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Association of serum ferritin level with Gestational Diabetes Mellitus: A case control study

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Abstract
Background: Gestational Diabetes Mellitus (GDM) is one of the most common medical complications of pregnancy. The disease has important health implications for mother and child. High serum ferritin levels have been linked with type 2 diabetes and the development of gestational diabetes mellitus (GDM) in pregnant women. The present study was designed to evaluate the association of serum ferritin with GDM.
Methods: Case control study was conducted in the Department of Obstetrics and Gynecology, Institute of Child and Mother Health (ICMH), Dhaka. Pregnant women at 2nd and 3rd trimester attended for antenatal care diagnosed as GDM was selected as cases. Non-diabetic pregnant women matching with cases by age and gestational age was selected as control in this study. GDM was diagnosed by oral glucose tolerance test (OGTT). The serum ferritin level of these patients was measured.
Results: The age groups (20-30 years) of cases (80.0%) and control (76.7%) were almost similar. In cases educational qualification was maximum (40.0%) up to SSC. Both in cases (60.0%) and in controls (93.3%) monthly income was 10000-25000 to which is statistically significant (P=<0.001). More than two third of the control (86.7%) group and 43.3% cases were present at the period of 25-32 weeks of gestation. 20.0% of cases and 23.3% of controls had history of preterm labour. Level of fasting blood sugar value increases with increasing serum ferritin level which is highly significant (r= 0.464, P=<0.001). A highly significant linear correlation was evident between serum ferritin level and blood glucose 2 hours after 75 gm glucose ingestion (r= 0.466, P=<0.001). The mean serum ferritin level was lower in control (22.9±3.2) group compared to that in case group (48.8±17.7) and the difference between the groups was statistically highly significant (P=<0.001). The mean serum ferritin level was lower in control (22.9±3.2) group compared to that in case group (48.8±17.7) and the difference between the groups was statistically highly significant (P=<0.001).High level of serum ferritin was more in case (70.0%) compared with that of the control (0.0%) group). All respondents of control group had low level of serum ferritin. This findings are statistically highly significant (p=0.000). Respondents with high ferritin level have 4.33 times more chance to develop GDM (OR=4.33; 95% CI = 2.44-7.68).
Conclusion: The study concludes that high level of serum ferritin serves as a risk factor for development of gestational diabetes mellitus. There is a positive correlation between serum ferritin level and GDM. This study, despite some limitations, raise strong concerns about the screening of ferritin level may predict gestational diabetes mellitus.

Keywords: Serum ferritin level, gestational, diabetes mellitus.

Introduction
Ferritin is the major iron storage protein that plays a key role in iron metabolism [1].Serum ferritin concentration affords an indirect estimate of body iron stores because it is highly correlated with bone marrow iron. It is also a positive acute-phase reactant and increases in the presence of various acute or chronic disease conditions. Elevated serum ferritin levels have been found in many chronic inflammation related diseases [2]. GDM is common medical disorder during pregnancy which is the new onset or new diagnosis of glucose intolerance during pregnancy, complicates 4% of pregnancies [3]. Like type 2 diabetes, GDM results from a combination of increased insulin resistance and impaired pancreatic insulin secretion and women with a history of GDM are at significantly increased risk of developing type 2 diabetes in the future.

The insulin resistance syndrome (IRS) is a condition of increasing incidence in western countries [4]. The metabolic syndrome is closely linked to insulin resistance and numerous studies indicate a link to hepatic iron overload. Increased serum ferritin, reflecting hepatic iron overload due to hemochromatosis or blood transfusions, is often associated with insulin resistance [1]. Also, patients with non-alcoholic steatohepatitis (NASH) are known to have an increased prevalence of the insulin resistance syndrome. Often these patients are obese and suffer from type 2 diabetes and hyperlipidemia [5]. High serum ferritin levels have been linked with type 2 diabetes and the development of gestational diabetes mellitus (GDM) in pregnant women [6]. There is a two fold increase in GDM risk in women in the highest quartile of serum ferritin [1]. However, data on whether or not elevated serum ferritin is an independent risk factor for diabetes, and whether or not higher levels reflect inflammation or increased iron stores, are conflicting. Studies showed a significant relation between higher serum ferritin levels and insulin resistance syndrome and risk of type 2 diabetes [6]. Gestational diabetes mellitus (GDM) increases the risk of macrosomia (birth weight of more than 8 pounds) and perinatal morbidity and mortality for the fetus, while presaging a long-term risk of development of type 2 diabetes for the mother. It is increasingly being recognized that there is a systemic inflammation in GDM indicated by higher levels of serum C-reactive protein (CRP) and/or interleukin-6 [7]. Serum ferritin level is highly associated with GDM independently of BMI and C-reactive protein, the mid-pregnancy ferritin level is not a prognostic factor for pregnancy morbidity or subsequent impaired glucose tolerance after delivery, and fasting plasma glucose values at the time of diagnosis of GDM are the most important prognostic factors for glucose concentration in an early postpartum oral glucose tolerance test. It is not clear how ferritin is related to insulin deficiency or to insulin resistance. Ferritin has been identified as a marker of inflammation, and pregnancy is considered an inflammatory state. GDM is a common pregnancy complication and is associated with increase maternal and neonatal morbidity. Identifying and treating women with or at risk for GDM is important to improve the outcomes. The objective of this study was to compare and determine the association of serum ferritin level between GDM and normal pregnant.

Materials and Methods

Study design: This study was a case control study.

Place of study: This study was carried out in the Department of Obstetrics and Gynecology of Institute of Child and Mother Health (ICMH), Matuail, Dhaka, Bangladesh.

Period of study: September 2018 to August 2019.

Study population: The study population was including the pregnant women in second and third trimester attending for antenatal care in the Department of Obstetrics and Gynecology of ICMH.

Case: Pregnant women with GDM.

Control: normal pregnant women without GDM.

Sampling method: Purposive sampling was done according to the availability of the patients who was fulfilling the inclusion criteria.

Sample size determination: To determine the sample size, following formula was considered as appropriate for study design [8].

Therefore, N=56 cases, 56 controls

Considering 10% non-response rate and missing value calculated sample size is to be,

Sample size, N=62 cases, 62 controls

We have taken 30 cases and 30 controls due to time and resources construing.

Inclusion criteria

Case

- Pregnant women with GDM attended to antenatal care in ICMH.

Control

- Pregnant women without GDM attended to antenatal care in ICMH.

Exclusion criteria

- Pre-gestational diabetes
- Pregnant women with twin pregnancy
- Haemoglobinopathies (elevated serum ferritin)
- Pregnancy with any other medical or obstetrical disorder
- Pregnant women with smoking or alcohol abuse or tobacco chewing habit

Study procedure

This case control study was conducted in ICMH, from September 2018 to August 2019. The study population was 2nd and 3rd trimester pregnant women attended in the department of Obstetrics and Gynecology, ICMH fulfilling the inclusion and exclusion criteria. A total number of 30 cases and 30 controls were included in the study. All participants were in second and third trimester of pregnancy, primi or multigravida and with a single fetus. The purpose and procedure of the study was discussed with the patients. Informed written consent was taken from those who agree to participate in the study. Ethical committee clearance was obtained from the institution. Thorough clinical examination was done in all the subjects. Blood was taken from the ante cubital vein using a sterile needle and syringe. For each and every subject separate data collection sheet was prepared. Data was collected from the patients on variables of interest using the structured questionnaire design by interview, observation, clinical examination, hematological investigations of the patients.

Data collection

Case and control was selected purposively according to the availability of the respondent. Detailed Obstetric and medical history and clinical information were obtained by preformed structured questionnaire.

Blood collection

Maternal blood samples were drawn from the antecubital vein (in an arm without intravenous infusion ongoing). 5 milliliters blood was drawn with proper aseptic precautions. The blood sample was transferred into a clean, dry test tube and taken to the laboratory.

Measurement of blood glucose level (OGTT)

After arrival in the laboratory, venous blood for the clients withdrawn from cubital vein.

- **Gestational Diabetes mellitus:** Diabetes mellitus in pregnancy diagonosed if one or more of the following criteria are met:

a) Fasting plasma glucose 5.1-6.9 mmol/l.
b) 2 hours plasma glucose 8.5-11.0 following 75 gm oral glucose load.

Measurement of serum ferritin level

Ax SYM Ferritin is a Microparticle Enzyme Immunoassay (MEIA) for the quantitative determination of ferritin in human serum or plasma.

Biological Principles of the procedure

Ax SYM Ferritin is based on Micro particle Enzyme Immunoassay (MEIA) technology. The Ax SYM Ferritin Reagents and sample are pipetted in the following sequence:

Sampling Center

Sample and all Ax SYM Ferritin reagents required for one test are pipetted by the Sampling Probe into various wells of a Reaction Vessel (RV). Sample is pipetted into one well of the RV. Anti-Ferritin Coated Microparticles, Anti-Ferritin Alkaline Phosphatase Conjugate, Specimen Diluent and TRIS Buffer are pipetted into another well of the RV. The RV is immediately transferred into the Processing Center. Further pipetting is done in the Processing Center with the Processing Probe.

Processing Center

An aliquot of the Specimen Diluent, Conjugate, Micro particles and TRIS Buffer mixture is pipetted and mixed with the sample. The ferritin, enzyme-labeled antibody and micro particles bind forming an antibody-antigen-antibody complex. An aliquot of the reaction mixture containing the antibody-antigen-antibody complex bound to the micro particles is transferred to the matrix cell. The micro particles bind irreversibly to the glass fiber matrix. The matrix cell is washed to remove unbound materials. The substrate, 4-Methylumbelliferyl Phosphate, is added to the matrix cell and the fluorescent product is measured by the MEIA optical assembly.

Data analysis

Statistical analyses were carried out by using Windows based Statistical Package for Social Sciences (SPSS-22). The descriptive statistics of the study was presented in Tables, figures or suitable graphs, frequency, percentage, Mean ± SD as per the requirement of qualitative and quantitative variables. Unpaired t test was done to see the difference of ferritin level between case and control. Pearson correlation coefficient analysis was used to observe the association between maternal serum ferritin level and GDM. The P-Value < 0.05 was considered as statistically significant.

Results

The hospital based case control study was carried out to evaluate the association of serum ferritin level with gestational diabetes mellitus. The cases were pregnant women (30 respondents) diagnosed as GDM and controls were pregnant women (30 respondents) who don't have GDM. Findings of the study are presented by graphs and Tables.

Table 1: Socio-demographic characteristics of study population (case=30, control=30)

Characteristics	Case n (%)	Control n (%)	P-Value
Age (yrs)			
20-30	24 (80.0)	23 (76.7)	0.754[a]
> 30	6 (20.0)	7 (23.3)	
Educational status			
Illiterate	1 (3.3)	0 (0.0)	0.636[b]
Primary	3 (10.0)	3 (10.0)	
SSC	12 (40.0)	9 (30.0)	
HSC	10 (13.3)	10 (13.3)	
Above HSC	4 (13.3)	8 (26.7)	
Occupation			
Housewife	23 (76.7)	26 (86.7)	0.236[b]
Student	2 (6.7)	3 (10.0)	
Service holder	5 (16.7)	1 (3.3)	
Religion			
Islam	30 (100.0)	27 (90.0)	0.237[b]
Hindu	0 (0.0)	3 (10.0)	
Monthly income status			
< 10,000	0 (0.0)	2 (6.7)	< 0.001[b]
10,000-25,000	18 (60.0)	28 (93.3)	
> 25,000	12 (40.0)	0 (0.0)	

[a] Chi Square Test; [b] Fisher's Exact Test

Table 1 describes the socio-demographic characteristics of the respondents. The age groups (20-30 years) of cases (80.0%) and control (76.7%) were almost similar. In cases educational qualification was maximum (40.0%) up to SSC followed by HSC and above HSC (13.3%), primary (10.0%) and illiterate (3.3%). In control group 30.0% educated up to SSC, 26.7% up to HSC and above, 13.3% up to HSC and 10.0% up to primary level. No one was illiterate among the control group. Most of the respondents of both cases (76.7%) and controls (86.7%) were housewife. Majority of the respondents both in cases (100%) and control (90%) were Muslim. Both in cases (60.0%) and in controls (93.3%) monthly income was 10000-25000 tk which is statistically significant (P=<0.001).

Table 2: Comparison of obstetric characteristics (case=30, control=30)

Clinical and obstetric characteristics	Case n (%)	Control n (%)	P-Value
Parity			
Nuliparous	14 (46.7)	16 (53.3)	0.606[a]
Multiparous	16 (53.3)	14 (46.7)	
Gravida			
Primigravida, n (%)	13 (43.3)	16 (53.3)	0.438[a]
Multigravida, n (%)	17 (56.7)	14 (46.7)	
Gestational age (weeks)			
20 to 24 weeks	11 (36.7)	10 (33.3)	0.580[a]
25 to 32 weeks	13 (43.3)	16 (53.4)	
33 to 36 weeks	6 (20.0)	4 (13.3)	

[a] Chi Square Test

Table 2 denotes the comparison of clinical and obstetric characteristics of the respondents. Majority (53.3%) of the case group was multiparous and majority (53.3%) of the control group was nuliparous. More than two third of the control (86.7%) group and (80.0%) cases were present at the period of 20-32 week of gestation. More than half (56.7%) of cases and 46.7% of controls were multigravid.

Table 3: Comparison of past obstetric history between cases and controls (Case=30, Control=30)

Past obstetric history	Case n (%)	Control n (%)	P-Value
H/O GDM, n (%)			
Yes	1 (3.3)	0 (0.0)	1.000[b]
No	29 (96.7)	30 (100.0)	
H/O Macrosomic baby, n (%)			
Yes	0 (0.0)	0 (0.0)	-
No	30 (100.0)	30 (100.0)	
H/O still born/IUD, n (%)			
Yes	2 (6.7)	1 (3.3)	1.000[b]
No	28 (93.3)	29 (96.7)	

[b] Fisher's Exact Test

Table 3 shows that past history of GDM and still born or IUD were more in cases (3.3%, 6.7% respectively) than that of control group (0.0%, 3.3% respectively) though the findings were not statistically significant (p=1.00). Among case group majority had no past history of GDM (96.7%), macrosomic baby (100.0%) and still born/IUD (93.3%). Among control group majority had no past history of GDM (100.0%), macrosomic baby (100.0%) and still born/IUD (96.7%).

Table 4: Comparison of Haemoglobin (g/dl) parameters between cases and controls (case=30, control=30)

Haemoglobin (g/dl)	Case n (%)	Control n (%)	P-Value
Up to 9	2 (11.1)	0 (0.0)	0.309[b]
10-11	11 (61.1)	12 (63.2)	
≥ 12	5 (27.8)	7 (36.8)	

*[b] Fisher's Exact Test

Table 4 states the comparison of biochemical parameters between cases and controls. Normal level of haemoglobin (≥ 12g/dl) was more in control group (36.8%) than that of case group (27.8%). Below normal level of haemoglobin is more common in cases (11.1%) than that of control (0.0%) group though the finding was not statistically significant (p=0.309).

Table 5: Association of elevated serum ferritin between normal pregnant woman and GDM (case=30, control=30)

Case/Control	N	Mean ± SD	T-Test	DF	P-Value
Case	30	48.8±17.7	7.9	58	<0.001
Control	30	22.9±3.2			

Table 5 explains the association of elevated serum ferritin between normal pregnant woman and GDM. The mean serum ferritin level was lower in control (22.9±3.2) group compared to that in case group (48.8±17.7) and the difference between the groups was statistically highly significant (P=<0.001).

Table 6: Association of elevated serum ferritin in different gestational age between normal pregnant woman and GDM (case=30, control=30)

Gestational age	Case/Control	N	Mean ± SD	T-Test	DF	P-Value
20 to 24 weeks	Case	11	53.6±16.3	4.0	11.3	0.002
	Control	10	21.8 ±17.9			
25-32 weeks	Case	13	48.0±17.9	5.0	12.3	< 0.001
	Control	16	22.9±3.1			
33-36 weeks	Case	6	41.4±19.6	2.2	5.8	0.067
	Control	4	22.7±4.5			

Table 6 shows the association of elevated serum ferritin in different gestational age between normal pregnant woman and GDM. Elevated level of serum ferritin was common in women who developed GDM than those who did not develop the disease. Risk of developing GDM was significantly high among the respondents whose gestational age within 25-32 weeks having elevated serum ferritin (P=<0.001).

Correlation between elevated serum ferritin and fasting blood sugar

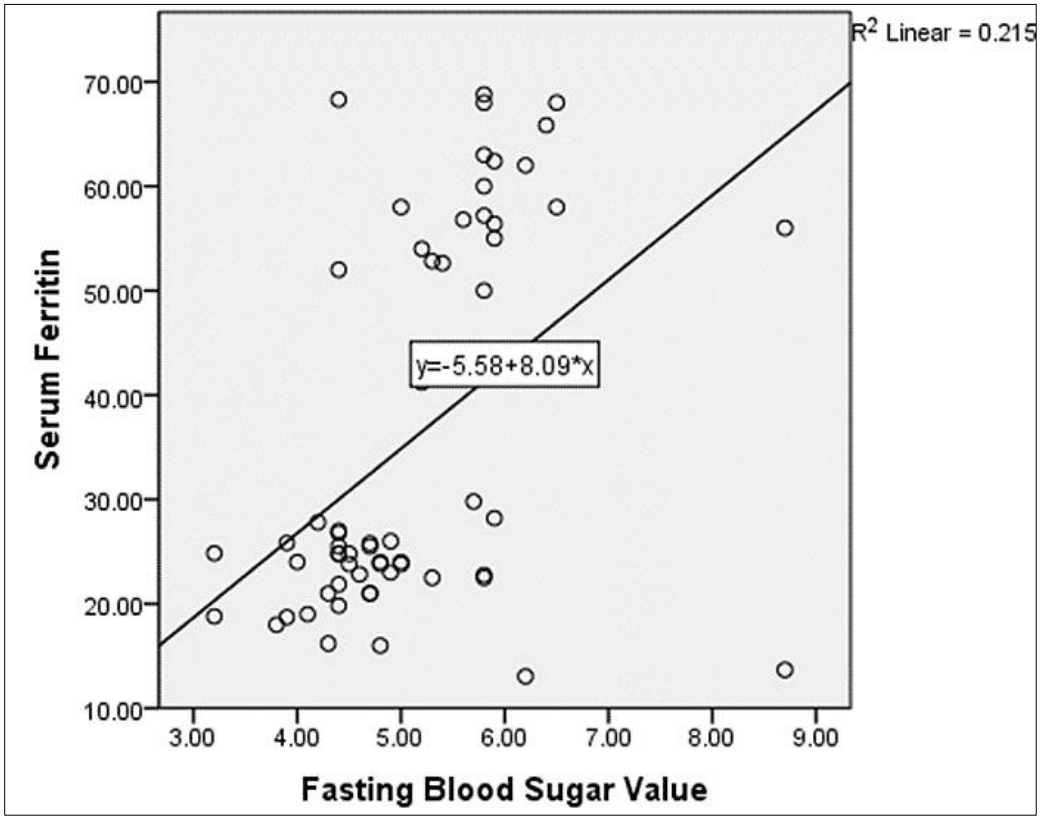

Fig 1: Correlation between elevated serum ferritin and fasting blood sugar (r = 0.464, P=<0.001).

Figure 1 shows positive correlation between elevated serum ferritin and fasting blood sugar. Level of fasting blood sugar value increases with increasing serum ferritin level which is highly significant (r= 0.464, P=<0.001).

Correlation between elevated serum ferritin and blood sugar 2 hours after 75 gm glucose intake

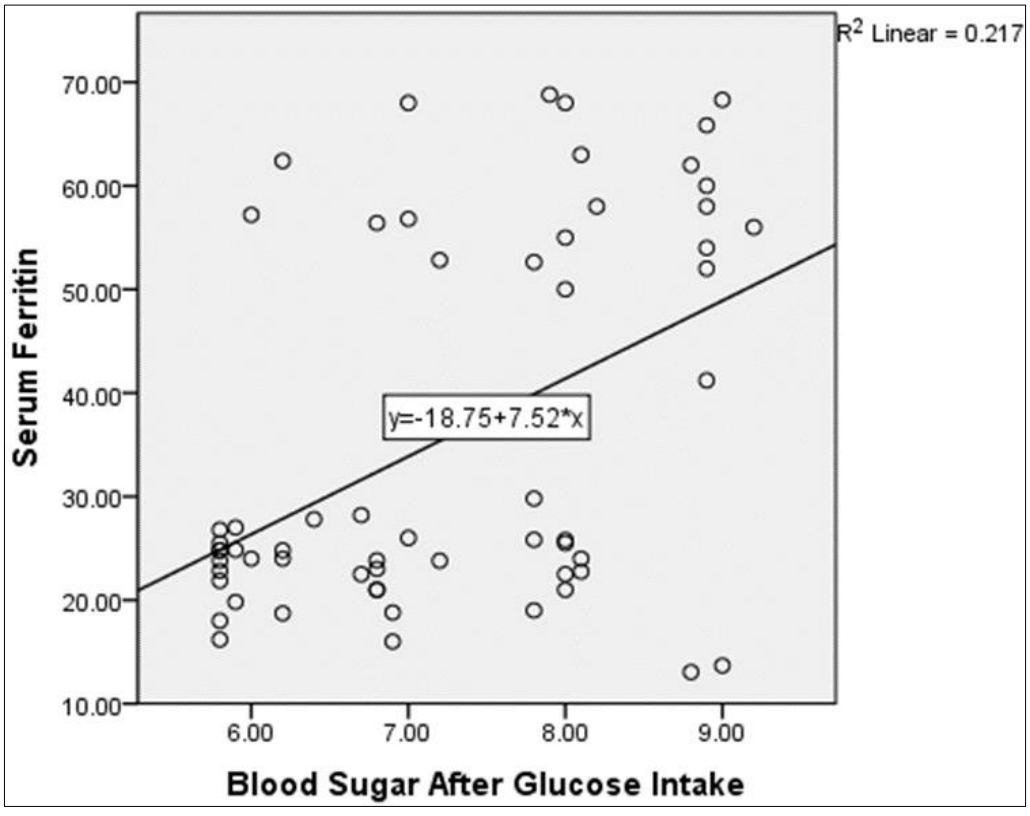

Fig 2: Correlation between elevated serum ferritin and blood sugar after glucose intake. (r = 0.466, P=<0.001).

Figure 2 shows positive correlation between elevated serum ferritin and blood sugar after glucose intake. A highly significant linear correlation was evident between serum ferritin level and blood glucose 2 hours after 75 gm glucose ingestion (r= 0.466, P=<0.001).

Table 7: Odds ratios (OR) and 95% confidence intervals (CI) for gestational diabetes (GDM) according to maternal serum ferritin concentrations in pregnancy

Serum ferritin (ng/ml)	Case N (%)	Control N (%)	P-Value	OR (95% CI)
≥ 45	21(70.0)	0 (0.0)	0.000	4.33(2.44-7.68)
< 45	9 (30.0)	30 (100.0)		Ref

High level of serum ferritin was more in case (70.0%) compared with that of the control (0.0%) group).All respondents of control group had low level of serum ferritin. This findings are statistically highly significant (P=0.000). Respondents with high ferritin level have 4.33 times more chance to develop GDM (OR=4.33; 95% CI = 2.44-7.68) (Table 7).

Discussion

The present study was carried out to evaluate the association of serum ferritin level with gestational diabetes mellitus. This study was carried out in the Department of Obstetrics and Gynecology of Institute of Child and Mother Health (ICMH), Dhaka. The cases were pregnant women (30 respondents) diagnosed as GDM and controls were pregnant women (30 respondents) who don't have GDM. Poor health care infrastructure and wide spread public ignorance of nutrition causes a large number of uncontrolled DM with anemia in Bangladesh. Iron is frequently prescribed without knowing its status in the pregnant, hencea probability of getting pregnancy with iron overload in Bangladesh Sarker et al [9]. In present study the age groups (20-30 years) of cases (80.0%) and control (76.7%) were almost similar. Islam and Chowdhury et al in a study stated that cases and controls were almost similar in terms of age, gestational age which is similar with present study Islam and Chowdhury [8]. In cases educational qualification was maximum (40.0%) up to SSC followed by HSC and above HSC (13.3%), primary (10.0%) and illiterate (3.3%). In control group 30.0% educated up to SSC, 26.7% up to HSC and above, 13.3% up to HSC and 10.0% up to primary level. No one was illiterate among the control group. Most of the respondents of both cases (76.7%) and controls (86.7%) were housewife. Majority of the respondents both in cases (100%) and control (90%) were Muslim. Both in cases (60.0%) and in controls (93.3%) monthly income was 10000-25000 to which is statistically significant (P=<0.001). Majority (53.3%) of the case group was multiparous and majority (53.3%) of the control group was nuliparous. More than two third of the control (86.0%) group and 80.0% cases were present at the period of 20-32 week of gestation. More than half (56.7%) of cases and 46.7% of controls were multigravid. In a study it was found that 70.3% of the case group was multiparous and 60% was present at the period of 28-30 weeks of gestation Soubasi et al [10] which was similar with this study. History of GDM and still born or IUD were more in cases (3.3%, 6.7% respectively) than that of control group (0.0%, 3.3% respectively) though the findings were not statistically significant (p=1.00). Among case group majority had no past history of GDM (96.7%), no history of macrosomic baby (100.0%) and no history of still born/IUD (93.3%). Among control group majority had no past history of GDM (100.0%), no history of macrosomic baby (100.0%) and no history of still born/IUD (96.7%). Gestational diabetes mellitus (GDM) increases the risk of macrosomia and perinatal morbidity and mortality for the fetus, while presaging a long-term risk of development of type 2 diabetes for the mother [1] and this was not similar with present study. This dissimilarity may be due reduced number of sample size. Incidence of anaemia was more in case group (43.3%) than that with the control group (30.0%). Normal level of haemoglobin (≥ 12g/dl) was more in control group (36.8%) than that of case group (27.8%). Below normal level of haemoglobin is more common in cases (11.1%) than that of control (0.0%) group though the finding was not statistically significant (P=0.309). A study suggested that in pregnant women, higher HB levels (> 13g/dL) are an independent risk factor for GDM, whereas women with iron-deficiency anaemia are reported to have a reduced risk of GDM [10]. Not find any association between high Hb level (Hb > 130g/l, highest quintile) and risk of GDM for the cohort (multi variable adjusted, AOR0.81 [95% CI 0.36-1.81], P>0.05) or among non-anemic patients (0.97 [0.42-2.24], P>0.05) Soubasi *et al.* [10]. Increased maternal ferritin concentration has been found at the time of diagnosis of GDM in the third trimester. It is therefore logical to hypothesize that women with iron deficiency anemia would have a reduced likelihood of GDM [11] which is similar with present study. In present study it was found that there was a positive correlation between elevated serum ferritin and fasting blood sugar. Level of fasting blood sugar value increases with increasing serum ferritin level (r= 0.464, P=<0.001). This study also stated that level of fasting blood sugar value increases with increasing serum ferritin level (r= 0.466, P=<0.001). Present study also evident a highly significant linear correlation between serum ferritin level and blood glucose 2 hours after 75 gm glucose ingestion (r= 0.466, P=<0.001). With elevated serum ferritin ranged from 45 to 158 ng/ml there was statistically significant increase in pregnant women developed GDM when compared to normal group (140.77±8.17 vs 82.56±29.64 respectively, p value was < 0.001 Chen *et al.* [1] which is similar to present study. In this study the mean serum ferritin level was lower in control (22.9±3.2) group compared to that in case group (48.8±17.7) and the difference between the groups was statistically highly significant (P<0.001). Elevated level of serum ferritin was common in women who developed GDM than those who did not develop the disease. Risk of developing GDM was significantly high among the respondents whose gestational age within 25-32 weeks having elevated serum ferritin (P=<0.001). Lao *et al.* reported significantly increased ferritin levels at 28-30 weeks of gestation in pregnant Chinese women with impaired glucose tolerance and in patients with GDM compared with control subjects [12]. In pregnant women, higher Hb levels (> 13g/dL) are an independent risk factor for GDM [10]. A study stated that in pregnant Chinese women, serum ferritin concentration was higher in women with impaired glucose tolerance and GDM [1] which is similar to this study. High level of serum ferritin was more in case (70.0%) compared with that of the control (0.0%) group). All respondents of control group had low level of serum ferritin. This findings are statistically highly

significant (P=0.000). Respondents with high ferritin level have 4.33 times more chance to develop GDM (OD=4.33; 95% CI = 2.44-7.68). Lao et al [13] found that hemoglobin more than13 g/dl) in pregnant women was an independent risk for GDM and that women with iron deficiency anemia had a reduced risk of GDM (16, 25). We did not find any association between high hemoglobin level and risk of GDM with OR=1.19 (95% CI 0.88-1.6) (P=0.27) Elevated serum ferritin concentration, which is associated with insulin resistance and diabetes in the general population, has also been recently described in gestational diabetes [14].

Limitations of the study

Although optimal care had been tried by the researcher in every steps of the study, but there were some limitations

- I measured serum ferritin as the only marker of iron storage, but did not measure other markers of iron overload such as transferrin saturation, serum iron concentration and total iron-binding capacity.
- Study was conducted in a single hospital. So, the study population might not represent the whole community
- The sample was taken purposively. So, there may be chance of bias which can influence the results
- Sample size was small
- Limited resources and facilities

Conclusions

Gestational diabetes is considered as a type of diabetes, which is the most common metabolic disorder during pregnancy. The study concludes that high level of serum ferritin serves as a risk factor for development of gestational diabetes mellitus. There is a positive correlation between serum ferritin level and GDM. As high level of haemoglobin corresponds to high serum ferritin and results from additional intake of iron, indiscriminate prescribing of iron without assessing the level of haemoglobin or serum iron parameters may cause more harm than good. Increased serum ferritin concentration accompanied by insulin resistance and diabetes in general population has recently been reported in gestational diabetes. Yet, the relationships between serum ferritin and insulin resistance or risk of diabetes have been announced controversially. Further investigations are required. There is a need for necessary awareness, utilizing screening facility and proper management that might help reduction of morbidity and mortality related to gestational diabetes mellitus.

Recommendations

To make more conclusive results the following recommendations are proposed for further studies

- Similar type of study can be done with large sample size
- Other co factors related to GDM should be evaluated
- Further national multicenter prospective studies can be done

References

1. Chen X, Scholl TO, Stein TP. Association of elevated serum ferritin levels and the risk of gestational diabetes mellitus in pregnant women: The Camden study. Diabetes Care. 2006;29:1077-1082.
2. Zadeh KK, Rodriguez RA, Humphreys MH. Association between serum ferritin and measures of inflammation, nutrition and iron in haemodialysis patients. Nephrology Dialysis Transplantation. 2004;19:141-149.
3. American Diabetes Association. Expert committee on the diagnosis and classification of diabetes mellitus. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care. 2003;26:S5-S20.
4. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. Jama. 2002;287:356-359.
5. Marchesini G, Bugianesi E, Forlani G, Cerrelli F, Lenzi M, Manini R, *et al.* Nonalcoholic fatty liver, steatohepatitis, and the metabolic syndrome. Hepatology. 2003;37:917-923.
6. Real FJM, Bermejo LA, Ricart W. Cross-talk between iron metabolism and diabetes. Diabetes. 2002;51:2348-2354.
7. Mainous III AG, Everett CJ, Liszka H, King DE, Egan BM. Prehypertension and mortality in a nationally representative cohort. The American Journal of Cardiology. 2004;94(12):1496-1500.
8. Islam N, Chowdhury SB. Serum ferritin and gestational diabetes mellitus: A case control study. Ibrahim Cardiac Medical Journal. 2011;1:15-19.
9. Sarker MR, Jebunnesa F, Khatun T, Helal R, Ali L, Rahim ATM. Role of maternal iron status in the pathogenesis of gestational diabetes mellitus. Bangladesh Medical Journal. 2011;40:55-60.
10. Soubasi V, Petridou S, Sarafidis K, Tsantali C, Diamanti E, Buonocore G, *et al.* Association of increased maternal ferritin levels with gestational diabetes and intra-uterine growth retardation. Diabetes & metabolism. 2010;36:58-63.
11. Lao TT, Ho LF. Impact of iron deficiency anemia on prevalence of gestational diabetes mellitus. Diabetes Care. 2004;27:650-656.
12. Lao TT, Chan LY, Tam KF, Ho LF. Maternal hemoglobin and risk of gestational diabetes mellitus in Chinese women. Obstetrics & Gynecology. 2002;99:807-812.
13. Lao T, Chan P, Tam K. Gestational diabetes mellitus in the last trimester-a feature of maternal iron excess? Diabetic medicine. 2001;18:218-223.
14. Soheilykhah S, Mojibian M, Moghadam MJ. Serum ferritin concentration in early pregnancy and risk of subsequent development of gestational diabetes: A prospective study. International Journal of Reproductive Biomedicine. 2017;15:155.