Gamma-glutamyltransferase, alanine transaminase and aspartate transaminase levels and the diagnosis of gestational diabetes mellitus

Peng Chiong Tan, Ainul Zahaniah Aziz, Ikram Shah Ismail, Siti Zawiah Omar

ARTICLE INFO

Introduction

A raised serum gamma glutamyltransferase (GGT) level is an independent risk factor for type 2 diabetes [1]. A higher GGT concentration even within its physiological range is a sensitive and early biomarker for the development of diabetes [2] probably mediated through enhanced hepatic neoglucogenesis or early alterations of insulin secretion [3]. The association of raised GGT and development of diabetes is apparent also in young adults [4]. GGT levels in diabetic patients are independent of their hyperglycemia [5] suggesting that it is not a direct consequence of hyperglycemia. High alanine transaminase (ALT) level is a marker of risk for type 2 diabetes [6], can predict incident diabetes even when within the normal range [7] and remains a significant risk factor after adjustments [8]. A higher aspartate transaminase (AST) level is associated with the development of impaired glucose tolerance [9] and incident diabetes [10] but its association with diabetes is not consistently demonstrated [8,9].

Women who manifested higher GGT levels when hospitalized for hyperemesis gravidarum in early pregnancy are more prone to be diagnosed as gestational diabetes (GDM) later into their pregnancy [11]. In women at very high risk of GDM who were undergoing diagnostic OGTT after mainly 50-g glucose challenge test (GCT) screening, raised GGT level has been found to be an independent risk factor for GDM [12,13]. In the first trimester, GGT level is not independently predictive of GDM [14]. It is not established whether a higher GGT level is predictive of GDM nor is it known whether ALT and AST are associated with GDM in the general antenatal population.

Up to 70% of women with GDM go on to develop Type 2 diabetes, with an especially rapid increase in incidence in the first five years [15]. For many of these women, GDM represents an underlying predisposition to glucose intolerance later in life unmasked by the diabetogenic effect of pregnancy. Thus we postulate that GGT, ALT and AST levels may be predictive of GDM.

Methods

Ethical oversight and approval for the study was provided by the University Malaya Medical Centre (UMMC) Medical Ethics Committee

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participants to answer and return at end of the clinic visit.

The study was done in our city-based university hospital conducting over 5000 deliveries per year. Our general antenatal population was at high risk for GDM with an incidence of at least 11.4% after universal 50-g GCT screening followed by diagnostic testing with the 75-g oral glucose tolerance test (OGTT) [16]. For this study, we aimed to recruit 3000 women based on the funding obtained.

Women who attended for their first antenatal care appointment were identified by clinic staff. Women not known to have diabetes mellitus or gestational diabetes at this point were approached and consented if they agreed to take part. The study required additional blood to be drawn for random plasma glucose, GGT, ALT and AST together with routine antenatal blood tests. The 50-g GCT was then performed (hence another blood sample was drawn for plasma glucose at 1 h) without consideration of recent oral intake. A questionnaire on basic demographics, timing and quantification of recent oral intake and tolerance towards the GCT was also distributed to participants to answer and return at end of the clinic visit.

All participants were given instruction on the preparation for a 3-point 75-g OGTT. Diagnostic OGTT was performed as specified by the World Health Organisation (WHO) [17]. We opted to apply the 3-point rather than 2-point OGTT to maximise data harvesting and future proofing as the diagnostic criteria for the OGTT seemed to be in a state of flux following publication of the HAPO study [18]. An appointment for the OGTT was then made for all participants within the next two weeks at their convenience irrespective of their initial test results. Participants who did not attend their OGTT appointment were contacted and given another if they agreed. Postnatal OGTT six or more weeks after delivery is planned but only for women diagnosed as GDM. Pregnancy outcome is to be retrieved from case notes after delivery.

All blood samples obtained for the purpose of the study were sent immediately to our hospital’s clinical chemistry laboratory for standard processing and reporting. Our hospital laboratory used Dimension Vista® 1500 Intelligent Lab System (Siemens AG, Germany) to analyse the samples. In the period July to Dec 2011, our laboratory reported (low test value) precisions of 2.2%, 3.1%, 3.3%, and 6.9% and (high test value) precisions of 2.2%, 1.9%, 2.0% and 2.3 for glucose, GGT, ALT and AST respectively in internal quality control analyses. All results for the random plasma glucose, GGT, ALT, AST, 50-g GCT and 3-point 75-g OGTT were promptly made available to care providers through the hospital’s computerised laboratory reporting service as they became ready.

In our hospital, the standard antenatal care for the identification of GDM was the two-step screen, using the 50-g GCT with screen positive threshold set at ≥ 7.2 mmol/L followed by diagnostic 2-point 75-g OGTT for those screened positive. The GCT was performed at the initial hospital visit as the mean gestational age of our patients at the first visit was about 28 weeks [16] in conjunction with other routine antenatal blood investigations. Women who did not wish to participate in our study were offered this routine screening. In our hospital, diagnosis of GDM after the 2-point 75-g OGTT was in accordance with WHO (1999) criteria (fasted plasma glucose ≥ 7.0 and/or 2-hour plasma glucose ≥ 7.8 mmol/L) [17].

All women diagnosed as GDM were referred to our joint clinic for diabetes care in pregnancy, provided by a team of obstetricians, diabetes physicians and nurses and nutritionists for their ongoing care.

For the purpose of this report, we restricted the study population to those participants whose GGT, ALT, AST as well as the 3-point OGTT results were complete. We excluded women with liver disease (e.g. Hepatitis B carrier status). We applied the American Diabetes Association (2011) position statement on the interpretation of the 3-point 75-g OGTT with GDM diagnostic criteria fulfilled if one or more point readings were at or above plasma glucose cut-offs of ≥5.1 mmol/ (fasted), ≥ 10.0 mmol/L (1-hour) and ≥8.5 mmol/L (2-hour) [19].

Data were entered into a statistical software package SPSS version 15 (SPSS Inc., Chicago IL). We also used MedCalc software (Mariakerke, Belgium) for Chi Square for Trend analysis. We determined the quartile cut-offs values for GGT, ALT and AST for the study population with a view to assessing trend (using the Chi Square for Trend test) for diagnosis of GDM versus quartile values of the transaminases and to assess relative risk for GDM utilising the bottom quartile as the referent value. We plotted the receiver operator characteristic curves for transaminases’ values against diagnosis of GDM to obtain the area under the curve. We also evaluated various characteristics including the random plasma glucose and GCT values in additional to the transaminases levels in women with and without GDM using the Student t test, Chi Square test or the Mann Whitney U test in bivariate analysis to establish significant associations of these characteristics with GDM. The characteristics with significant association (P<0.05) to GDM on bivariate analyses were included in a multivariable logistic regression analysis model to establish independent associations. P<0.05 in any 2-sided tests was considered statistically significant.

Results

3094 women were consented for the study. Fourteen women were later excluded due to liver disorders, mainly Hepatitis B infection found on routine antenatal screening. A number of 2-point OGTT were done for participants due principally to confusion with women on standard care as OGTTs for both groups were performed in the same clinic setting. Only 2610 women had complete liver transaminases and 3-point OGTT results and they formed the study population.

Of the women who did and did not attend for OGTT following their GCT, 1000/2758 (36.3%) vs. 29/287 (10.1%) respectively had a positive GCT screen (with 1-hour plasma glucose ≥7.2 mmol/L); P=0.001. This is expected as participants with a positive GCT screen as well as their providers were jointly aware of the GCT result and would have made a greater effort towards a diagnostic OGTT.

Receiver operator characteristic curve analysis for transaminases levels versus GDM showed area under the curve of 0.54 (P=0.021) for OGTT, 0.509 (P=0.61) for ALT and 0.475 (P=0.147) for AST indicating a statistically significant but rather weak practical utility for GGT as a marker for GDM but none at all for ALT and AST.

The demographics of the 2610 women stratified according to their GDM status are shown in Table 1. On bivariate analysis, women with GDM compared to those without were older, of higher parity, heavier and with higher body mass index (BMI) and had higher mean systolic and diastolic blood pressure. Biochemical characteristics are shown in Table 2. Random plasma glucose, GCT and ALT levels are higher in women with GDM but mean ALT and AST levels were not different. Chi Square for trend analysis after banding transaminases levels into quartiles showed a significant result for GGT but not for ALT or AST. The relative risk (RR) of GDM for the highest GGT quartile compared to the lowest GGT quartile RR 1.35 95% CI 1.02–1.80 was significantly higher (P=0.039).

Multivariable logistic regression analysis (Table 3) incorporating age, body weight, BMI, parity, systolic and diastolic blood pressure, random plasma glucose and 1-hour GCT plasma glucose as continuous variables and GGT quartiles (lowest quartile as referent) and ethnicity (Malay as referent) as categorical variables was performed.
After adjustment, maternal age, Indian ethnicity, random plasma glucose and 1-hour GCT plasma glucose remain significantly associated with GDM. GGT (P=0.339) as a category was not significant nor were the comparisons of higher bands against the bottom quartile. Even if random plasma glucose and 1-hour GCT plasma glucose are removed from the multivariable logistic regression model, GGT level is still not independently associated with GDM (P=0.135 after adjustment).

### Table 1
Demographics of unselected antenatal women with and without gestational diabetes after the 75 g 2-hour oral glucose tolerance test interpreted according to the American Diabetes Association Criteria (2011)\(^*\). N=2610.

<table>
<thead>
<tr>
<th></th>
<th>GDM(^*)</th>
<th>No GDM(^*)</th>
<th>Student t test</th>
<th>Chi Square test RR (95% CI)(^†)</th>
<th>Chi Square for Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>31.4±4.8</td>
<td>29.6±4.3</td>
<td>P&lt;0.001</td>
<td></td>
<td>P=0.001</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Malay</td>
<td>174 (10.6)</td>
<td>1467 (89.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>57 (13.4)</td>
<td>369 (86.4)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Indian</td>
<td>81 (18.2)</td>
<td>364 (81.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>7 (7.1)</td>
<td>91 (92.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestation at enrolment (weeks)</td>
<td>24.7±6.3</td>
<td>24.8±6.4</td>
<td>P=0.783</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestation at GCT (weeks)</td>
<td>26.6±6.3</td>
<td>27.0±6.3</td>
<td>P=0.289</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parity 1 [0–2]</td>
<td>1 (0.2)</td>
<td>1 (0.2)</td>
<td>P=0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parity 2 [3–4]</td>
<td>72 (10)</td>
<td>68 (10)</td>
<td>P=0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nulliparous</td>
<td>117 (36.8)</td>
<td>103 (45.1)</td>
<td>P=0.005</td>
<td>0.71 (0.36–0.90)</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>70.0±15.8</td>
<td>63.0±12.7</td>
<td>P&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.56±0.06</td>
<td>1.57±0.06</td>
<td>P=0.168</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI(^‡)</td>
<td>28.7±6.2</td>
<td>26.0±4.9</td>
<td>P&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>116±13</td>
<td>111±13</td>
<td>P=0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>72±10</td>
<td>68±10</td>
<td>P=0.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data expressed as mean ± standard deviation, number (%) and median [interquartile range]. Bivariate analyses with Student t test, Chi Square test, Mann Whitney U test and Chi Square for Trend test.

\(^*\) Gestational diabetes diagnosed if at least 1 out of 3 readings above the reference range after oral 75 g glucose load: Fasted ≥5.1, 1-hour ≥10 or 2-hour ≥8.5 mmol/L.

\(^†\) Relative risk and 95% Confidence Interval displayed for 2×2 Chi Square analysis.

\(^‡\) BMI (Body mass index) defined as Weight (in kg) ÷ [height × height (in m)].

Post hoc, we performed similar analysis on the relationship of the liver transaminases level and GDM, with GDM diagnosed based on WHO (1999) [17] criteria as well as on the previous (2003) ADA GDM criteria which has a higher threshold for GDM diagnosis [20]. A higher level of the liver transaminases was consistently demonstrated not to be independently associated with GDM whatever the GDM diagnostic criteria used. No independent association was demonstrated also when we restricted our analysis only to women with GDM diagnosed according to WHO (1999) [17] criteria.

### Table 2
Biochemical characteristics of unselected antenatal women with and without gestational diabetes after the 75 g 2-hour oral glucose tolerance test interpreted according to the American Diabetes Association Criteria (2011)\(^*\). N=2610.

<table>
<thead>
<tr>
<th></th>
<th>GDM(^*)</th>
<th>No GDM(^*)</th>
<th>Student t test</th>
<th>Chi Square test RR (95% CI)(^†)</th>
<th>Chi Square for Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random plasma glucose (mmol/L)</td>
<td>5.3±1.5</td>
<td>4.5±0.8</td>
<td>P&lt;0.001</td>
<td></td>
<td>P=0.030</td>
</tr>
<tr>
<td>Glucose challenge test (mmol/L)</td>
<td>8.4±2.0</td>
<td>6.4±1.4</td>
<td>P&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Glutamyltransferase (U/L)</td>
<td>18±12</td>
<td>16±11</td>
<td>P=0.033</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GGT expressed as quartiles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st quartile (≤ 10 U/L)</td>
<td>76 (11.2)</td>
<td>600 (88.8)</td>
<td>P=0.030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd quartile (11–14 U/L)</td>
<td>72 (10.0)</td>
<td>645 (90.0)</td>
<td>0.89 (0.66–1.21)</td>
<td>P=0.893</td>
<td></td>
</tr>
<tr>
<td>3rd quartile (15–20 U/L)</td>
<td>84 (13.0)</td>
<td>561 (87)</td>
<td>1.15 (0.87–1.55)</td>
<td>P=0.322</td>
<td></td>
</tr>
<tr>
<td>4th quartile (≥ 21 U/L)</td>
<td>87 (15.2)</td>
<td>485 (84.8)</td>
<td>1.35 (1.02–1.80)</td>
<td>P=0.039</td>
<td></td>
</tr>
<tr>
<td>Alanine transaminase (U/L)</td>
<td>23±11</td>
<td>23±13</td>
<td>P=0.843(^†)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALT expressed as quartiles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st quartile (≤ 16 U/L)</td>
<td>96 (12.5)</td>
<td>672 (87.5)</td>
<td>P=0.394</td>
<td></td>
<td></td>
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<tr>
<td>2nd quartile (17–21 U/L)</td>
<td>65 (10.3)</td>
<td>565 (89.7)</td>
<td>0.82 (0.61–1.11)</td>
<td>P=0.205</td>
<td></td>
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<tr>
<td>3rd quartile (22–27 U/L)</td>
<td>77 (13.3)</td>
<td>504 (86.7)</td>
<td>1.06 (0.80–1.40)</td>
<td>P=0.68</td>
<td></td>
</tr>
<tr>
<td>4th quartile (≥ 28 U/L)</td>
<td>81 (12.8)</td>
<td>550 (87.2)</td>
<td>1.02 (0.78–1.35)</td>
<td>P=0.85</td>
<td></td>
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<tr>
<td>Aspartate transaminase (U/L)</td>
<td>16±11</td>
<td>16±13</td>
<td>P=0.500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AST expressed as quartiles</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1st quartile (≤ 11 U/L)</td>
<td>103 (13.3)</td>
<td>673 (86.7)</td>
<td>P=0.254</td>
<td></td>
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<tr>
<td>2nd quartile (12–15 U/L)</td>
<td>91 (13.5)</td>
<td>585 (86.5)</td>
<td>1.01 (0.78–1.32)</td>
<td>P=0.92</td>
<td></td>
</tr>
<tr>
<td>3rd quartile (16–19 U/L)</td>
<td>61 (10.5)</td>
<td>521 (89.5)</td>
<td>0.79 (0.59–1.06)</td>
<td>P=0.12</td>
<td></td>
</tr>
<tr>
<td>4th quartile (≥ 20 U/L)</td>
<td>64 (11.1)</td>
<td>512 (88.9)</td>
<td>0.84 (0.62–1.22)</td>
<td>P=0.254</td>
<td></td>
</tr>
</tbody>
</table>

Data expressed as mean ± standard deviation and number (%). Bivariate analyses with Student t test, Chi Square test, Mann Whitney U test and Chi Square for Trend test.

\(^*\) Gestational diabetes diagnosed if at least 1 out of 3 readings above the reference range after oral 75 g glucose load: Fasted ≥5.1, 1-hour ≥10 or 2-hour ≥8.5 mmol/L.

\(^†\) Relative risk and 95% Confidence Interval displayed for 2×2 Chi Square analysis.

Post hoc, we performed similar analysis on the relationship of the liver transaminases level and GDM, with GDM diagnosed based on WHO (1999) [17] criteria as well as on the previous (2003) ADA GDM criteria which has a higher threshold for GDM diagnosis [20]. A higher level of the liver transaminases was consistently demonstrated not to be independently associated with GDM whatever the GDM diagnostic criteria used. No independent association was demonstrated also when we restricted our analysis only to women with GDM diagnosed according to WHO (1999) [17] criteria.
Table 3

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Adjusted odds ratio (95% Confidence Interval)</th>
<th>Adjusted P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malay</td>
<td>AOR 1.05 (95% CI 1.10–1.08)</td>
<td>P = 0.017</td>
</tr>
<tr>
<td>Chinese</td>
<td>AOR 1.28 (95% CI 1.08–1.46)</td>
<td>P = 0.020</td>
</tr>
<tr>
<td>Indian</td>
<td>AOR 1.59 (95% CI 1.11–2.28)</td>
<td>P = 0.011</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>AOR 1.00 (95% CI 0.98–1.03)</td>
<td>P = 0.833</td>
</tr>
<tr>
<td>Other</td>
<td>AOR 1.02 (95% CI 0.95–1.10)</td>
<td>P = 0.569</td>
</tr>
<tr>
<td>Parity</td>
<td>AOR 1.01 (95% CI 0.98–1.09)</td>
<td>P = 0.955</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>AOR 1.00 (95% CI 0.99–1.02)</td>
<td>P = 0.650</td>
</tr>
<tr>
<td>BMI</td>
<td>AOR 1.01 (95% CI 1.18–1.54)</td>
<td>P = 0.001</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>AOR 1.34 (95% CI 0.91–1.44)</td>
<td>P = 0.980</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>AOR 1.90 (95% CI 1.73–2.08)</td>
<td>P = 0.379</td>
</tr>
<tr>
<td>Ascending transaminase expressed as quartiles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st quartile (≥ 10 U/L)</td>
<td>AOR 0.80 (95% CI 0.54–1.19)</td>
<td>P = 0.266</td>
</tr>
<tr>
<td>2nd quartile (11–14 U/L)</td>
<td>AOR 1.03 (95% CI 0.71–1.52)</td>
<td>P = 0.862</td>
</tr>
<tr>
<td>3rd quartile (15–20 U/L)</td>
<td>AOR 1.15 (95% CI 0.78–1.70)</td>
<td>P = 0.480</td>
</tr>
<tr>
<td>4th quartile (≥21 U/L)</td>
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</tbody>
</table>

Note: *p* values were adjusted for age, parity, weight, BMI, systolic and diastolic blood pressures, random plasma glucose and 1-hour glucose challenge test plasma glucose all entered as continuous variables whilst ethnicity (Malay as referent) and gamma glutamyltransferase quartile values (lowest/first quartile as referent) entered as categorical variables in the multivariable logistic regression analysis.

Discussion

Statistically significant results are shown in our GDM women of a higher mean for their GGT concentration, a positive trend in the rate of GDM as GGT quartile band increased, a higher relative risk of GDM in the top versus bottom quartile GGT band and on receiver operator characteristic curve analysis. Raised GGT concentration on a number of bivariate analyses seems to be associated with GDM.

However, GGT level has been shown to increase with age and body mass index [21]. Body mass index also appeared to be more strongly associated with type 2 diabetes when GGT level is above the median [21] and particularly so in women [22]. In our study, women with GDM were older and heavier and when adjustments were made for these and other significant factors (see Table 2), GGT was no longer a significant predictive factor for GDM.

There was no suggestion of an association of GDM to either ALT or AST level in our analyses. This is in contrast to the literature which has shown an increased risk for the development of Type 2 diabetes in the non-pregnant populations when these liver transaminases are raised [6,7,10,23]. AST’s association to the risk of developing type 2 diabetes is typically weaker than that of ALT’s [9]. A recent review of 21 prospective population studies suggests that raised GGT maybe a better predictor for diabetes than raised ALT [24]. Our data in the context of GDM supports the general view that although not statistically significant after adjustment, raised GGT is the better marker of a tendency to glucose intolerance in pregnancy than either ALT or AST.

The predictive value of GGT and ALT for development of type 2 diabetes is at least in part explained by their role as a surrogate for liver fat content and non-alcoholic fatty liver disease (NAFLD) which has a strong link to the pathogenesis of type 2 diabetes [25,26]. Our result could imply that NAFLD may not be as important an element in the pathophysiology of GDM.

In a study of 488 pregnant women with GGT concentration assessed at the time of their diagnostic OGTT, raised GGT has been shown to be a predictor for GDM [12]. These 488 women, selected in many cases after a positive GCT were at very high risk for GDM and 30.9% fulfilled WHO (1999) [17] criteria for GDM. In the general antenatal population of our current study, we used ADA (2011) [19] criteria for GDM and only 319/2610 (12.2%) fulfilled criteria for GDM: by the WHO (1999) [27] criteria 11.5% would be diagnosed as GDM. OGTT was performed at a mean gestational age of 30.2 (vs. 26.3) weeks with mean BMI of 27.4 (vs. 26.9) in the earlier study compared to our present study. BMI has been shown to be associated with prevalent diabetes only among persons with high normal serum GGT activity [28]. As we have shown (stated in results), GGT level tends to decrease slightly with gestational age. The GDM risk profile, gestational age and BMI differences between the study populations may account for the contrasting findings.

There are strengths and weaknesses to our study. Our study population of 2610 and the 319 GDM cases identified are fairly large numbers which should limit the risk of type 2 error in our analysis compared to two earlier positive studies which comprised only 488 and 79 women [12,13]. We calculate that based on the earlier study whereby 23.2% of women with GDM had raised GGT compared to a 13.9% rate in women without GDM [12], our sample of 2610 women with a 319 to 2291 GDM to non-GDM split has a 98.1% power of detection. We have a dropout rate of 15.6% largely due either to the failure to attend for OGTT or to testing with the 2-point instead of the 3-point OGTT. This dropout rate is fairly low, biased towards those with a negative GGT screen, should increase the GDM risk profile of the study population rendering it closer to earlier studies which has found raised GGT to be associated with GDM [12,13] and thus rendering our negative findings more robust. In our protocol, blood samples for the transaminases were taken on average just over 2 weeks before the diagnostic OGTT. This might have affected results as there is a modest negative correlation of GGT level and gestational age (see results). Raised transaminases as markers for incipient Type 2 diabetes (or a tendency to glucose intolerance) are reflective of a chronic phenomenon, predictive of events sometimes years ahead, so an average 2 week gap between assessment of transaminases and OGTT should not have a significant effect on the predictive value of the transaminases.

Conclusion

In our multi-ethnic Asian population with a high background risk for GDM, the level of GGT, ALT and AST are not independently
predictive of prevalent GDM. This finding may indicate that the underlying predisposition and pathway for hyperglycaemia in GDM can be subtly different from that in the development of type 2 diabetes.

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Conflict of interest

The authors declare that they have no conflict of interest.

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