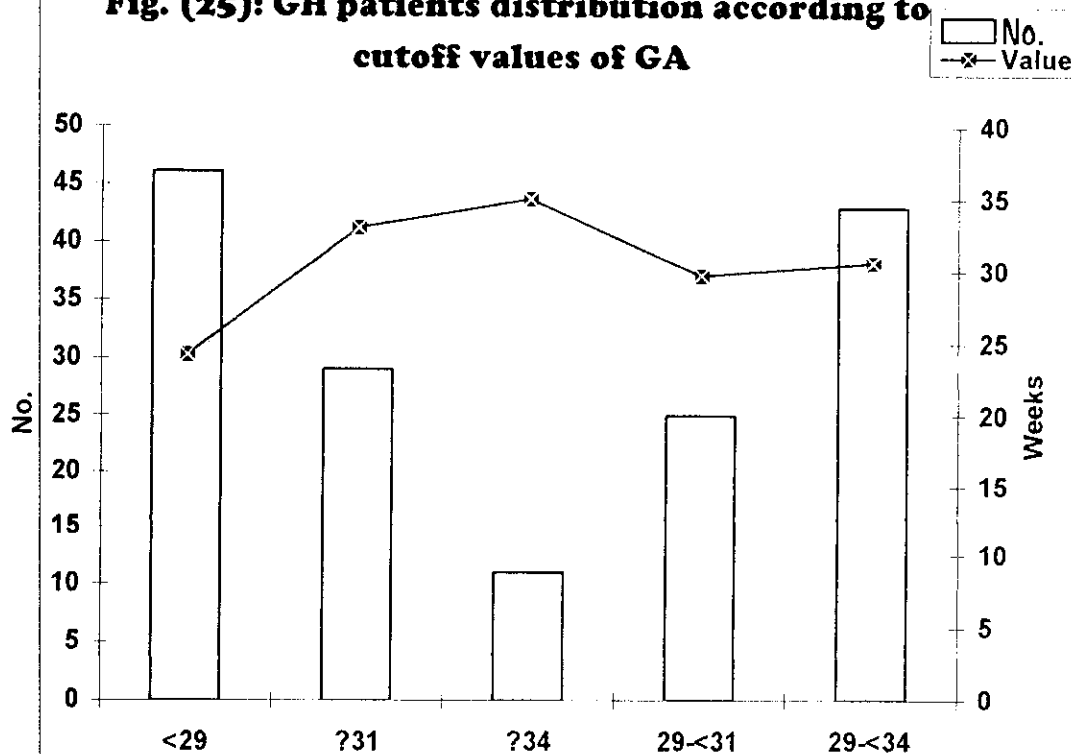## Fig. (26): Diagnosis of preeclampsia at three cutoff points of GA
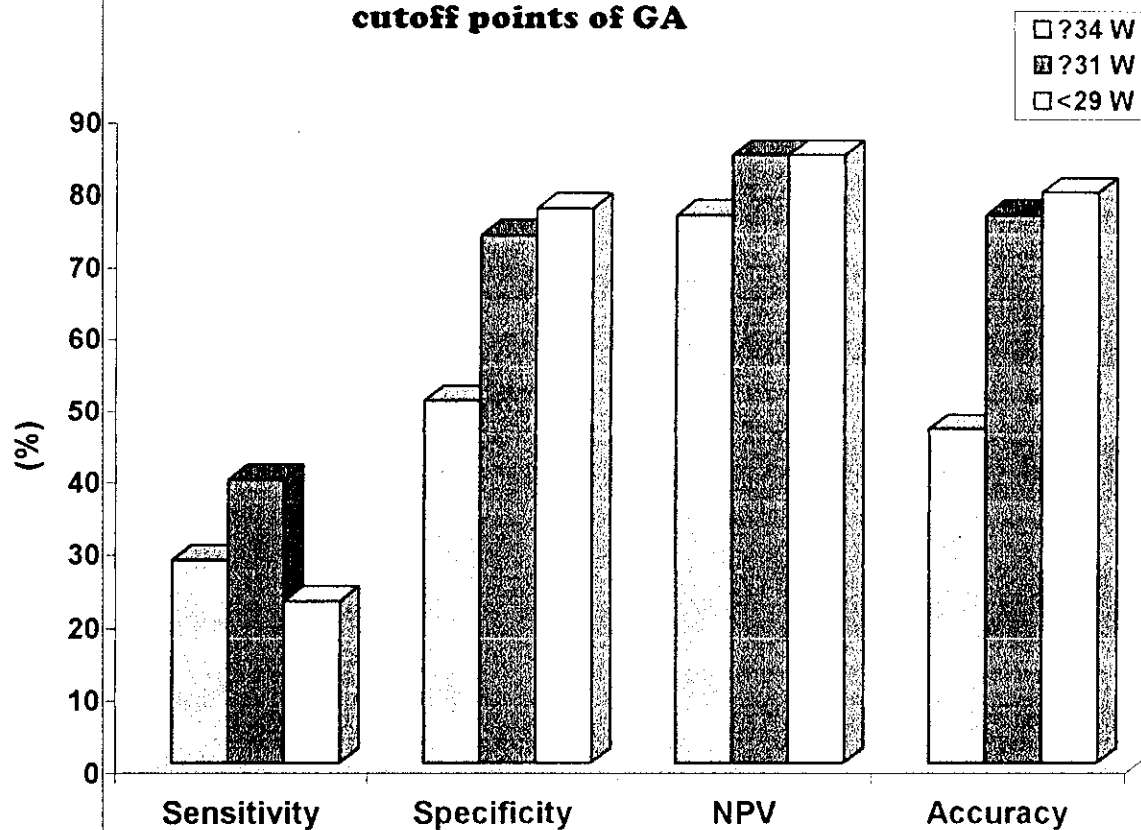

Fig. (26): Diagnosis of preeclampsia at three cutoff points of GA

Table (13): GH cases distribution according to serum levels of uric acid

	Value	Total		Preeclampsia	
		No.	Value	No.	Value
P_1 at 50th percentile	<4.55	19	3.77±0.22	2	3.8±0.14
P_1-P_2	4.55-<7.15	54	5.08±0.79	4	5.2±0.75
P_2 at 90th percentile	≥7.15	27	7.27±0.26	12	7.31±0.29

P: cutoff point

Table (14): Preeclampsia diagnostic yield at 2 cutoff points of serum uric acid

	Value	Sensitivity	Specificity	NPV	Accuracy
P_1 at 50th percentile	<4.55	66.7	83.7	92.8	80.9
P_2 at 90th percentile	≥7.15	88.9	20.7	89.5	33

For serum uric acid levels determined at time of inclusion in the study, considering P_2 at the 90th percentile of the total serum uric acid values (P_1≥7.15 mg/dl) and P_2 at the 50th percentile (P_1<4.55 mg/dl) there were 27 patients had serum uric acid at P_2, 19 patients with serum uric acid at P_1 and 54 patients had serum uric acid in range between P_1 and P_2. There were 12 preeclamptic women with serum uric acid at P_2, whereas 4 had serum uric acid in range between P_{1-2} and only 2 patients at P_1, (Table 12, Fig. 22). Thus, comparison of diagnostic yield at cutoff point at 7.15 mg/dl versus that at 4.55 mg/dl revealed that considering serum level of uric acid ≥7.15 mg/dl could exclude the probability of progression to preeclampsia with NPV of 92.8%, specificity rate of 83.7% and accuracy rate of 80.9%, whereas at serum level <4.55 despite the higher sensitivity rate (88.9%), it is not specific (specificity rate 20.7%) nor accurate (accuracy rate 33%), (Table 13, Fig. 23).

Fig. (27): GH patients distribution according to cutoff values of serum uric acid
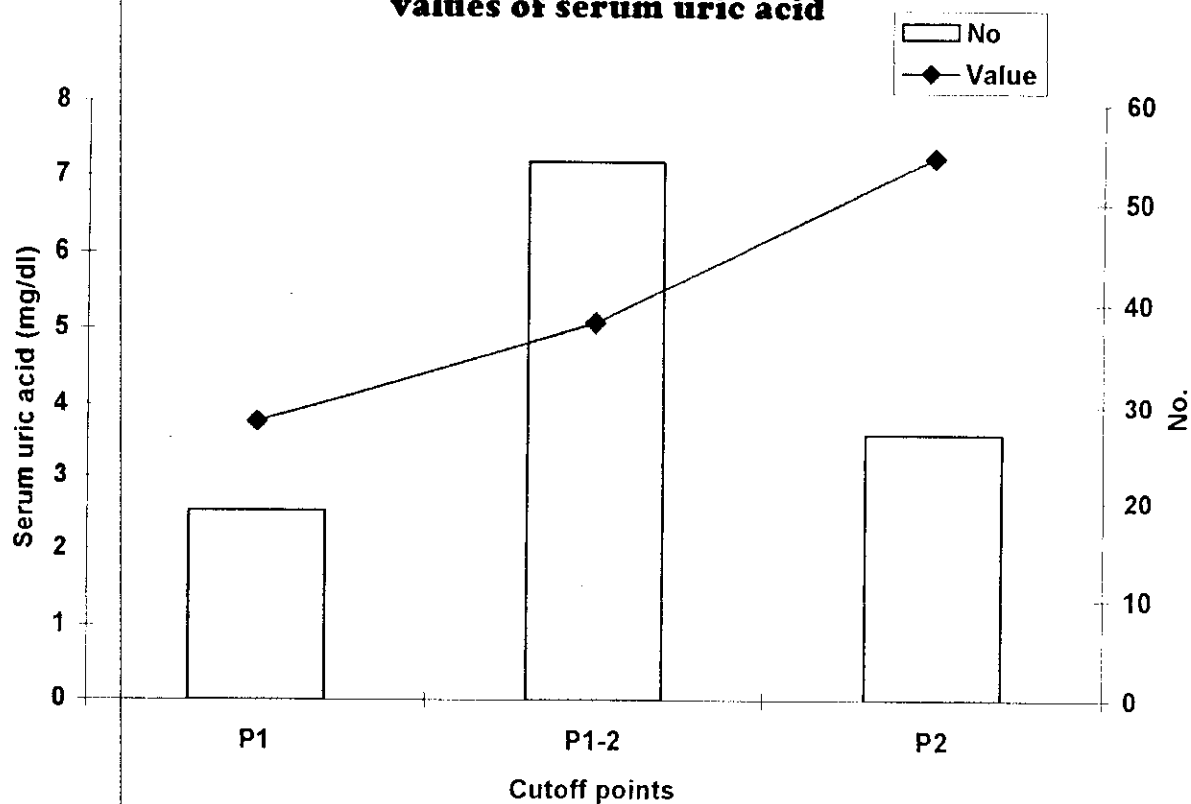

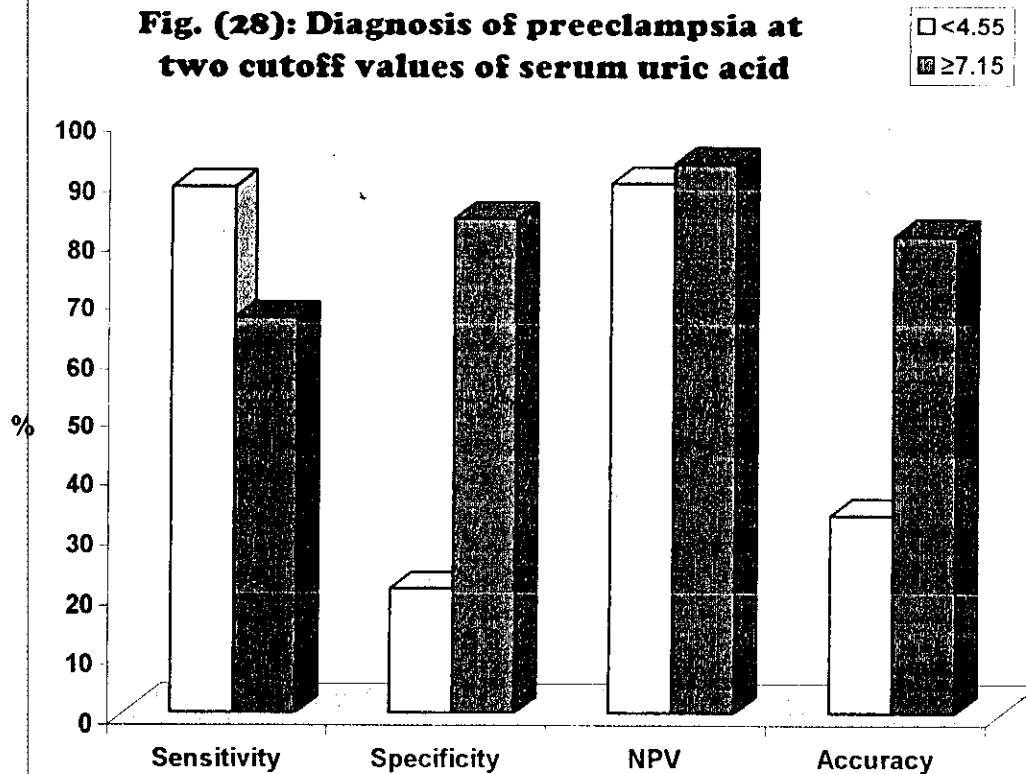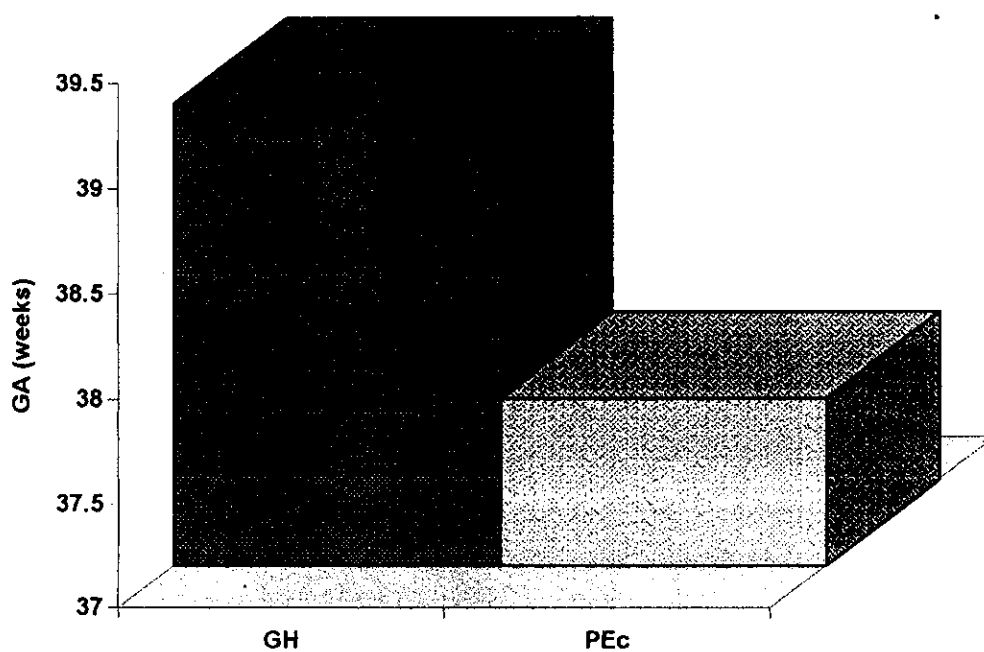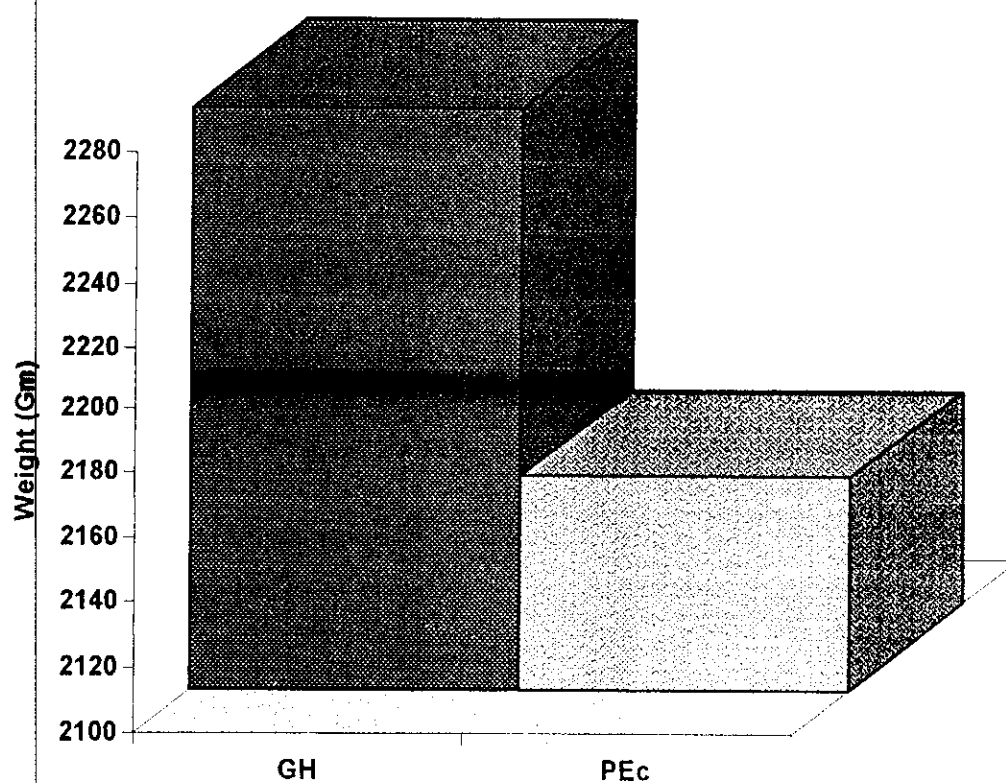# Fig. (28): Diagnosis of preeclampsia at two cutoff values of serum uric acid

## Fig. (29): Mean gestational age at time of delivery

Gestational age at delivery was 39.2±1.5 weeks in patients with GH, whereas it was 37.8±1.15 weeks in pre-eclampsia,with a significant (P<0.05) prolongation of gestational period in patients with GH,(Fig.29).

Fig. (30): Mean weight of LBW

There were 3 neonates were low birth weight in GH group,with mean weight of 2280±60 gm, whereas in pre-eclampsia group there were 5 neonates SGA with a mean weight of 2166±57.7 with a non-significant difference in between,(Fig.30).

Fig. (31): Mean neonatal weight
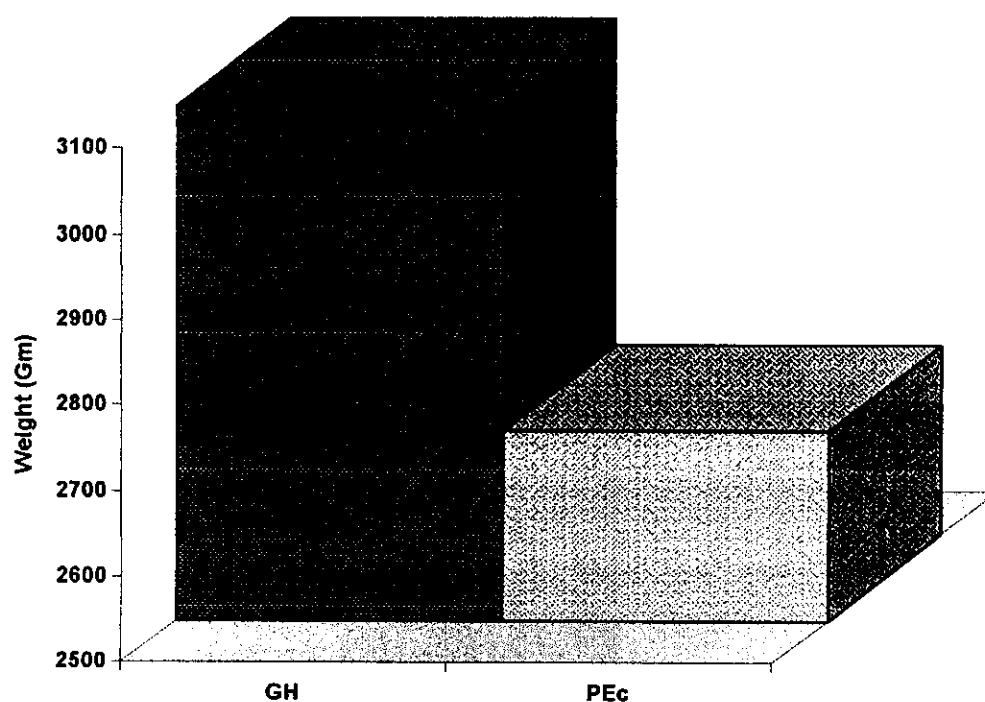
Neonatal weight was 3100±218 gm in GH group, while was 2720±320 gm with significant decrease (P<0.05) in neonates born for pre-eclamptic women,(Fig.31).