# Original Article

# Changes in body mass index in different periods of infants born to diabetic and non-diabetic mothers

Halim AKMY[1], Huda SN[2], Ahmed L[3], Begum S[4], Banu LA[5]

## Abstract

***Background:*** *The growth of infants born to diabetic mothers is at greater risks because of their pregnancy related complications.* ***Objectives:*** *This study concerns comparison of BMI changes in different periods of infants born to pre-diabetic mothers (DM) and gestational diabetic mothers (GDM) with control infants born to apparently healthy non-diabetic mothers (NDM).* ***Materials & Methods:*** *This study comprising 251 newborn-mother pairs (n: DM=86; GDM=86 and NDM=79) recruited from the Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM), Dhaka.* ***Results:*** *BMI at birth was significantly higher for DM (BMI: 13.3±0.2 vs.12.6±0.2; p=0.003) and GDM (BMI: 13.7±0.2 vs.12.6±0.2; p<0.001) groups compared to the NDM group. On paired t tests, BMI increased significantly during 0-3 month period and 3-6 months periods in all groups (DM, GDM and NDM). At 0 month, compared to babies in the NDM group, mean BMI z-scores were significantly higher for the DM (-0.095±1.2 vs. -0.73±1.4; p=0.003) and GDM (0.16±1.4 vs.-0.73±1.4; p<0.001) groups. On paired-samples t tests, BMI Z-scores decreased from birth to 3 month of age in DM and GDM groups, but this decrease was significant for the GDM group only. In subsequent periods, BMI z-scores increased in all groups but the increment was more evident in GDM and NDM groups.* ***Conclusion:*** *At 0 month (birth), compared to babies in the NDM group, mean BMIs were significantly higher for the DM and GDM groups which became normalised by 3rd month when they got rid of maternal metabolic influences. The changes in BMI Z-score during 9-12 months period were significantly positive for NDM group compared to others.*

***Keywords:*** *BMI, Diabetes, Infants growth.*

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## Introduction

Growth in infancy and children is a complex process and affected by many factors including improved maternal nutrition, breast feeding and infant feeding practices. Infant growth may be interfered for different other reasons including inherited attributes from mothers like intrauterine growth retardation due to maternal malnutrition or postnatally due to different morbid conditions including malnutrition, infection etc.[1-5] Diabetic pregnancy is characterized by poor pregnancy outcomes and increased obstetrical complications.[6-12] The infants of diabetic mothers usually showed higher growth as evidenced by greater values in weight, height and other anthropometric indicators at birth compared to infants of non diabetic mothers, but these increases are normally equalised by the turn of 1st year[13] only to reappear later in childhood[14-17] and adolescent periods.[18] Available literature search failed to find a single study from developing country examining growth of children of diabetic mothers. In this context, the present study was conducted to see the growth pattern of infants born to diabetic mothers pre-gestational (DM) and gestational (GDM), with control infants born to apparently healthy non-diabetic mothers (NDM).

## Materials & Methods

A prospective cohort study extending from birth up to their 12 months of age during the period from 2003 to 2005. Pregnant mothers attending for their delivery at the BIRDEM Hospital in Dhaka, Bangladesh were enrolled into the study.

1. A K M Yunus Halim, Vice Principal & Head, Department of Biochemistry, Army Medical College, Bogra, Bangladesh.
2. Syed Nazmul Huda, Professor, Institute of Nutrition and Food Science University of Dhaka, Bangladesh.
3. Luthfor Ahmed, Professor, Institute of Nutrition and Food Science University of Dhaka, Bangladesh.
4. Shireen Begum, Medical Officer, NIPSOM, Mohakhali, Dhaka, Bangladesh.
5. Laila Arjumand Banu, Chief Consultant, Department of Gynaecology & Obstetric, LASH, Dhanmondi, Dhaka, Bangladesh.

**Correspondence:** Dr. A K M Yunus Halim, Vice Principal & Head, Department of Biochemistry, Army Medical College, Bogra. Phone: +88 01819-239011, e-mail: yunushalim99@gmail.com

A total of 251 newborn-mother pairs, pre-gestational diabetic (n: DM=86), gestational diabetic (GDM=86) and non-diabetes (NDM=79) were recruited from the same hospital according to the set criterion of definition for the individual group as defined by the hospital authority. The hospital record books helped in the identification of the subjects at the time of enrolment. Detailed anthropometric measurements of infants including weight and recumbent length were taken at birth in the hospital and subsequently through home visits at 3 months interval according to the schedule of a particular baby. Infants follow up data concerning anthropometric indices in different periods were measured at their homes at 3 months interval and a detailed anthropometric measurement was made for each child. This section deals with the comparisons between the study groups at different points of time using Analysis of Covariance. For convenience of a fixed cohort, only those babies who were available for the final measurements were selected for all analyses in this section and reported as such. For all analyses, concurrent age, immediate previous measures and sex were controlled.

**Inclusion criteria:** a) Mothers with viable singleton babies. b) Mother's age: 21 to 35 years. c) Monthly income of the family in Taka: Tk10, 000 to 30,000. d) Mother's education: Grade VIII or above. e) For DM group, all cases of pre-gestational diabetic pregnancy irrespective of duration and minor complication. f) For GDM group, all cases of gestational diabetic pregnancy irrespective of duration and complication.

**Exclusion criteria-** a. Birth orders more than five. b. Mothers not willing to stay in the study for the whole period. The groups were matched on the following characteristics: a) Sex b) Mothers education c) Mothers occupation

**Data Analysis**

Data were entered into a SPSS spreadsheet and analyzed using SPSS windows version 17. The distributions were examined for normality and when required were normalized by appropriate transformations. Differences between the groups were examined using 't-tests' and 'general linear model univariate analyses' for continuous variables. Anthropometric z scores were calculated by using MGRS data usuing WHO_anthro soft ware.

**Results**

Baby's 3, 6, 9 and 12 months' weight and length measurements (mean ± SE) by different study groups. There were no significant differences observed amongst the groups at any period except at 12 month's weight, where a significant group effect was observed in the model when concurrent age, sex and 9 month's weight were controlled (Table I).

**Table I:** Baby's weight and length measurements (mean and SE) by groups by time periods

| Measures / Time | DM | | GDM | | NDM | | Group statistics | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SE | Mean | SE | Mean | SE | df | F | P-value |
| Weight (Kg) 3 month (DM: 81;GDM=74; NDM=76) | 5.67 | 0.07 | 5.60 | 0.07 | 5.72 | 0.07 | 2, 225 | 0.64 | 0.53 |
| 6 month (DM: 77;GDM=73; NDM=76) | 7.34 | 0.07 | 7.38 | 0.07 | 7.37 | 0.07 | 2, 220 | 0.07 | 0.93 |
| 9 month (DM:79;GDM=72; NDM=76) | 8.39 | 0.06 | 8.36 | 0.06 | 8.34 | 0.06 | 2, 221 | 0.22 | 0.81 |
| 12 month (DM:83;GDM=80; NDM=76) | 9.16 | 0.05 | 9.13 | 0.05 | 9.29 | 0.05 | 2, 233 | 3.48 | 0.03 |
| 3 month (DM: 73; GDM=66; NDM=76) | 59.53 | 0.25 | 59.43 | 0.26 | 59.40 | 0.24 | 2, 209 | 0.08 | 0.93 |
| 6 month (DM: 75; GDM=73; NDM=76) | 65.81 | 0.19 | 65.48 | 0.19 | 65.95 | 0.19 | 2, 218 | 1.65 | 0.19 |
| 9 month (DM: 79; GDM=72; NDM=76) | 69.86 | 0.16 | 70.21 | 0.17 | 69.96 | 0.16 | 2, 221 | 1.25 | 0.29 |
| 12month (DM: 83; GDM=80; NDM=76) | 73.46 | 0.16 | 73.23 | 0.16 | 73.17 | 0.17 | 2, 233 | 0.93 | 0.39 |

**Table II:** Mean weight and length changes at different time periods by groups

| Measures | Groups (n) | 0-3 mo | | 3-6mo | | 6-9mo | | 9 -12mo | |
|---|---|---|---|---|---|---|---|---|---|
| | | Changes | SE | Changes | SE | Changes | SE | Changes | SE |
| Weight (kg) | DM (81) | 2.56 | 0.07 | 1.66 | 0.07 | 1.07 | 0.06 | 0.82 | 0.05 |
| | | 2.44 | 0.07 | 1.72 | 0.07 | 1.00 | 0.06 | 0.79 | 0.05 |
| | NDM (76) | 2.61 | 0.07 | 1.68 | 0.07 | 1.00 | 0.06 | 0.94 | 0.05 |
| Length (cm) | DM (73) | 11.01 | | 6.48 | | 4.12 | | 3.47 | 0.17 |
| | GDM (66) | 10.57 | 0.30 | 6.02 | 0.21 | 4.43 | 0.17 | 3.49 | 0.17 |
| | NDM (76) | 10.52 | 0.28 | 6.53 | 0.19 | 4.22 | 0.17 | 3.21 | 0.16 |

BMI of infants at different periods and z-scores of the infant's anthropometric measures at different periods by groups. Z scores were calculated using reference values from WHO MGRS (Multicentre Growth Reference Study) (figure 1 & 2).

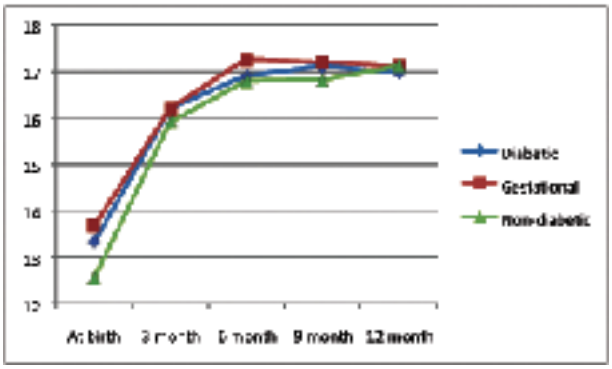


**Figure 1:** BMI of the infants

BMI of the infants at different periods from birth to 12 months period. At 0 month, compared to babies in the NDM group, mean BMIs were significantly higher for the DM (13.33±1.5 vs. 12.56±1.6; p=0.003) and GDM (13.68±1.7 vs. 12.56±1.6; p<0.001) groups. On subsequent follow ups at 3, 6, 9 and (figure 1).

**Table III:** Changes in BMI values between different periods by groups

| | 0 – 3 mo | 3 – 6mo | 6 – 9mo | 9 -12mo |
|---|---|---|---|---|
| DM | 2.87±0.21 (p<0.001) [n=76] | 0.75±0.11 (p<0.001) [n=78] | 0.22±0.12 (p=0.08) [n=82] | - 0.13±0.11 (p=0.23) [n=83] |
| GDM | 2.54±0.24 (p<0.001) [n=68] | 1.06±0.14 (p<0.001) [n=77] | - 0.10±0.12 (p=0.39) [n=76] | - 0.06±0.12 (p=0.62) [n=80] |
| NDM | 3.36±0.20 (p<0.001) [n=79] | 0.86±0.13 (p<0.001) [n=79] | 0.10±0.13 (p=047) [n=78] | 0.29±0.10 (p=0.004) [n=76] |

On paired t tests, BMI increased significantly during 0-3 month period and 3-6 months periods in all groups (Table III), but the changes were insignificant during 6-9 month period. However, during 9-12 month period, the changes in NDM was positive and significant (0.29±0.10; p=0.004), whereas insignificant decreases were found among the DM and GDM groups.

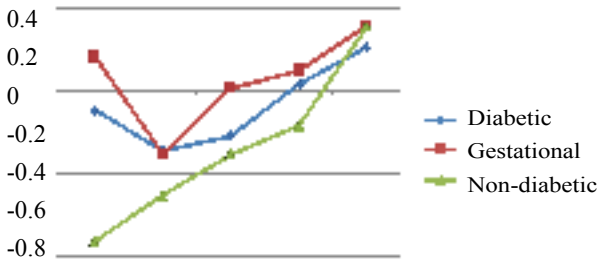


**Figure 2:** BMI for Age Z-Score

BMI z-scores at different age periods by groups. At 0 month, compared to babies in the NDM group, mean BMI z-scores were significantly higher for the DM (-0.095±1.2 vs. -0.73±1.4; p=0.003) and GDM (0.16±1.4 vs.-0.73±1.4; p<0.001) groups. On subsequent follow and GDM groups, but this decrease was significant for the GDM group only (Table IV). Incontrast, NDM group increased during this period; however, the increase was not significant. In subsequent periods, BMI z-scores increased in all groups but the increment was more evident in GDM and NDM groups. The DM group had increased significantly during 6-9 month (0.25±0.09; p=0.004) and 9-12 month (0.19±0.07; p=0.01) periods. The GDM group increased significantly during 3-6 month (0.33±0.09; p=0.001) and 9-12 month (0.23±0.08; p=0.004) periods. The NDM group increased significantly at 3-6 month (0.20±0.09; p=0.024) and 9-12 month (0.47±0.06.

**Table IV:** Changes in BMI Z-score values at different periods by groups

| | 0–3 mo | 3 – 6 mo | 6– 9 mo | 9 -12 mo |
|---|---|---|---|---|
| DM | - 0.20±1.15 (p=0.20) [n=76] | 0.11±0.07 (p=0.13) [n=78] | 0.25±0.09 (p=0.004) [n=82] | 0.19±0.07 (p=0.01) [n=83] |
| GDM | -0.48±0.18 (p=0.008) [n=68] | 0.33±0.09 (p=0.001) [n=77] | 0.06±0.08 (p=0.44) [n=76] | 0.23±0.08 (p=0.004) [n=80] |
| NDM | 0.22±0.17 (p=0.18) [n=79] | 0.20±0.09 (p=0.024) [n=79] | 0.18±0.09 (p=053) [n=78] | 0.47±0.06 (p<0.001) [n=76] |

## Discussion

As a whole the mothers from both diabetic groups had significantly higher BMI and the percentage of 'overweight & obese' was more in the DM and significantly more in the GDM group compared to the NDM group. In this study, except BMI, other simple measures of obesity were not used that are shown by many as important indicators of obesity associated significantly with type 2 diabetes. Simple waist circumference was shown to be highly correlated with type 2 diabetes, in Poland[19] and in the USA[20] for Mexican-Americans.

Waist-height ratio (WHtR) among other two abdominal obesity variables (WC: waist circumference or WHR: waist-hip-ratio) also was found to be stronger than BMI in identifying men with potential type 2 diabetes in an Iranian study.[21] In this study, most of the birth anthropometric parameters showed accelerated growth of babies of both DM and GDM groups compared to babies of NDM group. However, it was interesting to note that by 3 months, these differences were no longer present. Probably these infants got away from maternal metabolic influences by this time and started their individual trajectories of growth. In some studies, obesity and overweight or greater BMI at later lives were found more frequent in children born to GDM mothers[16,22-24] but, children of pre-gestational diabetic mothers[19,22] or gestational diabetic mothers[25,26] were not different compared to control group. Some studies did not differentiate between IPGDM (insulin dependent-pregestational diabetic) and GDM and reported as such.[27,28] Most of these studies examined children at one or two points after birth, rather doing a systematic continuous evaluation. In a Chinese study,[29] high BMI, WC and WHtR were all found associated with the prevalence of glucose intolerance, with the highest prevalence ratio for high WHtR. In an Australian study,[30] WHR was suggested as the most useful measure of obesity to identify individuals with CVD risk factors. In a meta-analysis,[31] it is concluded that BMI, WC and WHR, respectively, have similar associations with incidence of diabetes. Furthermore, in a recent review it is also concluded that either BMI or WC or WHR independently predicted or was associated with type 2 diabetes, regardless of the controversial findings on which of these obesity indicators is better.[32] Considering this overall view, this present study only used BMI as an indiactor of obesity that has got good predictive validity for diabetes.

## Conclusion

In conclusion this study revealed that, the changes in BMI-Z score was more for NDM group compared to DM and GDM group during 9-12 months period. Accelerated growth from intrauterine lives in infants of both pre-gestational and gestational diabetic mothers were normalised by 3rd month when they got rid of maternal metabolic influences.

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