Abdominal Adiposity and Insulin Resistance in Early Pregnancy

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Abstract

Background: High pre-pregnancy body mass index is a known risk factor for gestational diabetes mellitus, but the contribution of abdominal adiposity to insulin resistance (IR) in pregnancy is not well understood. We assessed the association between abdominal adiposity in early pregnancy and IR.

Methods: We completed a prospective cohort study of 79 pregnant women. Visceral adipose tissue (VAT) depth was measured by ultrasonography at 11 to 14 weeks' gestation, at the time of routine fetal nuchal translucency assessment. A two-hour 75 g oral glucose tolerance test was subsequently completed at 16 to 22 weeks' gestation and IR was estimated by the homeostatic model assessment of insulin resistance (HOMA-IR) as well as by the insulin sensitivity index.

Results: After adjusting for maternal age, parity, ethnicity, and pre-pregnancy BMI, VAT depth explained 42% of the variance in HOMA-IR, which was slightly better than the variance in the multivariable model examining HOMA-IR and pre-pregnancy BMI (40%). For the insulin sensitivity index, the model variance values were 36% and 32%, respectively.

Conclusion: Measurement of maternal adipose tissue depth at the time of routine first-trimester ultrasonography may provide additional information about maternal IR, beyond pre-pregnancy BMI.

Key Words: Central adiposity, obesity, body mass index, insulin resistance, insulin sensitivity index, gestational diabetes, glucose handling

Competing Interests: None declared.

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Résumé

Contexte : Bien que la présence d'un indice de masse corporelle prégrossesse élevé soit un facteur de risque connu pour ce qui est du diabète sucré gestationnel, l'apport de l'adiposité abdominale à l'insulinorésistance (IR) pendant la grossesse n'est pas bien compris. Nous avons évalué l'association entre l'adiposité abdominale aux débuts de la grossesse et l'IR.

Méthodes : Nous avons mené une étude de cohorte prospective auprès de 79 femmes enceintes. La profondeur du tissu adipeux viscéral (TAV) a été mesurée par échographie à 11-14 semaines de gestation, dans le cadre de l'évaluation systématique de la clarté nucale fœtale. Une épreuve d'hyperglycémie provoquée par voie orale (deux heures, 75 g) a par la suite été menée à 16-22 semaines de gestation et l'IR a été estimée au moyen du modèle homéostatique d'évaluation de l'insulinorésistance (HOMA-IR), ainsi qu'au moyen de l'indice de sensibilité à l'insuline.

Résultats : À la suite de la neutralisation des effets de l'âge maternel, de la parité, de l'ethnicité et de l'IMC prégrossesse, la profondeur du TAV a permis d'expliquer 42 % de la variance constatée dans le cadre du HOMA-IR, ce qui était légèrement mieux qu'en ce qui concerne la variance constatée dans le cadre du modèle multivarié faisant appel au HOMA-IR et à l'IMC prégrossesse (40 %). Pour ce qui est de l'indice de sensibilité à l'insuline, les valeurs quant à la variance pour chacun des modèles ont été de 36 % et de 32 %, respectivement.

Conclusion : La mesure de la profondeur du tissu adipeux maternel, au moment de la tenue systématique de l'échographie au cours du premier trimestre, pourrait fournir des renseignements supplémentaires au sujet de l'IR maternelle, au-delà de ce qu'indique l'IMC prégrossesse.

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INTRODUCTION

Approximately 4% to 8% of pregnancies are affected by gestational diabetes mellitus.[1] Maternal obesity is associated with a higher risk of GDM[2] and adverse pregnancy outcomes.[3–5] Moreover, GDM and type 2 diabetes mellitus share common risk factors,[3] including pre-pregnancy obesity and non-Caucasian ethnicity.[5] It is understood that women with a history of GDM are at increased risk of type 2 DM[5,6]; however, those with even subtle abnormalities of glucose homeostasis in pregnancy are also at higher risk of developing glucose impairment and DM.[6]

Current guidelines recommend screening for GDM at 24 to 28 weeks' gestation with a one-hour glucose challenge test, followed by a confirmatory two-hour oral glucose tolerance test, or simply screening with the two-hour OGTT alone.[7] However, initiating dietary or pharmacological therapy after 24 to 28 weeks' gestation may be too late to favourably affect fetal growth or placental integrity. First trimester assessment of insulin resistance, using the homeostatic model assessment of insulin resistance or the insulin sensitivity index, appears to correlate well with later development of GDM.[8,9] Other first trimester biomarkers have also been shown to predict the future onset of GDM, albeit with limited consistency.[10–17]

Measurement of central obesity in early pregnancy may be another method to predict the onset of GDM. In a pilot study, we showed that ultrasound-measured visceral adipose tissue depth above the upper quartile in early pregnancy was associated with a positive GCT in later pregnancy (adjusted OR 16.9; 95% CI 1.5 to 194.6),[18] independent of BMI. Whether central adipose tissue depth is associated with IR or dysglycemia in early pregnancy remains unknown. Accordingly, we investigated the relationship between first trimester measurement of central adipose tissue depth and IR in early pregnancy.

ABBREVIATIONS

DM	diabetes mellitus
GCT	glucose challenge test
GDM	gestational diabetes mellitus
HOMA-IR	homeostatic model assessment of insulin resistance
IR	insulin resistance
ISI	insulin sensitivity index
OGTT	oral glucose tolerance test
SAT	subcutaneous adipose tissue
TAT	total adipose tissue
VAT	visceral adipose tissue

METHODS

We conducted a prospective cohort study at a general obstetrics outpatient clinic at St. Michael's Hospital in Toronto, Ontario. Participants provided written informed consent.

Women aged 18 years and older were eligible for entry into the study if they had a viable singleton pregnancy at 11 to 14 weeks' gestation. We excluded those who had known pre-pregnancy type 2 DM or a prior pregnancy affected by GDM.

At 11 to 14 weeks' gestation, the abdominal adipose tissue compartments were distinguished and measured by a trained ultrasound technician at the time of a routine fetal ultrasound, as previously described.[18] In brief, subcutaneous adipose tissue depth was measured from the SAT layer to the outer border of the rectus abdominus muscle at the level of the linea alba and the umbilicus. VAT depth was measured from the inner border of the rectus abdominus muscle, at the level of the linea alba, to the anterior wall of the abdominal aorta. Total adipose tissue depth was measured from the SAT layer to the anterior wall of the abdominal aorta. Depth and zoom settings were standardized, such that the aorta was at the bottom of the screen and the vertebral bodies were just visible. The performance characteristics of this technique include an interobserver reliability of 0.79 (95% CI 0.69 to 0.88) for SAT and 0.87 (95% CI 0.82 to 0.93) for VAT.[18] Measurements were taken using a Phillips IU22 ultrasound system (Philips Electronics NV, Eindhoven, The Netherlands) with either a 5–2 MHz or 9 MHz probe.

A brief questionnaire was completed by each participant immediately following the 11- to 14-week ultrasound. Therein, we collected information about age, ethnicity (Caucasian, black, South Asian, East Asian, or other), self-reported pre-gestational height and weight, and a family history of type 2 DM in first-degree relatives. Current weight was measured in person using a calibrated scale during the routine ultrasound appointment.

At 16 to 22 weeks' gestation, at the time of routine blood sampling for integrated prenatal screening, each participant completed a two-hour, 75 g OGTT following an overnight fast. In addition to serum glucose, we measured the fasting, one-hour, and two-hour serum insulin concentrations. The HOMA-IR and ISI composite at 0, 60, and 120 minutes were calculated as previously described.[8,19] Insulin concentration was measured in pmol/L, so the data were converted to μU/mL to calculate HOMA-IR. Glucose concentration was measured in mmol/L, so the data were converted to mg/dL to calculate ISI.