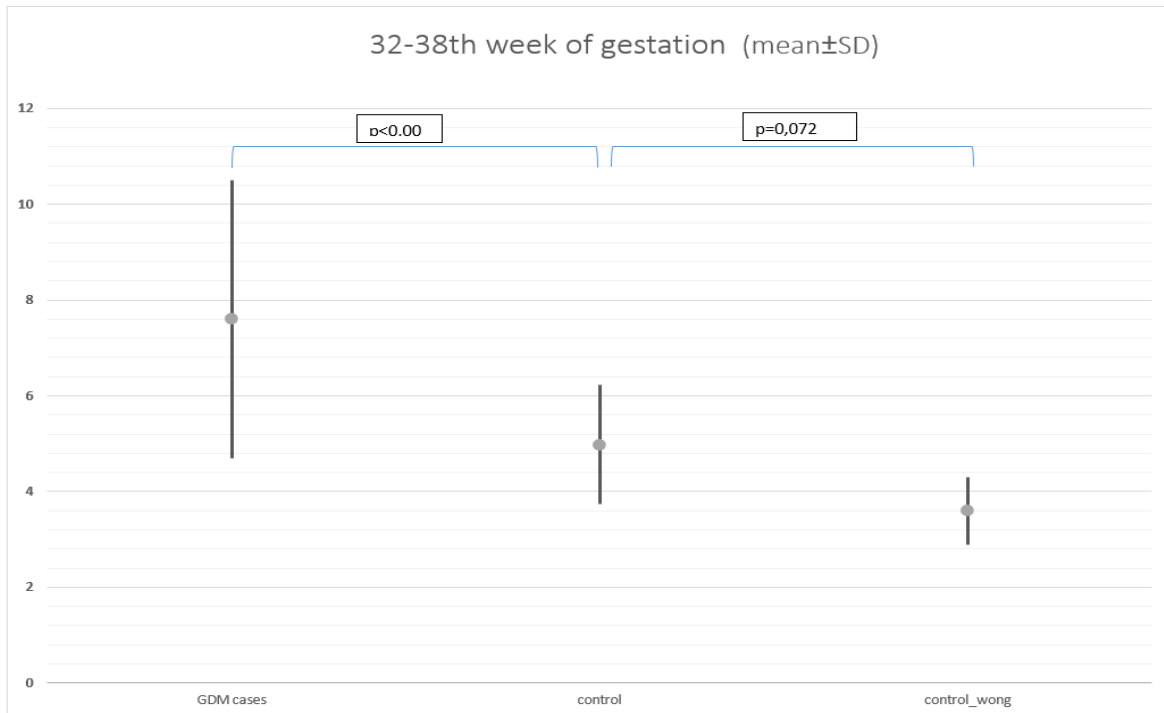


Measurement of intraventricular septum in four-chamber view using M-mode (24-28th gestational weeks). Control_Wong [14].



Measurement of intraventricular septum in four-chamber view using M-mode (32-38th gestational weeks). Control_Wong [14]

before pregnancy, out of first-degree obese pregnant women, 50% were diagnosed with GDM. 33% of ones with GDM gave birth in due time to normal-weight infants, while in cases (16%) of the pathological flow of uterine artery was registered and gave birth as a premature infant needing transportation to neonatal intensive centre. In summary, 75% of the newborns with IUGR had pathological Apgar-scores,

while 25% of the macrosomic infants received a score of 7 in the first minute, but on the whole, their condition was stabilised after 5 and 10 minutes of the delivery. The average value of their umbilical cord's pH is 7.24 ± 0.14 . 15% of them had to be transported to NIC due to perinatal complications (meconium aspiration, acute intrauterine distress).

Table 1b: Neonatal characteristics

Neonatal characteristics	Normal cases (N=40)	GDM cases (N=44)	p value
Gestational age at birth (weeks)	38.9 ± 3.20	36.7 ± 5.15	0,04
Birth weight (grams)	3355.7 ± 517.15	3253,16±848,42	0,00
Birth weight (percentile)	52,00	86,00	0,00
5-minute Apgar score < 7 (%)	2,00	15,00	0,00
Umbilical cord arterial pH <7.2 (%)	3,30	21,00	0,00
Admission to NICU ¹ (%)	11.33	39,70	0,00
Short-term adverse perinatal outcome ² (%)	12.67	32,00	0,00
caesarean section. (%)	12,00	85,00	0,00
gender of newborn (female(%))	47,00	63,00	0,03

Discussion

During the measuring process we utilised many advantages of the ultrasound equipment: all structures to be examined could be placed into the field of vision quickly and precisely, without invasion or danger.

Discussion/ Fetal cardio disorders

Measurements were implemented in the two indicated intervals, because in case of gestational diabetes mellitus, visible thickening of the interventricular septum in the fetus can be expected from the end of the second trimester, which may result in hypertrophic cardiomyopathy [6]. During our measurements we did register thicker interventricular septum and left chamber hypertrophy in the second trimester, but the mutations became more significant in the third trimester. In that period, we registered a significantly greater average value regarding the intraventricular septum, however, as opposed to [6,14] description. The consequence of fetal hypertrophic cardiomyopathy was that 15% of the new-born infants had to be transported to NIC, and they received the worst Apgar-scores.

Discussion /Other disorders connected to maternal diabetes mellitus

The eastern region presented the highest GDM prevalence (14-31%) in Europe. GDM prevalence was 2.14-fold increased in pregnant women with maternal age ≥ 30 years (*versus* 15-29 years old), 1.47-fold if the diagnosis was made in the third trimester (*versus* second trimester), and 6.79- fold in obese and 2.29-fold in overweight women (*versus* normal

weight) [17]. Diabetes already diagnosed before or during pregnancy, or greater than 28 kg/m² BMI before pregnancy imposes triple risk on the development of congenital growth disorder. The risk of this is further enhanced by the increase of BMI [18]. In the second and third trimesters of pregnancy, the most common complication of pathologically high maternal blood-sugar level is macrosomia. As opposed to this, the occurrence of IUGR infants is more likely for mothers already diagnosed with diabetes mellitus before their pregnancy, the reason of which is the existence of maternal vascular damage for years [19]. However, during our measurements 75% of macrosomic infants, occurrent in 25%, were delivered by a mother with GDM. 100% of the IUGR infants, occurrent in 16%, were delivered by mothers with GDM. The flow of umbilical artery was within normal range in all cases. In connection with the pathological flow of uterine artery all of the notches was complicated by IUGR. We measured a pathological excess of amniotic fluid in some in 3rd trimester. Complications concerning pregnant women and fetuses alike were present amongst, according to BMI-categorisation, normal weight, overweight and first-degree obese individuals. Complication can be caused by GDM [6], its appearance can mostly be expected from the end of the second trimester. The cardiac thickening is asymmetric, and primarily concerns the interventricular septum's left ventricle-side. Its danger is that it may obstruct the left heart ventricular outflow. However, the mutation is mostly benign and regresses by the sixth month after birth [6]. All pregnant women gave birth at the Obstetrics and Gynaecology Clinic of the University of Szeged, therefore, after analysing the deliveries we can conclude, taking the pre-pregnancy BMI-values into consideration, that 100% of the pregnant women of normal body weight presented some kind of complication during pregnancy, in case of overweight pregnant women, a pathological state was registered in 66,67%, while amongst first-degree obese women an occurrence of complication was experienced in 50%. Based on a research by Yeh et al. [20], the ideal pH-value of the umbilic artery's blood is 7.26-7.30, when the risk of unfavourable neurological outcome is the lowest. The worst umbilical pH were measured in GDM group, 31 % were in obese pregnancies with GDM.

Conclusion

Based on our examination, we can conclude that although we experienced conditions differing from physiological among normal body weight pregnant women with diabetes mellitus many times, but when diabetes is present with obesity, there is a greater risk of complications concerning the pregnant woman, the fetus and the infant. The low number of elements between gestational weeks 24-28 is probably the explanation to why we did not experience significant discrepancy regarding intraventricular thickness, but during the measurements between gestational weeks 32-38, the

average thickness of interventricular septum and left chamber walls are significantly greater in fetuses of pregnant women with complicated by GDM. The notion that complications occurred, even cumulatively, in case of pregnant women treated with insulin just as much as to those not treated with insulin, further supports the fact that maternal blood sugar level must be kept under regular control and modified by therapy if any complication is detected during fetal cardio-ultrasound examinations. Thus, following the fetal myocardium's parameters in the perinatal outcome of the mother's blood glucose system's discrepancies can be a well-applicable filtering method. It is suitable for early detection of complications, therefore their degree and proportion can be favourably influenced in prenatal existence.

What is Known

It is already known that carbohydrate intolerance develops often during pregnancy. In diabetic pregnancies, the high serum glucose level can affect fetal carbohydrate metabolism and have influence on fetal heart growth.

What is New

It is the first prospective case-control study to investigate the fetal myocardium in second and third trimesters in pregnancies complicated by gestational diabetes mellitus. Our purpose was to determine the early detection interval for fetal myocardial dysfunction.

Ethics Approval

Our study protocol has been reviewed and approved by the institutional research ethics committee (Human Investigation Review Board, University of Szeged, Szeged, Hungary, H-6701 P.O.Box:427). Ethical registration number: 237/2015-SZTE. All procedures followed in accordance with the ethical standards of the Helsinki Declaration of 1975, as revised in 2000.

Consent to Participate

Written informed consent to participate in the study were obtained from all participants.

Conflict of Interest Statement

The authors report no conflicts of interest.

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

Each author's participation in the manuscript. All authors have read and approved the manuscript.

Z.P: ultrasound investigation, data collection, manuscript editing and revision

Zs.K. data collection, statistical analysis, manuscript revision

G.N: project development, manuscript revision

A.S: project development, study design, ultrasound investigation, manuscript writing and editing

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

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