International Journal of Research in Medical Sciences
*Rahman Y et al. Int J Res Med Sci. 2023 May;11(5):1450-1455*
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20231022

**Original Research Article**

# Comparison of ultrasonographically measured fetal interventricular septal thickness between diabetic and healthy mother

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**Received:** 13 March 2023
**Accepted:** 29 March 2023

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## ABSTRACT

**Background:** During pregnancy, metabolic changes occur in response to increased nutrient needs of the fetus and mother, including progressive insulin resistance that can lead to gestational diabetes mellitus (GDM). GDM can result in fetal complications. This study aimed to compare fetal interventricular septal thickness, measured by ultrasound, between diabetic and healthy mothers.
**Methods:** This cross-sectional study was conducted at the department of radiology and imaging, BIRDEM, Dhaka, Bangladesh. A total of 334 subjects were enrolled in this study as per inclusion criteria. The study duration was 2 years; from July 2012 to June 2014. All study subjects were divided into 3 groups named group A, group B, and group C. 167 non-diabetic, 84 controlled diabetics, and 83 uncontrolled diabetic mothers were considered as group A, group B, and group C respectively. Data were analyzed by SPSS computed program.
**Results:** In this study, 47.9% of subjects in group A were ≤25 years old, while 52.4% of group B and 53.0% of group C were in the 26-30 age range. The mean age was 25.9±3 years in group A, 25.5±2.9 years in group B, and 25.2+3.3 years in group C, with no statistically significant difference between the three groups ($p>0.05$). The mean gestational age was similar across the three groups, with no statistically significant difference ($p>0.05$). However, the mean fetal interventricular septal thickness was significantly different between the groups, with group A and B having similar thicknesses, while group C had a significantly larger thickness ($p<0.05$). The difference in fetal interventricular septal thickness was also statistically significant between the three groups at 32 weeks of gestational age ($p<0.05$).
**Conclusions:** In this study, the fetal interventricular septal thickness was significantly higher in uncontrolled diabetic mothers followed by controlled diabetic and non-diabetic and almost alike between non-diabetic and controlled diabetic mothers. The study also revealed that M-mode ultra-sonogram measurement of interventricular septal thickness can be included in routine scanning during the third trimester.

**Keywords:** Interventricular septum, GDM, USG

## INTRODUCTION

Diabetes is the most common medical condition to complicate pregnancy and includes type I, type II, and gestational diabetes.[1] The prevalence of diabetes in Bangladesh was reported from 4 to 13% among adults. Bangladesh currently has over three million people with diabetes and this number will reach 11 million by the year 2030.[2] Poor glycemic control during pregnancy is associated with a 6-fold increase in perinatal mortality, a 4 to 8-fold increase in congenital malformations, and 8 fold increase in preterm delivery compared to the general population.[3] Fetal complications in diabetic pregnancy include-cardiac defects, CNS defects (including

anencephaly and spina bifida), genitourinary and limb defects, excessive fetal growth (macrosomia), fetal growth retardation, and so on.[4] The risks of congenital anomalies are increased in infants of diabetic mothers and are estimated to be between 2.5 to 12%, with an over-representation of congenital heart defects.[5] The congenital heart defects identified in the offspring of diabetic mothers include-double outlet right ventricle, truncus arteriosus, transposition of the great arteries, ventricular septal defect, and hypoplastic left heart syndrome.[6,7] Respiratory problems are frequently found in these infants, they need to be differentiated from cardiovascular problems, which include cardiovascular maladaptation to extra-uterine life, congenital heart defects, and hypertrophic cardiomyopathy.[8] Infants of diabetic mothers have long been recognized to be at risk of having hypertrophic cardiomyopathy, a condition that is characterized by the thickening of the interventricular septum. This condition is normally asymptomatic in utero and may only result in congestive heart failure in the immediate postnatal period. In hypertrophic cardiomyopathy, the left ventricular mass and contractility are increased and there is left ventricular outflow tract (LVOT) obstruction with apposition of the anterior leaflet of the mitral valve to the interventricular septum during systole. Cardiac output is significantly reduced, secondary to reduced stroke volume, and is directly related to the degree of septal hypertrophy. This asymmetric septal enlargement, with a disproportionally hypertrophic septum, is an anabolic result of fetal hyperinsulinemia triggered by maternal hyperglycemia during the third trimester. These changes are more prominent and easily detectable during 32-35 weeks of gestation because it includes a period of a significant increase in the interventricular septal thickness among the fetuses with asymmetrical septal hypertrophy compared to those who do not have asymmetrical septal hypertrophy at birth.[9-11] There is also the relevance of persistent pulmonary hypertension and idiopathic respiratory distress syndrome in infants of diabetic mothers with asymmetrical septal hypertrophy during the third trimester. Specific management of these fetuses is different and digoxin or inotropic agents which may be used in heart failure associated with structural heart defects are contraindicated if hypertrophic cardiomyopathy is present.[1] This study aimed to compare fetal interventricular septal thickness between diabetic and healthy mothers.

### *Objective*

*General objective*

General objectives were to compare ultrasonographically measured fetal interventricular septal thickness in non-diabetic, controlled diabetic, and uncontrolled diabetic mothers in 32 to 35 weeks of gestation and to find out the correlation between, interventricular septal thickness with gestational age.

*Specific objectives*

Specific objectives were to measure fetal interventricular septal thickness by ultrasonography in non-diabetic, controlled diabetic, and uncontrolled diabetic mothers at 32-35 weeks of gestation, to compare fetal interventricular septal thickness measured by ultrasonography in healthy normal subjects and diabetic mothers with controlled glycemic levels and uncontrolled glycemic levels and to find out correlation between fetal interventricular septal thickness with gestational age.

## METHODS

This cross-sectional study was conducted at the department of radiology and imaging, BIRDEM, Dhaka, Bangladesh. A total of 334 subjects were enrolled in this study as per inclusion criteria. The study duration was 2 years; from July 2012 to June 2014. All study subjects were divided into 3 groups named group A, group B, and group C. 167 non-diabetic, 84 controlled diabetics, and 83 uncontrolled diabetic mothers were considered as group A, group B, and group C respectively. Appropriate data were collected by using a preformed data sheet. All respondents underwent the necessary investigation techniques. Data were analyzed by SPSS computed program. Approval of the research protocol was taken from the respective authority. All the patients and control subjects included in this study were informed about the risk and benefits of the study. Proper written consent was obtained from the study subjects.

### *Data analysis*

The study coordinators performed random checks to verify data collection processes. Completed data forms were reviewed, edited, and processed for computer data entry. Frequencies, percentages, and cross-tabulations were used for descriptive analysis. The data analysis was performed using statistical package for the social sciences (SPSS) version 25.0. The significance level of 0.05 was considered for all tests.

### *Inclusion criteria*

Non-diabetic and diabetic pregnant women, women with a gestational age of 32-35 weeks, diabetic mothers with recent reports of HbA1C level, women with Singleton pregnancy and patients who had given consent to participate in the study were included in the study.

### *Exclusion criteria*

Women with twin/ multiple pregnancies, pregnant mother having medical disorder other than diabetes mellitus. (e.g., renal disease, cardiac disease), patients who had any fetal, placental, or umbilical cord anomaly detected at USG and fetus with intrauterine growth retardation (IUGR) or macrosomia were excluded.

## RESULTS

Almost half of 80 (47.9%) subjects belonged to ≤25 years in group A, 44 (52.4%) belonged to 26-30 years in group B and 44 (53.0%) belonged to 26-30 years of age in group C. The mean age was found 25.9±3 years in group A, 25.5±2.9 years in group B, and 25.2±3.3 years in group C. The difference was not statistically significant (p>0.05) among the three groups (Table 1). It was observed that almost one-third; 54 (32.3%) subjects were 32 weeks in group A, 33 (39.3%) in group B, and 30 (36.1%) in group C. The mean gestational age was found 33.3±1.1 weeks in group A, 33.6±0.9 weeks in group B, and 33.5±1.1 weeks in group C. The difference was not statistically significant (p>0.05) between the three groups (Table 2). Among the study subjects, almost two-thirds; of 108 (64.7%) subjects had 3.5 mm in group A, 79 (94%) had 3.6-4.5 mm in group B and 76 (91.6%) had >4.5 mm in group C. The mean fetal interventricular septal thickness was found 3.83±0.31 mm in group A, 3.9±0.25 mm in group B, and 6.6±0.43 mm in group C. The difference was statistically significant (p<0.05) between the three groups (Table 3). Regarding variation in fetal interventricular septal thickness, it was observed that group A vs group C and group B vs group C was statistically significant (p<0.05), but group A vs group B was not statistically significant (p>0.05) (Table 4). It was observed that the mean fetal interventricular septal thickness was found 3.44±0.22 mm in group A, 3.91±0.11 mm in group B, and 6.94±0.19 mm in group C during 32 weeks of gestational age. During 33 weeks of gestational age, the mean fetal interventricular septal thickness was found 3.38±0.2 mm in group A, 3.83+0.24 mm in group B, and 6.88±0.83 mm in group C. During 34 weeks of gestational age the mean fetal interventricular septal thickness was found 3.50±0.23 mm in group A, 4.01±0.22 mm in group B and 6.76±0.35 mm in group C. During 35 weeks of gestational age the mean fetal interventricular septal thickness was found 3.42±0.24 mm in group A, 3.94±0.19 mm in group B and 7.0±0.18 mm in group C. The difference was statistically significant (p<0.05) between the three groups (Table 5).

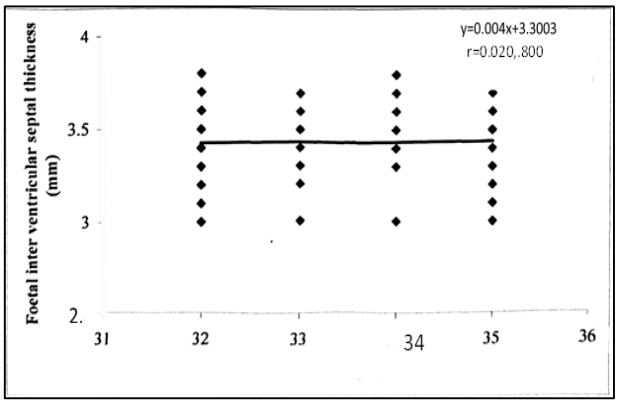


**Figure 1: Scatter diagram showing no significant positive correlation (r=0.020; p=0.800) between fetal interventricular septal thickness and gestational age of non-diabetic mothers.**

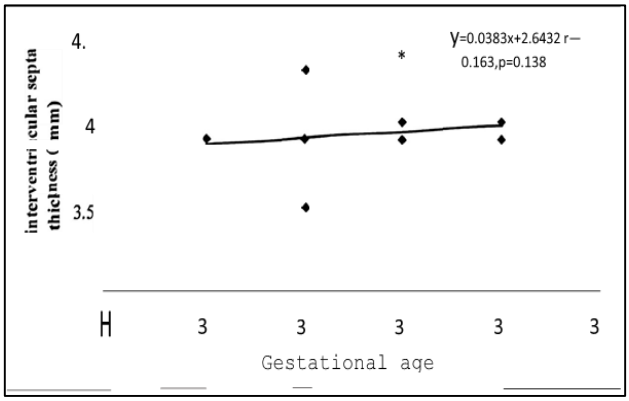


**Figure 2: Scatter diagram showing no significant positive correlation (r=0.163; p=0.138) between fetal interventricular septal thickness and gestational age of controlled diabetic mothers.**

**Table 1: Distribution of the study subjects by age (n=334).**

| Age (years) | Group A (n=167) | | Group B (n=84) | | Group C (n=83) | | P value |
|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | |
| **≤25** | 80 | 47.9 | 36 | 42.9 | 36 | 43.4 | |
| **26-30** | 78 | 46.7 | 44 | 52.4 | 44 | 53.0 | 0.213 |
| **>30** | 09 | 5.4 | 04 | 4.8 | 03 | 3.6 | |

Mean±SD =25.9±3.0, 25.5±2.9, 25.2±3.3, range (min-max) =(20,34); (21,33); (20,31).

**Table 2: Distribution of the study subjects according to gestational age (n=334).**

| Gestational age (weeks) | Group A (n=167) | | Group B (n=84) | | Group C (n=83) | | P value |
|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | |
| **32** | 54 | 32.3 | 10 | 11.9 | 22 | 26.5 | |
| **33** | 48 | 28.7 | 24 | 28.6 | 15 | 18.1 | 0.079 |
| **34** | 33 | 19.8 | 33 | 39.3 | 30 | 36.1 | |
| **35** | 32 | 19.2 | 17 | 20.2 | 16 | 19.3 | |

Mean±SD=(33.3±1.1), (33.6±0.9), (33.5±1.1).

**Table 3: Distribution of the study subjects according to fetal interventricular septal thickness, (n=334).**

| Fetal interventricular septal thickness (mm) | Group A (n=167) | | Group B (n=84) | | Group C (n=83) | | P value |
|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | |
| **≤3.5** | 108 | 64.7 | 03 | 3.6 | 0 | 0.0 | 0.001 |
| **3.6-4.5** | 59 | 35.3 | 79 | 94.0 | 7 | 8.4 | |
| **>4.5** | 0 | 0.0 | 02 | 2.4 | 76 | 91.6 | |

Mean±SD =(3.83±0.31), (3.9±0.25), (6.6±0.43).

**Table 4: Statistical analysis (Level of significance) of inter-group (n=334).**

| Groups of subjects | Level of significance |
|---|---|
| **Group A vs group B** | 0.071 |
| **Group A vs group C** | 0.001 |
| **Group B vs group C** | 0.001 |

**Table 5: Mean fetal interventricular septal thickness according to different gestational ages among the study subject (n=334).**

| Gestational age (weeks range) (min-max) | Group A (n=167) mean±SD | Group B (n=84) mean±SD | Group C (n=83) mean±SD | P value |
|---|---|---|---|---|
| **32** | 3.44±0.22 (3.3,8) | 3.91±0.11 (3.8,4.1) | 6.94±0.19 (6.7,7.3) | 0.001 |
| **33** | 3.38±0.2 (3,3.7) | 3.83±0.24 (3.8,4.1) | 6.88±0.83 (5.9,7.2) | 0.001 |
| **34** | 3.5±0.23 (3,3.8) | 4.01±0.22 (3.6,4.4) | 6.76±0.35 (5.9,7.2) | 0.001 |
| **35** | 3.42±0.24 (3,3.7) | 3.94±0.19 (3.6,4.2) | 7±0.18 (6.7,7.2) | 0.001 |

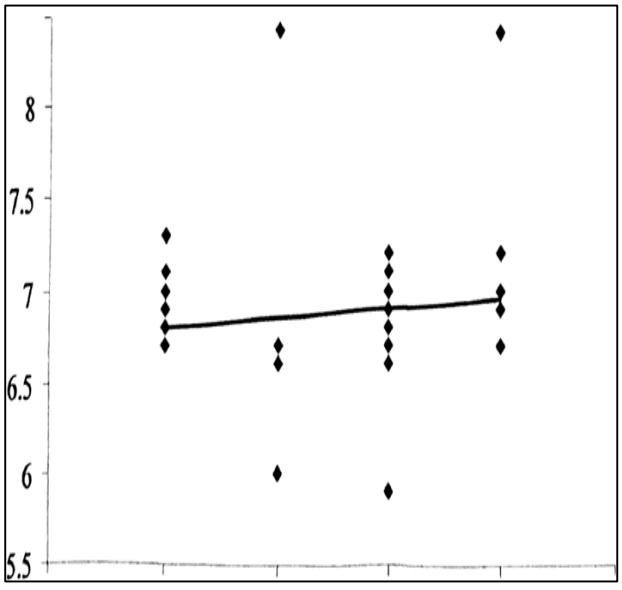


**Figure 3: Scatter diagram showing no significant positive correlation (r= 0.136; p=0.221) between fetal interventricular septal thickness and gestational age of uncontrolled diabetic mothers.**

## DISCUSSION

In this study, almost half of 80 (47.9%) subjects belonged to ≤25 years in group A, 44 (52.4%) were age belonged to 26-30 years in group B and 44 (53.0%) were age belonged to 26-30 years in group C. The mean age was found 25.9±3 years in group A, 25.5±2.9 years in group B, and 25.2+3.3 years in group C. The difference was not statistically significant (p>0.05) among the three groups. Another study showed mean age was found 29.5±2.8 years varying from 24-36 years in the diabetic group, and 28.4±4.35 years varying from 25-34 years in the non-diabetic group.[1] In another study, the mean age of the women was 27.69±5.53 years, which was comparable with the current study.[12] In this series, it was observed that almost one-third of subjects were 32 weeks in group A, 39.3% in group B, and 36.1% in group C. The mean gestational age was 33.3±l.1 week, 33.6±0.9 weeks, and 33.5±1.1 weeks in group A, group B, and group C respectively, which were almost identical among the three groups, and no statistically significant (p>0.05) difference was found among the three groups. Similarly, another study showed the mean gestational age at the time of examination was 30.6±3.1 weeks varied from 25-36 weeks in the non-diabetic group, 28.5±2.7 weeks varied from 23-33 weeks in the controlled diabetic group and 32.3±3.5 weeks varied from 24-39 weeks in the uncontrolled diabetic group.[13] Another study found the mean gestational age was 33.24±0.99 weeks varied from 32-35 weeks of gestational age, which closely resembled the present study.[12] Among the study subjects, almost two-thirds 108 (64.7%) subjects had 3.5 mm in group A, 79 (94%) had 3.6-4.5 mm in group B and 76 (91.6%) had >4.5 mm in group C. The mean fetal interventricular septal thickness was found 3.83±0.31 mm in group A, 3.9±0.25 mm in group B, and 6.6±0.43 mm in group C. The difference was statistically significant (p<0.05) between the three groups. A significant (p>0.05)

difference was found as regards the septal thickness between uncontrolled and controlled diabetics and between the uncontrolled and non-diabetic groups and no difference was found between the controlled diabetics and non-diabetic group (p>0.05).another study revealed, that the eight cases had a mean interventricular septal thickness of 7.38±0.74 mm which was relatively higher in comparison to the mean of the total cases of the non-diabetic group. ln, in the present study, there were 4 cases of uncontrolled diabetic subjects having an interventricular septal thickness of 8.4 mm, which resembled their study.[1] Similar observations to this study regarding the inter-ventricular septal thickness were also observed by several studies.[13-15] In this current study it was observed that the mean fetal interventricular septal thickness was found 3.44±0.22 mm during 32 weeks of gestational age in group A, 3.91±0.11 mm in group B and 6.94±0.19 mm in group C. The mean fetal interventricular septal thickness was significantly higher in group C followed by group B and group A in each week of gestational age in the present study, which was comparable with another study.[15] In this study, it was observed that a non-significant positive correlation (r=0.020, p>0.06) was found between fetal interventricular septal thickness and gestational age in nondiabetic patients. Another author showed the correlation coefficients of the IVSD and IVSS over the gestation age were 0.11 and 0.12 respectively.[12] The values of fetal IVST were not significantly different with advancing gestation from 32 to 35 weeks. The 95$^{th}$ percentile of the IVSD and IVSS was 4.51 mm and 6.2 mm, respectively. The above findings were similar to several studies[17-20]

### *Limitations*

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community. Moreover, there was a lack of full neonatal echocardiograms. Further study should include longitudinal neonatal follow-up and postnatal echocardiographic examination to relate changes in the IVST which occur as fetuses adapt to postnatal periods.

## CONCLUSION

In this study, the fetal interventricular septal thickness was significantly higher in uncontrolled diabetic mothers followed by controlled diabetic and non-diabetic, and almost alike between non-diabetic and controlled diabetic mothers. So, it can be concluded that an m-mode ultra-sonogram is valuable in the measurement of interventricular septal thickness in non-diabetic, controlled diabetic, and uncontrolled diabetic mothers.

### *Recommendations*

M-mode ultra-sonogram measurement of interventricular septal thickness can be included in routine scanning during the third trimester. However, further studies are needed with larger numbers and postnatal follow-up to reach a cut-off value of the septal thickness for the prenatal prediction of symptomatic cardiomyopathy in infants of diabetic mothers.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Rahman Y, Mohiuddin AS, Sultana S, Zahan N, Johora FT. Comparison of ultrasonographically measured fetal interventricular septal thickness between diabetic and healthy mother. Int J Res Med Sci 2023;11:1450-5.