Ponderal index and other anthropometric measures in infants of women with pre-gestational and gestational diabetes

Klodiana Poshi[1,2], Geriolda Topi[1], Sofika Qamirani[1]

[1]Morphology Department, Anatomy Section, Faculty of Medicine, Medical University of Tirana, Albania;
[2]Morphology Department, Technical Faculty of Medical Sciences, Tirana, Albania.

Corresponding author: Klodiana Poshi
Address: Morphology Department, Anatomy Section, Faculty of Medicine, Medical University, Tirana, Albania;
Telephone: +355666661200; E-mail: klodiposhi@yahoo.com

Abstract

Aim: The aim of this study was to evaluate the ponderal index (PI) and other anthropometric measures in newborn infants of women with gestational diabetes (GD) and pre-gestational diabetes (PGD).
Methods: We conducted a cross-sectional study including 110 pregnant women (38 with diabetes mellitus and 72 with GD) and their newborn babies, during the period January 2010-February 2013. All the data for pregnant mothers were taken form medical records of University Hospital Obstetric and Gynecology "Koco Gliozheni" in Tirana. Anthropometric measures of infants were recorded within 24 hours after birth. All women included in the study were pregnant for the first time (primigravidae) and with singleton pregnancies.
Results: There was no statistically significant difference of PI between infants born from pre-gestational diabetic mothers and mothers with GD. Infant's body mass index (BMI) of mothers with PGD was strongly and significantly correlated with infant's head perimeter ($r=0.635$, $P<0.001$), thorax perimeter ($r=0.676$, $P<0.001$) and abdominal perimeter ($r=0.536$, $P=0.001$). For infants of mothers with GD, no correlation was found between baby's BMI and head, thorax and abdominal perimeters. There was no correlation of infant's PI with pre-pregnancy and current maternal BMI, and this was consistent for both women with pre-gestational and gestational diabetes.
Conclusion: No statistically significant changes were found regarding anthropometric values such as BMI, PI, head, thorax and abdomen perimeter in newborn infants of long-time diabetic mothers and mothers with gestational diabetes.

Keywords: anthropometric measure, BMI, diabetes mellitus, gestational diabetes, newborns, ponderal index.

Introduction

Gestational diabetes (GD), defined as a condition of glucose intolerance developed after 24 weeks of gestation, affects 1%-14% of all pregnancies, depending on the population studied and the diagnostic tests employed (1-4). Gestational diabetes poses maternal and fetal risks (5,6). The two main risks of both pre-gestational and gestational diabetes are growth abnormalities and chemical imbalances after birth (7,8). In unmanaged GD the infants are at risk of being macrosomic (large for gestational age – LGA) and in managed GD they are in risk of being small for gestational age (SGA) or develop intrauterine growth retardation (IUGR) (9).

Ponderal index (PI), that shows the relation between body weight (in grams) and body length (in cm), has been used in many epidemiological studies as a proxy for body composition to evaluate the growth abnormalities of infants (9-13). Previous studies have shown that newborns of diabetic mothers and mothers with GD have a PI significantly higher compared to non-diabetic mothers (9,10,13,14). If diabetes is well controlled, newborns of women with PGD and GD do not differ from newborns of non-diabetic mothers (15,16).

Previous research has reported that maternal pre-pregnancy body mass index (BMI) is the best predictor for newborn parameters, especially for birth weight (17-20). However, few studies have investigated the relation between infants PI and maternal BMI and the results are contradictory (21-24). Some of these studies, conducted in healthy mothers, showed no association between maternal BMI and newborn PI (21,22). Two other studies, conducted also in healthy mothers, have shown a positive association between maternal pre-pregnancy BMI and male newborns PI (23,24). However, the association between maternal BMI and infants PI is not clear and still needs to be evaluated.

The aim of this study was to investigate the anthropometric measures of infants born form mothers with pre-gestational and gestational diabetes. Furthermore we aimed to evaluate the correlation of infants BMI with infants' head, thorax and abdominal circumference and the correlation of PI with current and pre-pregnancy maternal BMI.

Methods

Study design and population

We conducted a cross-sectional study including 110 pregnant women in total (38 with pre-gestational diabetes mellitus and 72 with gestational diabetes) and their newborn babies, during the period January 2010-February 2013. All women included in the study were pregnant for the first time (primigravidae) and with singleton pregnancies. We excluded women with pregnancy pathologies (pre-eclampsia, placenta pathologies etc.), multiple pregnancies, babies born with congenital malformations and stillbirths.

All the data for pregnant women were taken form medical records of University Hospital Obstetric and Gynecology "Koco Gliozheni" in Tirana. Screening and diagnoses for gestational diabetes were made using recommended guidelines (25,26). The diagnosis of women with pre-gestational diabetes was confirmed by using the WHO diabetes diagnostic criteria (27). Women with PGD continued regular treatment with insulin during all pregnancy. From all women who presented GD, only 18 (6.8%) had good glycaemia levels which had permitted treatment with diet and exercise. 20 (7.6%) of GD women were treated with an average dosage of insulin 20 unit/day (range: 8-105 units/day), since the 28 week of pregnancy. A rich diet in fibers and 20 minutes of walk per day was recommended to all women.

Parameters measured

In both groups of women, current and pre-pregnancy, BMI was calculated. Anthropometric measures of infants were recorded within 24 hours

after birth. Body weight was calculated with the use of electronic weight with sensitivity of 50 gr. Body height was measured with statometer with infant's head fixed straight and mobile meter placed at the end of legs. For measuring head perimeter (HP), thorax perimeter (TP) and abdominal perimeter (AP), a plastic tape meter with sensitivity of 0.1 cm was used and measurements were repeated three times to reduce the chance for mistakes. Ponderal index in newborn infants was calculated using the formula:

PI = 100 x mass / height^3, where mass is the body weight.

Statistical analysis

Statistical analysis was done using SPSS software version 16. The continuous variables were expressed as mean values ± standard deviation (SD). The Student's t-test and one-way ANOVA were used for comparison of continuous variables and Chi-square test for proportions. Correlation between the variables was evaluated using Pearson's correlation coefficients. All the tests were two-sided and $\leq$0.05 was considered as statistically significant.

Results

From 110 women included in the study, there were 38 women with pre-gestational diabetes mellitus and 72 women with gestational diabetes. The average age of women with PGD was 30.68±4.51 and of women with GD 33.88±5.72, with a statistically significant difference between them (P=0.003). Women with GD had a current BMI statistically significant higher than women with PGD (P=0.028). There was no significant difference of pre-pregnancy BMI between two groups of women. Characteristics of women with PGD and women with GD are presented in Table 1.

Table 1. Characteristics of women with diabetes mellitus and gestational diabetes

Variables	Type of Diabetes		Total	P value
	Diabetes Mellitus	Gestational Diabetes		
Age (years)	30.68 ± 4.51*	33.88 ± 5.72	32.77 ± 5.53	0.003†
Pre-pregnancy weight (kg)	68.53 ± 9.35	71.29 ± 10.04	70.34 ± 9.85	0.157
Current weight (kg)	83.89 ± 8.33	87.65 ± 10.58	86.35 ± 9.98	0.091
Height (cm)	161.63 ± 6.43	161.82 ± 6.28	161.75 ± 6.30	0.639
Pre-pregnancy BMI	26.28 ± 3.61	27.22 ± 3.48	26.89 ± 3.53	0.125
Current BMI	32.16 ± 3.12	33.46 ± 3.37	33.01 ± 3.33	0.028

* Mean value ± standard deviation (SD).
† P value according to non-parametric Mann-Whitney U test.

Anthropometric measures of newborns

The mean weight of infants was 4050 gr ± 501 for mothers with PGD and 3900±550 g for mothers with GD, with no significant difference between them (P=0.231). There was no difference of PI between infants born from women with PGD and women with GD (P=0.461). Furthermore, no statistically significant changes were found during the comparison of other anthropometric values (BMI, HP, TP and AP) in newborn infants from long-time diabetic mothers and mothers with gestational diabetes (Table 2).

Correlations between maternal and infants anthropometric measures

BMI of infants born form mothers with PGD was strongly and significantly correlated with infant's head perimeter (r=0.635, P<0.001), thorax perimeter (r=0.676, P<0.001) and abdominal perimeter (r=0.536, P=0.001). For infants of mothers with GD, no correlation was found between infants BMI and HP (r=0.172, P=0.148), TP (r=0.129, P=0.281), AP (r=0.101, P=0.397) (Table 3).

Table 2. Characteristics of infants born from diabetic mothers and mothers with gestational diabetes

Variables	Type of diabetes		Total	P value
	Diabetes Mellitus	Gestational Diabetes		
Infant's sex				
Male	20 (52.6) *	45 (62.5)	65 (59.1)	0.317¶
Female	18 (47.4)	27 (37.5)	45 (40.9)	
Infant's height (cm)	52.39 ± 1.48	51.29 ± 4.45	51.67 ± 3.73	0.243 ‡
Infant's BMI	14.71 ± 1.38	15.78 ± 10.12	15.41 ± 8.23	0.371 ‡
Ponderal Index	2.81 ± 0.25	3.49± 5.46	3.25± 4.43	0.461‡
Head Perimeter (cm)	36.11 ± 1.48	35.59 ± 1.99	35.77 ± 1.84	0.186 ‡
Thorax Perimeter (cm)	35.18 ± 1.61	34.90 ± 1.65	35.00 ± 1.63	0.376 ‡
Abdomen Perimeter (cm)	33.84 ± 1.76	33.29 ± 1.87	33.48 ± 1.85	0.127 ‡
Pregnancy age (in weeks)	38.03 ± 1.16	37.84 ± 1.16	37.91 ± 1.16	0.392 ‡

* Absolute number and percentage as per columns (in brackets)
† Average value ± Standard deviation (SD)
¶ P value as per the chi-squared test
‡ P value according to non-parametric Mann-Whitney U test

Table 3. Correlations between maternal and infants anthropometric measures in two groups of mothers

		Mother's pre-pregnancy BMI	Mother's current BMI	Infant's BMI	Head Perimeter (HP)	Thorax Perimeter (TP)	Abdomen Perimeter (AP)
Diabetes mellitus	Mother's pre-pregnancy BMI	1.00	0.925 (<0.001)*	0.020 (0.906)	-0.107 (0.523)	0.042 (0.803)	-0.022 (0.897)
	Mother's current BMI		1.00	-0.111 (0.506)	-0.178 (0.261)	-0.045 (0.788)	-0.046 (0.784)
	Infant's BMI			1.00	0.635 (<0.001)	0.676 (<0.001)	0.536 (0.001)
	Head perimeter				1.00	0.737 (<0.001)	0.389 (0.016)
	Thorax perimeter					1.00	0.535 (0.001)
	Abdomen perimeter						1.00
Gestational diabetes	Mother's pre-pregnancy BMI	1.00	0.851 (<0.001)	0.109 (0.362)	-0.052 (0.666)	-0.006 (0.963)	-0.129 (0.281)
	Mother's current BMI		1.00	0.139 (0.244)	0.028 (0.816)	0.034 (0.776)	-0.101 (0.397)
	Infant's BMI			1.00	0.172 (0.148)	0.129 (0.281)	0.101 (0.397)
	Head perimeter				1.00	0.594 (<0.001)	0.526 (<0.001)
	Thorax perimeter					1.00	0.746 (<0.001)
	Abdomen perimeter						1.00

*Correlation coefficient and p value (in bracket).

We found no correlation of infant's PI with pre-pregnancy BMI (r=0.096, P=0.317) and current maternal BMI (r=0.114, P=0.236), and this was consistent for both women with PGD and GD. Correlation coefficients between infant's PI and maternal BMI are presented in Table 4.

Table 4. Correlation coefficients between infant's PI and maternal BMI

		Pre-pregnancy BMI	Current mother's BMI	Ponderal index
All mothers	Pre-pregnancy BMI	1	0.876 (<0.0001)	0.096 (0.317)
	Current mother's BMI	0.876 (<0.0001)*	1	0.114 (0.236)
	Ponderal index	0.096 (0.317)	0.114 (0.236)	1
Diabetic mothers	Pre-pregnancy BMI	1	0.925 (<0.0001)	0.094 (0.575)
	Current mother's BMI	0.925 (<0.0001)	1	-0.075 (0.656)
	Ponderal index	0.094 (0.575)	-0.075 (0.656)	1
Mothers with GD	Pre-pregnancy BMI	1	0.851 (<0.0001)	0.108 (0.368)
	Current mother's BMI	0.851 (<0.0001)	1	0.125 (0.296)
	Ponderal index	0.108 (0.368)	0.125 (0.296)	1

*Correlation coefficient and p value (in bracket).

Discussion

Our aim was to investigate the characteristics of newborns from women with pre-gestational diabetes and women with gestational diabetes. Furthermore we aimed to evaluate the relationship between maternal and newborn anthropometric measurements. Our results demonstrated that there was no difference in anthropometric measures between newborns of long-time diabetic women and women with gestational diabetes. In our study, we found no association of infant's PI with pre-gestational and current BMI.

Advanced maternal age and increased pre-gestational BMI are known risk factor for gestational diabetes. Previous studies, comparing women with pre-gestational and gestational diabetes have reported an older mean age and higher BMI of women with GD (2,6,28-31). In accordance, we also found that women with GD had a mean age significantly older than those with pre-gestational diabetes. For women with GD, pre-pregnancy BMI was higher bur not significantly different form the other group, while current BMI was significantly higher compared to women with pre-gestational diabetes. Knowing their condition, women with pre-gestational diabetes were under regular treatment and strict diet since the beginning of pregnancy. In contrary, since gestational diabetes is diagnosed after 24 weeks of gestation, women with this condition may have abused with their diet in the beginning of pregnancy.

One of the fetal complications of both pre-gestational and gestational diabetes is macrosomia (7,8). Fetal macrosomia has been defined in several different ways, including birth weight of 4000-4500 g or greater than 90% for gestational age after correcting for neonatal sex and ethnicity (32,33). All of the nutrients the fetus receives come directly from the mother's blood. If maternal blood has too much glucose, the pancreas of the fetus senses the high glucose levels and produces more insulin in an attempt to use this glucose. Insulin acts as the primary anabolic hormone of fetal growth and development, resulting in visceromegaly and converting the extra glucose into fat. Even when the mother has gestational diabetes, the fetus is able to produce all the insulin it needs. The combination of high blood glucose levels from the mother and high insulin levels in the fetus results in large deposits of fat that causes the fetus to grow excessively large (34,35). Previous studies have reported that when diabetic mothers are treated properly with insulin and diet during pregnancy, their newborns do not differ from those of non-diabetic mothers (9,15,16). In our study, diabetic women continued regular treatment with insulin and women with GD were under treatment with diet and/or insulin since the 28 week of pregnancy. The mean age of infants from both groups did not exceed 4000 gr.

Infants of women with pre-gestational diabetes, being exposed to high levels of glucose in blood since the beginning of pregnancy, would be expected to be "bigger" than those of women with GD. In fact, we did not find any significant difference in all anthropometric measures between infants of both groups. Literature says that levels of glucose in the third trimester are important for predicting macrosomia (25-27,32,34,35). In our study both pre-gestational and gestational diabetic women were under treatment in the third trimester.

We found a strong and significant correlation of infant's BMI with HP, TP and AP only for infants of women with pre-gestational diabetes but not for those of women with gestational diabetes. This result is inconsistent with our conclusion of no difference in all anthropometric measures between infants of two groups, and with results of previous studies that have shown a correlation between infant's birth weight and other infant's measures (9,10,21,36). One explanation for this inconsistent result may be the small number of women included in the study.

Previous research has reported that maternal pre-pregnancy BMI is the best predictor for newborn parameters, especially for birth weight (17-20). However, few studies have investigated the relation between infant's PI and maternal body mass index (BMI) and the results are contradictory (21-24). Some of these studies, conducted in healthy mothers, showed no association between maternal BMI and newborn PI (21,22). Two other studies, conducted also in healthy mothers, have shown a positive association between maternal pre-pregnancy BMI and male newborns PI (23,24). We found no correlation of infant's PI with pre-pregnancy and current mother's BMI, and this was consistent in both groups of women.

One limitation of our study is the small sample size that can lead to low precision and inconsistent results. Future studies, with bigger number of women included, needs to be conducted.

In conclusion, no statistically significant changes were found during the comparison of anthropometric values (BMI, PI, head, thorax and abdomen perimeter) in newborn infants from long-time diabetic mothers and mothers with gestational diabetes. The study emphasizes that during a perfect pregnancy checkup and good control of glycaemia levels, the newborn infant from both pre-gestational and gestational diabetic women result to have normal anthropometric parameters.

Conflict of interest: None declared.

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