Relationship Between Leg Length and Gestational Diabetes Mellitus in Chinese Pregnant Women

RUN MEI MA, PHD, MD[1]
TERENCE T. LAO, MD[2]
CHUN LING MA, MPHIL[1]
SHU JIE LIAO, MPHIL[1]
YAN FENG LU, MPHIL[1]
MING YU DU, MPHIL[1]
HONG XIAO, BSC[1]
LAN ZHANG, BSC[1]
MING HUI YANG, BSCN[1]
XUE XIAO, MPHIL[1]

The relationship between maternal short stature and gestational diabetes mellitus (GDM) remains controversial. While such an association has been shown in Europeans, South Americans, and Southern Asians (1–5), it was not demonstrated in Hungarians of European origin (6). Apart from ethnic differences, the contribution of the different components of height to overall height could have influenced this association, since leg length rather than trunk length has been correlated with type 2 diabetes in British women (7), and a similar observation in women with GDM has since been reported (5). As Chinese women are generally shorter than their European counterparts because of shorter legs, we have examined the relationship between overall height and components of height with the development of GDM in Chinese women to address this issue.

RESEARCH DESIGN AND METHODS— This prospective cohort study was conducted in Kunming, China, from August 2004 to March 2005. All the patients were ethnic Chinese. A 75-g oral glucose tolerance test (OGTT) was arranged at booking for women with risk factors for GDM. If the initial results were normal, the OGTT was repeated at 28–32 weeks. All low-risk women received the OGTT at 28–32 weeks. No preliminary challenge test was used. The OGTT results were interpreted by World Health Organization criteria (8), which have been studied in Chinese populations before (9–11).

Maternal demographic data were collected at the first visit. Height and weight at the time of OGTT were recorded, with the weight measurement taken to the nearest 0.1 kg while subjects wore light clothing. Height without shoes was measured with a stadiometer to the nearest 0.5 cm with the subject standing and also while sitting on a stool (5). Trunk length was calculated by deducting the stool height from the measured sitting height. Leg length was calculated by deducting the trunk height from the measured standing height as previously described (5), and the absolute and percentage values were compared between women with and without GDM.

Statistical analysis was performed with SPSS (version 11.5; SPSS, Chicago, IL). Comparison between the GDM and non-GDM groups was performed with Student's t test for maternal characteristics and OGTT results, and the multiple stepwise linear regression analysis was performed to examine the independent determinants of GDM.

RESULTS— Of the 994 women who completed the study, 163 (16.4%) developed GDM (Table 1). This group was older ($P < 0.001$) and had greater weight gain at OGTT ($P = 0.005$), and their overall height tended to be shorter ($P = 0.06$). However, leg length ($P = 0.004$), leg-to-height percentage ($P = 0.018$), and leg-to-trunk ratio ($P = 0.004$) were significantly reduced, while the trunk-to-height ratio ($P = 0.018$) was significantly increased, without any difference in trunk length. Using the receiver operating characteristic curve, trunk-to-height percentage, weight gain, age, and trunk length were found to be significant but weak predictors for GDM, while the height components were correlated with only the OGTT fasting value on partial correlation analysis. Regression analysis, adjusting for age, total height, BMI at OGTT, and parity, indicated that leg-to-trunk ratio ($P = 0.003$) and leg length ($P = 0.004$) were significantly independent determinants of fasting and 2-h values, respectively.

CONCLUSIONS— In agreement with the study by Moses and Mackay (5), we have demonstrated a significant association between maternal leg length and GDM. Specifically, leg length is an independent determinant of, and inversely correlated with, the OGTT 2-h glucose value. While the design of our study did not allow us to explore the underlying pathophysiological mechanisms, this phenomenon may be related to glucose disposal after ingestion of a glucose load. It has been reported (12) that leg uptake of glucose was significantly stimulated above basal values after an oral glucose ingestion and that 71% of the ingested load was eventually taken up by peripheral tissues, primarily muscles, suggesting that it is the peripheral and not splanchnic tissues that play the predominant role in the disposal of an oral glucose load. It can be envisaged that subjects with shorter legs have fewer peripheral muscles than subjects with longer legs and that their ability to dispose of an orally ingested glucose load would have decreased, thus resulting in a higher 2-h glucose value in the OGTT.

Nevertheless, the leg-to-trunk ratio

From the [1]Department of Obstetrics and Gynecology, 1st Affiliated Hospital of Kunming Medical College, Kunming, Yunnan Province, P. R. China; and the [2]Department of Obstetrics and Gynaecology, University of Hong Kong, Hong Kong, P. R. China.
Address correspondence and reprint requests to Dr. Run Mei Ma, Department of Obstetrics and Gynecology, 1st Affiliated Hospital of Kunming Medical College, P.O. Box 650032, 295 Xichang Rd., Kunming, Yunnan Province, P. R. China. E-mail: marunmei@hotmail.com.
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Abbreviations: GDM, gestational diabetes mellitus; OGTT, oral glucose tolerance test.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Maternal characteristics in subjects with versus without GDM*

	Non-GDM	GDM	*P*
n	831	163	<0.001
Maternal age (years)	28.4 ± 3.6	29.6 ± 4.0	<0.001
Gestational age at OGTT (weeks)	31.0 ± 3.0	29.9 ± 3.4	NS
Maternal height (cm)	160.0 ± 4.3	159.3 ± 4.7	NS
Weight (kg)			
Prepregnant	51.7 ± 6.5	51.0 ± 6.7	NS
At OGTT	63.8 ± 7.4	64.0 ± 7.8	0.005
Weight gain at OGTT	12.1 ± 4.0	13.1 ± 4.4	NS
BMI (kg/m^2)			
Prepregnant	20.2 ± 2.3	20.1 ± 2.4	NS
At OGTT	24.9 ± 2.7	25.2 ± 2.7	0.004
Leg length (cm)	72.2 ± 3.6	71.3 ± 3.3	0.018
Leg-to-height ratio (%)	45.1 ± 1.7	44.8 ± 1.5	NS
Trunk length (cm)	87.8 ± 3.4	88.0 ± 3.3	0.018
Trunk-to-height ratio (%)	54.9 ± 1.7	55.3 ± 1.5	0.004
Leg-to-trunk ratio (%)	81.8 ± 5.6	80.4 ± 4.3	<0.001
OGTT results (mmol/l)			
Fasting	3.7 ± 0.6	4.3 ± 1.0	<0.001
2-h	6.0 ± 1.0	9.0 ± 1.3	<0.001

Data are means ± SD. NS, not significant.

was shown to be an independent determinant of, and again inversely correlated with, the OGTT fasting glucose value in our subjects. As a relatively larger trunk would imply a greater amount of centrally distributed fat cells, an increasing proportion of the trunk relative to overall height could have contributed to the impairment of insulin secretory capacity and increased insulin resistance reported in shorter pregnant and nonpregnant women (2,7). These factors could in turn be responsible for the inverse correlation between leg-to-trunk ratio and fasting glucose values.

Our finding that reduced leg length and the leg-to-height ratio, rather than the overall height itself, was associated with GDM can help explain the controversial observations in the literature. We suspect that leg length plays a greater role than overall height in this regard in ethnic groups that tend to be shorter, such as the Chinese, in whom the difference in overall height between the GDM and non-GDM subjects became reduced. Although short leg length is an independent predictor of GDM in the Chinese, this was less significant than other factors such as age and weight gain, while in the nonpregnant Hong Kong Chinese population, BMI, waist-to-hip ratio, waist circumference, and waist-to-height ratio are strong predictors of diabetes and hypertension (13). Thus, the additional measurement of leg length in clinical practice is unlikely to enhance the prediction of GDM or type 2 diabetes in the Chinese population, even though these findings may have explained the occasional unexpectedly high postprandial glucose levels in subjects who are short but not obese, as encountered in some of our patients with GDM.

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