Body Composition Is Normal in Term Infants Born to Mothers With Well-Controlled Gestational Diabetes Mellitus

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OBJECTIVE—This study aims to describe body composition in term infants of mothers with gestational diabetes mellitus (GDM) compared with infants of mothers with normal glucose tolerance (NGT).

RESEARCH DESIGN AND METHODS—This cross-sectional study included 599 term babies born at Royal Prince Alfred Hospital, Sydney, Australia. Neonatal body fat percentage (BF%) was measured within 48 h of birth using air-displacement plethysmography. Glycemic control data were based on third-trimester HbA1c levels and self-monitoring blood glucose levels. Associations between GDM status and BF% were investigated using linear regression adjusted for relevant maternal and neonatal variables.

RESULTS—Of 599 babies, 67 (11%) were born to mothers with GDM. Mean ± SD neonatal BF% was 7.9 ± 4.5% in infants with GDM and 9.3 ± 4.3% in infants with NGT, and this difference was not statistically significant after adjustment. Good glycemic control was achieved in 93% of mothers with GDM.

CONCLUSIONS—In this study, neonatal BF% did not differ by maternal GDM status, and this may be attributed to good maternal glycemic control.
formed written parental consent was obtained, and participation was voluntary.

RESULTS—Eight hundred fifteen mothers and their babies were approached for our study. Thirty-three were ineligible due to >2 days of neonatal intensive care unit admission, of which 2 were in the GDM group; 150 women were ineligible as they were discharged early before measurements could be taken, and 30 refused participation. A further three mothers had pregestational diabetes and were excluded. Thus, our study population consisted of 532 participants in the NGT group and 67 in the GDM group.

There was no significant difference in maternal age between the GDM (33.2 ± 4.7 years) and NGT (32.5 ± 5.1 years, P = 0.22) groups. There was a significant difference (P = 0.001) in the distribution of maternal ethnicity between the GDM and NGT groups: 27 (40%) versus 335 (63%) Caucasians, respectively; 36 (54%) versus 164 (31%) Asians, respectively; and 4 (6%) and 33 (6%) other ethnicities including African, Middle Eastern, and Polynesian, respectively. Mothers with GDM were more likely to be overweight or obese (36 compared with 22%; P = 0.011).

Good glycemic control was achieved in most subjects, with 56 of 62 (90%) women meeting both fasting and postprandial ADIPS targets at the time of study. Mean ± SD third-trimester HbA1c for the whole GDM group was 5.4 ± 0.4 mmol/L. We obtained self-monitoring data for 46 women (mean of 132 readings per patient): mean ± SD BGLs were 4.8 ± 0.5 mmol/L fasting, 6.7 ± 1.1 mmol/L 1-h postbreakfast, 6.4 ± 0.7 mmol/L postlunch, and 6.5 ± 0.7 mmol/L postdinner.

After adjusting for gestational age, neonatal sex, and maternal variables known to influence body composition (Table 1), there was no significant difference in BF% between the GDM and NGT infants (mean difference 0.095 [95% CI −0.00 to 0.31]; P = 0.151) (Table 1). Similarly, after adjustment, there were no significant differences between the GDM and NGT infants in terms of birth weight and other anthropometric measurements.

CONCLUSIONS—To our knowledge, this is the first study to demonstrate that normal neonatal body composition can be achieved in infants born to mothers with GDM with good glycemic control. Previous studies have reported increased FM and birth weight, as well as disproportionate anthropometry (decreased head-to-shoulder ratio) in infants of mothers with GDM compared with infants born to nondiabetic mothers (1,12,13). A recent study using ADP found a higher mean BF% in GDM infants of 12.1% (5). It is difficult for us to make comparisons with that study because the proportion of GDM control, as well as maternal characteristics such as pregravid BMI and ethnicity, are different, and this may account for the differences in BF%.

Nevertheless, the degree of glycemic control achieved in our mothers with GDM was consistent with the recent consensus guidelines from ADIPS, which recommend a fasting BGL ≤5.0 mmol/L and 1-h postprandial BGL ≤7.4 mmol/L (14). It was therefore reassuring that neonatal BF% was normalized with good maternal glycemic control and establishes that this is the benchmark for other clinical settings.

This study suggests that fetal adiposity is corrected with the treatment and control of GDM, and thus early detection and treatment of GDM can be a means to prevent neonatal overgrowth, which is strongly related to childhood obesity and diabetes. Our future work includes follow-up of our cohort to evaluate long-term outcomes.

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**Table 1—Neonatal anthropometric data for GDM versus NGT infants**

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>GDM (n = 67)</th>
<th>NGT (n = 532)</th>
<th>Unadjusted</th>
<th>Adjusted*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B coefficient**</td>
<td>95% CI</td>
<td>P value</td>
<td>B coefficient**</td>
</tr>
<tr>
<td>Birth weight (g)</td>
<td>3,271 ± 488</td>
<td>3,436 ± 471</td>
<td>−188.6</td>
<td>308.7 to −68.4</td>
</tr>
<tr>
<td>LGA (&gt;90th centile)</td>
<td>5 (7)</td>
<td>46 (9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGA (&lt;10th centile)</td>
<td>7 (10)</td>
<td>60 (11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGA (10–90th centile)</td>
<td>55 (82)</td>
<td>426 (80)</td>
<td></td>
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<tr>
<td>Length (cm)</td>
<td>49.1 ± 2.1</td>
<td>49.7 ± 2.0</td>
<td>−0.82</td>
<td>−1.32 to −0.31</td>
</tr>
<tr>
<td>Head circumference (cm)</td>
<td>34.1 ± 1.4</td>
<td>34.5 ± 1.2</td>
<td>−0.50</td>
<td>−0.81 to −0.19</td>
</tr>
<tr>
<td>Abdominal circumference (cm)</td>
<td>29.5 ± 2.4</td>
<td>30.5 ± 2.1</td>
<td>−0.71</td>
<td>−1.35 to −0.07</td>
</tr>
<tr>
<td>Chest circumference (cm)</td>
<td>31.7 ± 1.6</td>
<td>32.5 ± 1.9</td>
<td>−0.62</td>
<td>−1.11 to −0.13</td>
</tr>
<tr>
<td>Percent fat</td>
<td>7.9 ± 4.5</td>
<td>9.3 ± 4.3</td>
<td>−1.34</td>
<td>−2.44 to −0.23</td>
</tr>
<tr>
<td>FFM (g)</td>
<td>2,846 ± 338</td>
<td>2,959 ± 342</td>
<td>−0.12</td>
<td>−0.21 to −0.03</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>28 (42)</td>
<td>284 (53)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>39 (58)</td>
<td>248 (47)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data are mean ± SD or n (%) unless otherwise indicated. AGA, appropriate for gestational age; LGA, large for gestational age; SGA, small for gestational age. *Adjusted for gestational age, neonatal sex, maternal age, maternal pregravid BMI, gestational weight gain, parity, maternal smoking status, maternal ethnicity, and maternal hypertension. **B coefficient is the difference in outcome for GDM compared with NGT.
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C.P.A. contributed to the data design and acquisition of data, analyzed the data, and wrote the manuscript. C.H.R.-G. designed the study, contributed to the analysis and interpretation of data and the discussion, and reviewed and edited the manuscript. R.M.T. provided statistical advice and reviewed and edited the manuscript. A.E.C. assisted with the study design and supervised data collection. H.E.J. designed the study, supervised data collection, contributed to data analysis, interpretation, and discussion, and reviewed and edited the manuscript. C.P.A. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

These data were presented as an oral paper to the Australian Diabetes in Pregnancy Society Annual Scientific Meeting, Queensland, Australia, 31 August to 1 September 2012 and the 16th Annual Congress of the Perinatal Society of Australia and New Zealand and 17th Congress of the Federation of Asian and Oceania Perinatal Societies, Sydney, Australia, 18–21 March 2012 and as a poster at the GP11 conference of the Royal Australian College of General Practitioners, Hobart, Tasmania, 6–8 October 2011. This study was also published in abstract form in The Journal of Paediatrics and Child Health [Au CP, Raynes-Greenow CH, Carberry AE, Jeffery HE. Body composition and neonatal outcomes of infants born to mothers with gestational diabetes mellitus. J Paediatr Child Health 2012;48(Suppl. 1):79].

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References
AUTHOR QUERIES

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Q3: Please provide volume, page numbers, and publication year for reference 11, if now available.

Q4: Check that the conflict of interest information for each author is presented in full in the Acknowledgments section.