# Association of Prenatal Exposure to Gestational Diabetes with Offspring Body Composition and Regional Body Fat Distribution

Michèle Kearney[1,2], Julie Perron[2], Isabelle Marc[3], S. John Weisnagel[3,4], André Tchernof[1,2,3] and Julie Robitaille[1,2,3]

[1]*School of Nutrition, Laval University, Québec, Québec, Canada.*
[2]*Institute of Nutrition and Functional Foods (INAF), Laval University, Québec, Québec, Canada.*
[3]*Endocrinology and Nephrology Axis, CHU de Québec Research Center, Québec, Québec, Canada.*
[4]*Diabetes Research Unit, Laval University Medical Research Center, Québec, Québec, Canada.*

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**Author for correspondence:**

Julie Robitaille, R.D., Ph.D., Professor, School of Nutrition
Institute of Nutrition and Functional Foods (INAF), Laval University
Pavillon des services, room 2729N
2440 boul. Hochelaga
Quebec (Quebec) G1V 0A6
Phone: 418-656-2131 ext. 4458
Email: julie.robitaille@fsaa.ulaval.ca

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**What is already known?**

- Although body mass index (BMI) is frequently used to assess children adiposity, other anthropometric measures may be better indicators of cardiometabolic risk. Few studies investigated others adiposity measures in children exposed to gestational diabetes.

**What this study adds?**

- In the current study, adiposity of children exposed to gestational diabetes is evaluated in a more complete and precise manner with assessment of body composition and fat distribution by dual-energy X-ray absorptiometry.
- This study also investigates the association of those adiposity measures with children glycemic and insulin profile.

**Abstract**

**Objectives** The aim of this cohort study was to compare body composition and regional body fat distribution between children exposed (GDM+) or unexposed (GDM-) *in utero* to gestational diabetes mellitus (GDM) and to investigate the association with the glycemic and the insulin profile. **Methods** Data from 56 GDM+ and 30 GDM- were analysed. Height, weight and waist circumference were measured. Total and regional body composition was measured by dual-energy X-ray absorptiometry. Insulin, glucose and $HbA_{1c}$ were obtained from a fasting plasma sample and the HOMA-IR index was calculated. ANOVA was performed to compare adiposity measures between GDM+ and GDM-. Associations between the glycemic and insulin profile and adiposity measures were studied using partial Pearson correlations. **Results** Mean age was 6.6 ± 2.3 years. Waist circumference, fat mass percentage, android fat mass, android fat mass percentage and android-to-gynoid fat mass ratio were higher among GDM+ and lean mass percentage was lower ($p<0.05$). Among GDM+ children, BMI *z* score, waist circumference, fat mass percentage, android fat mass percentage and android-to-gynoid fat mass ratio were all positively correlated with $HbA_{1C}$ ($r=0.32$-$0.43$, $p<0.05$). **Conclusions** Prenatal exposure to GDM is associated with increased total and abdominal adiposity. This increased adiposity observed among GDM+ children is associated with an altered glycemic profile.

This study is registered in the Clinical Trials.gov registry (NCT01340924).

## Abbreviations

GDM: gestational diabetes mellitus

BMI: body mass index

INAF: Institute of Nutrition and Functional Foods

DXA: dual-energy X-ray absorptiometry

$HbA_{1c}$: glycated hemoglobin

HOMA-IR: Homeostasis model assessment for insulin resistance

GDM+: exposed to gestational diabetes *in utero*

GDM-: unexposed to gestational diabetes *in utero*

## Introduction

Gestational diabetes mellitus (GDM) is a state of glucose intolerance that is first diagnosed during pregnancy (1). In addition to neonatal complications, such as macrosomia and hypoglycemia at birth (2), growing evidence suggests that GDM is associated with long term health risks in children exposed *in utero* (3). Results from a multiethnic case-control study comparing youth with and without a diagnosis of type 2 diabetes demonstrated an association between intrauterine exposure to maternal diabetes (including both GDM and pregestational diabetes) and type 2 diabetes in youth (4). In a recent multinational study, prenatal exposure to GDM was positively associated with obesity at 9-11 years of age (5). Accordingly, results from a cohort study of 7355 mothers and their child reported an increased risk of overweight and obesity in children exposed to GDM (6).

Although body mass index (BMI) is frequently used to assess children adiposity, other anthropometric measures may be better indicators of cardiometabolic risk (7). In order to improve our understanding of the relationship between GDM exposure and long term health risk, there is a need for more studies investigating the adiposity of children born from a GDM pregnancy in a more precise manner (5, 8). Since body composition and fat distribution may be predictive of cardiometabolic disease, their consideration would be of primary interest (7). Therefore, our study aims to compare body composition and regional body fat distribution between children that have been exposed or not to GDM *in utero* and to investigate the association of adiposity measures with the glycemic and insulin profile.

## Materials and methods

### Study population

Subjects were children aged between 3 to 12 years who participated in an ongoing cohort study that aims to evaluate the impact of GDM exposure during pregnancy and the influence of prenatal and postnatal lifestyle factors on offspring metabolic alterations predicting future risk of type 2 diabetes and obesity in childhood. This study started in 2012 and takes place at the Institute of Nutrition and Functional Foods (INAF), at Laval University (Quebec City, Canada). Mothers who had a pregnancy complicated or not complicated by GDM between 2003 and 2013 were recruited, as well as their children. They were recruited through invitation letters sent to women with a diagnosis of GDM according to medical records of the two major hospitals with a neonatal care unit in the metropolitan area of Quebec City (*Hôpital Saint-François d'Assise, Centre Hospitalier de l'Université Laval-CHUL*) or according to administrative data from the provincial health plan registry (*Régie de l'assurance maladie du Québec*) (9). Recruitment was also conducted by emails sent to Laval University community as well as posts on Facebook and healthcare websites. Children born from a pregnancy complicated by type 1 or type 2 diabetes were not eligible. The GDM status during pregnancy was obtained from medical records (53%) or from the provincial health plan registry (*Régie de l'assurance maladie du Québec*) databanks (39%). For the remaining participants (8%), GDM status was self-reported. Outcomes were measured during a 1 hour visit that took place at the INAF clinical unit. Written consent was obtained from all participants. This project was approved by the Laval University Ethics Committee (2011-196-A-4 R-3) and the *Centre hospitalier universitaire* Ethics Committee (2015-2031) and is registered in the Clinical Trials.gov registry (NCT01340924).

**Outcomes**

*Adiposity measures*

Children's height was measured to the nearest millimeter with a stadiometer. Weight was measured to the nearest 0.1 kilogram with a calibrated balance (Tanita BC-418, Tanita Corporation of America Inc; Arlington Heights, IL, USA) and BMI was calculated ($kg/m^2$). Weight and BMI *z* scores were obtained from the WHO AnthroPlus software (version 1.0.4, World Health Organization; Geneva, Switzerland). Since weight-for-age cannot distinguish between height and body mass during the pubertal growth spurt, weight *z* score was available for children under 10 years old only (10). Waist circumference was measured twice to the nearest millimeter at the umbilical level (11). The average of the 2 measures was considered for the analysis.

Total body composition was measured with a dual-energy X-ray absorptiometry scanner (DXA, GE Lunar Prodigy Bone Densitometer, GE Healthcare Lunar; Madison, WI, USA) by trained professionals using the Lunar enCORE software version 13.40. Thereafter, the first step was to exclude subjects with blurred image. To do so, two trained professionals (MK and JP) independently examined all scans to identify subjects with blurred image (i.e. when a deformation of body outlines was observed, probably caused by children movements during the exam). Disagreements were resolved by a third investigator (JR) and seven subjects were finally excluded. All scans were subsequently examined by a unique trained professional (MK) to ensure that lines automatically positioned by the software were correctly aligned with specific anatomic points and to manually adjust these lines when needed. This procedure ensures that all body parts, including the android and gynoid regions, were correctly framed in the regions of interest. As such, the head line and the caudal limit of the android region were exactly placed at the base of the chin and at the top of the iliac crest respectively. The upper limit of the android region was then automatically set to a height corresponding to 20% of the distance between the caudal limit

and the head line. The upper limit of the gynoid region was automatically set below the android region, at a distance of 1.5 time the height of the android region. The caudal limit of the gynoid region was automatically set to a distance of 2 time the height of the android region. Thereafter, all scans were transferred to the version 14.1 of the Lunar enCORE software to create the report of all body fat measures since this version includes the CoreScan option which enables the estimation of visceral fat. Total fat mass, lean mass, and their proportion were obtained. Fat mass and fat mass percentage in the android and the gynoid regions were assessed and the android-to-gynoid fat mass ratio was calculated (android fat mass percentage/gynoid fat mass percentage). Furthermore, we obtained the visceral fat mass and the visceral fat volume in the android region, a method that has been previously validated in the pediatric population (11).

*Glycemic and insulin profile*

Blood samples were collected after a twelve hour fasting period. Plasma glucose was measured enzymatically by hexokinase (12) and plasma insulin was measured by electrochemiluminescence (Roche Diagnostics; Indianapolis, IN, USA). The glycated hemoglobin ($HbA_{1c}$) level was measured using the Cobas Integra 800 analyzer standardized to the National Glycated Haemoglobin Standardisation Program (Integra inc.; Roche, Switzerland). The Homeostasis model assessment for insulin resistance (HOMA-IR) index was calculated (fasting insulinemia (μU/L)*fasting glycemia (mmol/L)/22.5) (13).

*Other measurements*

Information regarding pregnancy, breastfeeding and sociodemographic characteristics were obtained from the mother using self-administered questionnaires. Birth weight *z* score were calculated according to a population-based Canadian reference of birthweight for gestational age (14). Pubertal status was assessed by a questionnaire based on the Marshall and Tanner method (15, 16). The questionnaire was filled by children or their mother, according to their age and their

preference. Children who were at least at Tanner stage 2 for genital/breast development or for pubic hair development were considered to have reached puberty onset (17). Information about lifestyle habits was also collected. A first 24-hour food recall was administered, in person, using the Automated Multiple Pass Method. The recall was administered to the mother if the children was younger than 10 years and to the children if he was older. In each case, both the mother and the child were present to add information, when needed. A second 24-hour food recall was administered to the mother, by phone, within 7-10 days after the visit to the testing unit. Both recalls were analyzed with the Nutrition Data System for Research software (NDSR version 2011, Nutrition Coordinating Center; University of Minnesota, USA) and the average caloric intake was obtained. Mother's current waist circumference was measured twice, to the nearest millimeter, at the midpoint between the iliac crest and the lateral lowest limb and the average of the two measures was calculated (18). Mother's fat mass percentage was obtained by bioelectrical impedance analysis (Tanita BC-418). Measurement of height, weight and calculation of BMI was obtained by following the same method used for children.

**Statistical analyses**

Participants' characteristics were compared between children exposed (GDM+) and unexposed (GDM-) to GDM *in utero* using Chi-square tests for categorical variables and student t-tests for continuous variables. ANOVA was used to compare adiposity measures and glycemic and insulin profile between groups with adjustments for age and sex. The HPGENSELECT procedure, which use maximum likelihood techniques and a stepwise selection method, was used to determine for which additional co-variables it was relevant to adjust among the following: pubertal onset status (yes/no), breastfeeding (yes/no), total duration of breastfeeding (months), birth weight *z* score, daily energy intake, annual family income and the mother's current BMI. Subsequently, pubertal

status, birth weight *z* score and the mother's current BMI were added in the model for adiposity measures variables. Variables were transformed according to Box-Cox analysis, when needed, to meet basic assumptions of the model. Partial Pearson correlation coefficients were calculated to study the association between adiposity measures and the fasting glycemic and insulin profile among GDM+ children with adjustments for age and sex. Participants who had missing data for a variable were excluded from specific analyses that required this variable. Statistical significance was fixed to $p<0.05$ and the SAS software (version 9.4, SAS Institute inc.; Cary, USA) was used for analyses.

**Results**

A total of 161 children participated to the study but 86 of them (56 GDM+ children and 30 GDM-) were included in these analyses since they had complete measures of body composition and fat distribution. Participants' characteristics according to GDM exposure status are presented in Table 1. GDM+ children tended to be younger (p=0.091). Birth weight was similar between groups. Although gestational age at birth was lower among GDM+ children (p=0.024), birthweight for gestational age *z* score was also similar. Energy intake and the proportion of breastfed children tended to be lower among GDM+ children ($p$=0.077 and 0.090 respectively). Furthermore, current BMI, waist circumference and fat mass percentage were higher among mothers of GDM+ children ($p$=0.015, 0.003 and 0.011 respectively).

Associations between GDM exposure status and the various adiposity measures are shown in Table 2. Weight *z* score, BMI *z* score and total lean mass were similar between groups ($p$=0.508, 0.224 and 0.959 respectively). Nevertheless, GDM+ children tended to have increased total fat mass (p=0.098) and they had a significantly higher fat mass percentage and lower lean mass percentage compared to GDM- children ($p$=0.022 and 0.025 respectively). GDM+ children also

183 presented a higher total and relative amount of fat in the android region ($p$=0.048 and 0.025
184 respectively), a larger waist circumference ($p$=0.034) and a higher android-to-gynoid fat mass
185 ratio ($p$=0.019). The total and relative amount of fat in the gynoid region tended to be higher
186 among GDM+ children, although this difference did not reach statistical significance ($p$=0.062
187 and 0.051 respectively). The estimated volume of visceral adipose tissue in the android region
188 was not associated with GDM exposure status. Adjustment for birth weight *z* score did not
189 substantially change these results. On the other hand, additional adjustment for mother's BMI
190 attenuated the associations in a more important manner as none of the outcomes remained
191 significantly higher. Adjustment for the mother's waist circumference or fat mass percentage
192 attenuated the associations in a similar manner (data not shown). Regarding the fasting glycemic
193 and insulin profile, none of the four biochemical markers was associated with GDM exposure
194 status (Table 3).

195 As shown in Table 4, among GDM+ children, BMI z score, waist circumference, fat mass
196 percentage, android fat mass percentage and android-to-gynoid fat mass ratio were all positively
197 correlated with $HbA_{1C}$ (r=0.32-0.43, p<0.05). In addition, BMI *z* score and waist circumference
198 tended to be positively correlated with fasting glycemia (r=0.26 and 0.25, respectively, $p$<0.10).
199 None of the adiposity measures were correlated with fasting insulinemia and HOMA-IR.

200 **Discussion**

201 In this cohort study, being born from a mother with a pregnancy complicated by GDM was
202 associated with alterations in fat mass proportion and distribution. Indeed, *in utero* exposure to
203 GDM was associated with a higher fat mass proportion and with indicators of abdominal fat
204 deposition. Moreover, these alterations were associated with a less favourable glycemic profile.

Results from this study showed that GDM+ children presented increased fat mass percentage compared to GDM- children. This is in agreement with results from a multinational cohort study conducted by Zhao *et al*., where body fat *z* score was also higher among children aged 9-11 years that have been exposed to GDM *in utero* compared to children that have not been exposed (5). However, this study also reported an increased BMI *z* score among children exposed to GDM which was not observed in the current study (5). In contrast, Wright *et al.* observed an association between GDM exposure and children adiposity measured by the sum of skinfolds, but not by BMI *z* score at 3 years old (19). Moreover, in a study including overweight and normal weight children that had been exposed or not to GDM, a main effect of GDM exposure status on fat mass percentage was observed irrespective of weight status (20). Those results combined with results obtained in the current study suggest that there might be body composition alterations in GDM+ children even in the absence of apparent increased weight. BMI is a less precise marker of adiposity compared to fat mass suggesting that subtle changes in body composition may not be reflected by measured weight (7, 19). Considering that our cohort includes a majority of young children (57% are 6 years old or under), we can hypothesize that current alterations in fat mass are subtle and that alterations in BMI may not be fully apparent before a certain age (8, 19).

We also observed that GDM+ offspring presented higher measures of waist circumference, android fat mass, android fat mass percentage and android-to-gynoid fat mass ratio compared to GDM- children. Other studies reported increased waist circumference among children exposed to GDM or pre-existing diabetes (5, 8). In addition, 82 children aged 6-13 years exposed to maternal GDM from the retrospective EPOCH cohort Study presented an increased subscapular-to-triceps skinfold thickness ratio, another indicator of central fat deposition, and a larger quantity of subcutaneous fat in the abdominal area measured by magnetic resonance imaging (8). Chandler-

Laney also reported an increased trunk fat mass measured by DXA among 24 children aged 5-10 years exposed to maternal GDM (20). These results are consistent with results obtained in the current study and suggest that children born from a pregnancy complicated by GDM are predisposed to a more centralized fat pattern, which may influence the risk of cardiovascular disease (7). Similar to the EPOCH study, we did not observe significant increased quantity of visceral adipose tissue in the abdominal area (8). Considering that the majority of children's abdominal fat is subcutaneous and that visceral fat deposition generally increases with age, we can hypothesize that it was too early to detect increased visceral adipose tissue (8, 21, 22).

Mechanisms explaining the association between GDM exposure and alterations in fat proportion and distribution are not fully understood. Existing, albeit limited, sibling studies suggest that the association between maternal GDM or pregestational diabetes and offspring long-term health cannot be entirely explained by genetic inheritance (23, 24). It has been proposed that maternal hyperglycemia creates an altered *in utero* environment which leads to fetal hyperinsulinemia (2). This may result in increased fetal growth, or more specifically, in increased fat mass at birth that could persist in childhood (2, 25-27). However, in the current study and others, the association between GDM exposure and adiposity measures remained significant after adjustment for birthweight suggesting that the association observed cannot completely be explained by fetal overgrowth (8). One possibility is that birthweight is probably not the most precise indicator of fetal overgrowth (25). Indeed, Catalano *et al.* observed that normal weight neonates of GDM pregnancies still present increased fat mass (27). Another explanation is that the altered *in utero* environment associated with GDM may predispose to later body composition and fat distribution alterations through epigenetic mechanisms (2, 28). In the present report as well as in other studies (5, 8), results were attenuated when adjustments for maternal BMI or other adiposity measures

were performed. Indeed, obesity is a risk factor for GDM and is associated with insulin resistance (1, 25). This physiological state, in addition of contributing to hyperglycemia, is also associated with increased free fatty acids and triglyceride levels, which may possibly promote fetal growth (25). Thus, maternal adiposity may contribute to the altered *in utero* environment to which the fetus is exposed in GDM pregnancies (25).

This study has some limitations. Reliable information about mothers' blood glucose levels during pregnancy was unavailable. It has been previously shown that outcomes in children born from diabetic pregnancies may be dependent on the degree of hyperglycemia to which they were exposed *in utero* (29). Consequently, the degree of GDM severity and the glycemic control of the recruited mothers may have modulated the association that we have observed. For the same reason, an accurate value for mothers' pre-pregnancy BMI was not available and current BMI was used in the present study. Nevertheless, other authors noted that current BMI strongly correlates with pre-pregnancy BMI suggesting that it is a reliable estimate (5, 30). Finally, family income was relatively high in our cohort which may limit the generalisability of our results. This study also presents many strengths. Among those, various adiposity measures of body composition and body fat distribution were investigated while most studies reported results on children BMI only. Moreover, adiposity measures were obtained with a DXA scan, which is considered a precise and accurate method in the pediatric population (31). Finally, only exposure to maternal GDM (not other types of diabetes) was investigated and GDM status was medically confirmed for the majority of the participants.

This study suggests that despite a normal BMI, children born from a pregnancy complicated by GDM may present alterations in body fat proportion and distribution that are associated with a less favourable glycemic profile. These results highlight the importance of expanding

anthropometric evaluation in this population to other measurements than BMI alone, both in research and clinical settings. Future researches are needed to identify how to prevent these alterations during the prenatal period or during infancy and childhood.

## Conflicts of interest

Dr. Tchernof reports grants from Johnson & Johnson Medical Companies, outside the submitted work. Other authors declared no conflict of interest.

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*Contribution statement*

IM, SJW, AT and JR participated to the conception and the design of the study. MK and JP had a substantial contribution to data acquisition. MK, JP and JR participated to data analysis and interpretation. The first draft of the manuscript was written by MK and all authors revised it critically for important intellectual content and approved the final version. JR is responsible of the integrity of the study.

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299 **Table 1**. Participant's characteristics according to GDM exposure status

| | **GDM+** n=56 | **GDM-** n=30 | ***p*** |
|---|---|---|---|
| Age (years) | 6.3 ± 2.4 | 7.0 ± 2.1 | 0.091 |
| 3-6 years | 35 (62.5) | 14 (46.7) | 0.313 |
| 7-9 years | 14 (25.0) | 12 (40.0) | |
| 10-12 years | 7 (12.5) | 4 (13.3) | |
| Sex | | | |
| Boys | 29 (51.8) | 14 (46.7) | 0.651 |
| Pubertal status[a] | | | |
| Puberty onset | 12 (22.2) | 4 (13.3) | 0.320 |
| Gestational age[b] | 38.8 ± 1.4 | 39.5 ± 1.2 | **0.024** |
| Birth weight (g)[c] | 3346 ± 442 | 3267 ± 558 | 0.479 |
| Birth weight > 4000 g | 1 (1.9) | 2 (6.9) | 0.284 |
| Birth weight *z* score[d] | 0.03 ± 0.85 | -0.39 ± 1.18 | 0.102 |
| Birth order[a] | | | |
| 1st | 26 (48.1) | 17 (56.7) | 0.722 |
| 2nd | 18 (33.3) | 9 (30.0) | |
| ≥3rd | 10 (18.5) | 4 (13.3) | |
| Breastfed children[b] | 46 (83.6) | 29 (96.7) | 0.090 |
| Energy intake (kcal/day) | 1611 ± 339 | 1787 ± 473 | 0.077 |
| ***Maternal characteristics*** | | | |
| GDM treatment | | | |
| Diet[e] | 51 (94.4) | - | - |
| Insulin[f] | 33 (62.3) | | |
| Other medication[f] | 1 (1.9) | | |
| Annual family income ($ CA)[g] | | | |
| 0 – 39 999 | 8 (18.2) | 6 (25.0) | 0.768 |
| 40 000 – 79 999 | 10 (22.7) | 7 (29.2) | |
| 80 000 – 99 999 | 9 (20.4) | 3 (12.5) | |
| ≥ 100 000 | 17 (38.6) | 8 (33.3) | |
| Current BMI (kg/m$^2$) | 27.2 ± 7.2 | 23.6 ± 4.4 | **0.015** |
| Current waist circumference (cm) | 89.4 ± 16.8 | 79.9 ± 8.9 | **0.003** |
| Current fat mass percentage | 33.8 ± 8.9 | 28.8 ± 7.7 | **0.011** |

**Table 2.** Association between *in utero* GDM exposure and adiposity measures

| | **GDM+** n=56 | **GDM-** n=30 | **Cohen's d** | ***P*[1]** | ***P*[2]** | ***P*[3]** |
|---|---|---|---|---|---|---|
| Weight (kg) | 25.2 ± 10.9 | 24.9 ± 6.9 | 0.03 | 0.395 | 0.807 | 0.629 |
| Weight *z* score[a] | 0.27 ± 0.86 | 0.08 ± 0.71 | 0.24 | 0.508 | 0.771 | 0.727 |
| BMI ($kg/m^2$) | 16.6 ± 2.9 | 16.0 ± 1.7 | 0.25 | 0.109 | 0.151 | 0.618 |
| BMI *z* score | 0.33 ± 1.02 | 0.03 ± 0.81 | 0.33 | 0.224 | 0.376 | 0.918 |
| Waist circumference (cm) | 56.8 ± 8.1 | 55.3 ± 5.8 | 0.21 | **0.034** | **0.040** | 0.255 |
| Fat mass (g) | 7182 ± 5273 | 6205 ± 2323 | 0.49 | 0.098 | 0.157 | 0.997 |
| Fat mass percentage | 27.0 ± 6.4 | 24.7 ± 4.0 | 0.43 | **0.022** | **0.023** | 0.381 |
| Lean mass (g) | 16 988 ± 5762 | 17 707 ± 4676 | 0.14 | 0.959 | 0.649 | 0.411 |
| Lean mass percentage | 69.3 ± 6.2 | 71.5 ± 3.9 | 0.42 | **0.025** | **0.025** | 0.401 |
| Android fat mass (g) | 355.8 ± 365.8 | 257.4 ± 152.2 | 0.35 | **0.048** | 0.055 | 0.571 |
| Android fat mass percentage | 20.3 ± 9.4 | 16.7 ± 6.0 | 0.46 | **0.025** | **0.023** | 0.359 |
| Gynoid fat mass (g) | 1157 ± 890 | 1005 ± 435 | 0.22 | 0.062 | 0.101 | 0.806 |
| Gynoid fat mass percentage | 32.1 ± 7.1 | 29.5 ± 4.8 | 0.43 | 0.051 | **0.048** | 0.519 |
| Android-to-gynoid fat mass ratio | 0.61 ± 0.17 | 0.56 ± 0.13 | 0.33 | **0.019** | **0.019** | 0.251 |
| Android visceral adipose tissue mass (g) | 82.6 ± 131.8 | 53.7 ± 42.8 | 0.29 | 0.191 | 0.224 | 0.599 |
| Android visceral adipose tissue volume ($cm^3$) | 87.6 ± 139.6 | 56.9 ± 45.4 | 0.30 | 0.193 | 0.228 | 0.605 |

**Table 3.** Association between *in utero* GDM exposure and glycemic and insulin profile

| | **GDM+** n=52 | **GDM-** n=26 | **Cohen's d** | ***P*[1]** |
|---|---|---|---|---|
| Glycemia[a] | 5.09 ± 0.40 | 5.07 ± 0.40 | 0.05 | 0.528 |
| Insulinemia[a] | 59.2 ± 25.9 | 55.2 ± 17.4 | 0.18 | 0.204 |
| $HbA_{1c}$ | 0.053 ± 0.003 | 0.052 ± 0.002 | 0.39 | 0.107 |
| HOMA-IR[b] | 1.97 ± 1.02 | 1.80 ± 0.66 | 0.20 | 0.155 |

**Table 4.** Association between adiposity measures and fasting glycemic and insulin profile among GDM+ children

| | Glycemia[a] | Insulinemia[a] | $HbA_{1c}$[a] | HOMA-IR[a] |
|---|---|---|---|---|
| BMI *z* score | 0.26* | 0.14 | **0.37**** | 0.17 |
| Waist circumference | 0.25* | 0.19 | **0.37**** | 0.21 |
| Fat mass percentage | 0.17 | 0.21 | **0.43**** | 0.22 |
| Android fat mass percentage | 0.21 | 0.08 | **0.41**** | 0.11 |
| Android-to-gynoid fat mass ratio | 0.22 | 0.01 | **0.32**** | 0.05 |

## Table Legends

Table 1: Results are expressed as raw means ± standard deviations or n (%). GDM: gestational diabetes mellitus, GDM+: exposed to gestational diabetes *in utero*, GDM-: unexposed to gestational diabetes *in utero*, [a]n=84 [b]n=85 [c]n=82 [d]n=81 [e]n=54 [f]n=53 [g]n=68

Table 2: Results are expressed as raw means ± standard deviations. BMI: body mass index, GDM: gestational diabetes mellitus, GDM+: exposed to gestational diabetes *in utero*, GDM-: unexposed to gestational diabetes *in utero* [1]Adjusted for age and sex (except for *z* scores) and puberty onset (yes/no) [2]Adjusted for age and sex (except for *z* scores), puberty onset (yes/no) and birthweight *z* score [3]Adjusted for age and sex (except for *z* scores) puberty onset (yes/no), birthweight *z* score and actual maternal BMI, [a]n=75

Table 3: Results are expressed as raw means ± standard deviations. GDM+: exposed to gestational diabetes *in utero*, GDM-: unexposed to gestational diabetes *in utero*, HOMA-IR: Homeostasis model assessment for insulin resistance, [1]Adjusted for age and sex, [a]n=25 for GDM-children, [b]n=24 for GDM- children

Table 4: Results are expressed as partial Pearson's correlation coefficients (r) with adjustments for age and sex. BMI: body mass index, GDM+: exposed to gestational diabetes *in utero*, $HbA_{1c}$: glycated hemoglobin, HOMA-IR: Homeostasis model assessment for insulin resistance, [a]n=52, $^{*}p<0.10$, $^{**}p<0.05$

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