

# Self-Reported Past Gestational Diabetes Mellitus as a Risk Factor for Abnormal Glucose Tolerance Among Australian Women

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ethics committees and signed individual consent obtained.

At least 50% of women who have a pregnancy complicated by gestational diabetes mellitus (GDM) progress to permanent type 2 diabetes (1). While few long-term studies have been undertaken (2), progression from GDM to abnormal glucose tolerance (AGT) may not occur in all women. We hypothesized that if AGT occurs, then progression to diabetes would be more likely and that a greater excess of diabetes rather than impaired glucose tolerance (IGT)/impaired fasting glucose (IFG) would occur over time. We used two cohorts of Australian women who participated in either AusDiab (Australian Diabetes, Obesity and Lifestyle Study) (3,4) or CUDS (Crossroads Undiagnosed Disease Study) (5) to investigate the relationship between current glucose tolerance status and self-reported history of diagnosis of GDM.

## RESEARCH DESIGN AND METHODS

AusDiab (May 1999 through December 2000) involved 42 randomly selected areas across Australia, and CUDS (June 2001 through March 2003) randomly selected households across six small towns and a regional center in rural Victoria, Australia (3–5). Both studies included residents aged  $\geq 25$  years within a household who responded to an initial census and used identical questionnaires

and laboratories (and much of the same staff) for sample analysis. Attendance rates for women were 58% ( $n = 6,198$ ) and 69% ( $n = 819$ ), respectively, among whom 174 had incomplete data, 991 were nulliparous, and 13 had type 1 diabetes on clinical criteria. Among the remaining 5,839 parous women, those without known diabetes had a 75-g oral glucose tolerance test (6) and height, weight, and blood pressure measurements. Plasma glucose and serum lipid concentrations were determined enzymatically. Adult Treatment Panel-III criteria were used for the metabolic syndrome (7). Questions regarding women's health included the following. 1) "When you were pregnant, were you ever tested for diabetes? That is a blood or urine sugar test. This may have involved drinking a very sugary drink." 2) "Were you ever told that you had gestational diabetes or pregnancy-related diabetes?" 3) "Were you ever tested again for diabetes after pregnancy?"

All tests are two tailed, with  $P < 0.05$  taken as significant. Discrete variables were compared using the  $\chi^2$  test and adjusted for age-group using the Mantel-Haenszel test. Odds ratios are shown with 95% CIs. Continuous variables are compared using ANOVA or ANCOVA. The studies were approved by the relevant

**RESULTS**— Past GDM was reported in 4.1%. In comparison with other women, those with past GDM were younger ( $44 \pm 12$  vs.  $53 \pm 14$  years,  $P < 0.001$ ), with a higher BMI ( $28.0 \pm 6.5$  vs.  $27.0 \pm 5.6$  kg/m<sup>2</sup>,  $P = 0.006$ ), and were more likely to be of non-European descent (10.0 vs. 5.8%,  $P = 0.008$ ). Parity and age at first pregnancy were comparable. Current diabetes was more likely among those with past GDM (12.5 vs. 7.0%,  $P < 0.05$ ), but the prevalence of IGT/IFG was similar in the two groups (16.7 vs. 16.2%). Metabolic syndrome prevalence was not significantly different (25.4 vs. 21.9%).

The prevalence of self-reported GDM screening decreased progressively with increasing age, as did the proportion with self-reported past GDM (Table 1). Current diabetes and IGT/IFG prevalence was similar among women, regardless of whether they remembered being screened. Among the former, the proportion with past GDM remained similar across all age-groups.

The excess of current diabetes among women with past GDM commenced from 35 to 44 years. A statistically significant excess of IGT/IFG was apparent in those aged 25–44 years but not in older age-groups. A significant excess of any AGT among those with past GDM was seen up to age 54 years but not beyond.

**CONCLUSIONS**— Attempting to interpret longitudinal patterns across cross-sectional data is fraught with difficulty (8,9). Notwithstanding this, and the unreliability of self-reports of past GDM testing and diagnosis, data validity here is supported by the relative risk of diabetes among women with past GDM, as compared with the sixfold excess shown by Cheung and Byth (2). Furthermore, with increasing age, the proportion of "screened" women with current diabetes after self-reported past GDM increased to a proportion slightly less than the original

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**Abbreviations:** AGT, abnormal glucose tolerance; GDM, gestational diabetes mellitus; IFG, impaired fasting glucose; IGT, impaired glucose tolerance.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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Table 1—Prevalence of diabetes, penetration of screening by recall, and proportion with self-reported GDM and AGT

	Age-group (years)						Total	P*
	25-34	35-44	45-54	55-64	65-74	≥75		
<i>n</i>	571	1,384	1,528	1,073	829	454	5,839	
Current diabetes (%)	2 (0.4)	27 (2.0)	80 (5.2)	93 (8.7)	130 (15.7)	91 (20.0)	423	<0.001
Recalls being screened (%)	427 (74.8)	680 (49.1)	323 (21.1)	160 (14.9)	83 (10.0)	32 (7.0)	1,705 (29.2)	<0.001
Self-reported past diabetes in pregnancy (%)	62 (10.9)	87 (6.3)	50 (3.3)	26 (2.4)	9 (1.1)	6 (1.3)	240 (4.1)	<0.001
Current diabetes prevalence (%)	0.2	2.1	5.0	11.9	16.9	12.5	4.0	<0.001
Recalls being screened	1.0	1.6	5.4	9.2	16.3	21.1	9.3	<0.001
Recalls not being screened	0	2.6	4.9	5.0	12.3	17.9	6.3	<0.001
Not sure								
Current IGT/IFG prevalence (%)	7.5	10.6	13.3	19.4	27.7	31.3	12.4	<0.001
Recalls being screened	3.8	9.4	16.1	19.6	27.4	23.1	18.3	<0.001
Recalls not being screened	2.5	9.4	15.1	15.7	28.8	26.9	16.4	<0.001
Not sure								
GDM within reportedly screened women	62/427 (14.7)	87/680 (12.8)	50/323 (15.5)	26/160 (16.3)	9/83 (10.8)	6/32 (18.8)	240/1,705 (13.7)	0.632
Current diabetes among reportedly screened women								
No past GDM	0.3	1.2	1.8	9.7	14.9	3.8		
Past GDM	0	8.0	22.0	23.1	33.3	50.0		
OR (past vs. no past GDM)	—	7.3 (2.5-21.4)	15.1 (5.0-45.8)	2.8 (1.0-8.2)	2.9 (0.6-13.2)	25.0 (1.9-324)	6.0 (3.5-10.2)	
Current IGT/IFG among reportedly screened women								
No past GDM	6.3	9.6	12.1	19.4	29.7	38.5		
Past GDM	14.5	17.2	20.0	19.2	11.1	0		
OR (past vs. no past GDM)	2.5 (1.1-5.8)	2.0 (1.1-3.6)	1.8 (0.8-4.0)	1.0 (0.3-2.9)	0.3 (0.1-2.5)	—	1.5 (1.0-2.1)	
Current diabetes/IGT/IFG among "screened" women								
No past GDM	6.6	10.8	13.9	29.1	44.6	42.3		
Past GDM	14.5	25.3	42.0	42.3	44.4	50.0		
OR	2.4 (1.1-5.5)	2.8 (1.6-4.8)	4.5 (2.3-8.6)	1.8 (0.8-4.2)	1.0 (0.2-4.0)	1.4 (0.2-8.1)	2.6 (1.9-3.6)	

Data are *n* (%), %, and OR (95% CI). \*Significance across age-groups.

O'Sullivan cohort follow-up (in spite of the different diagnostic criteria) (10).

Among women with past GDM, the excess of current diabetes was seen at all ages, while no excess of current IGT/IFG was shown after age 55 years. If our observations are not a product of the various confounders, the proportion of older women with any AGT is comparable with and without past GDM. This suggests an excess loss of women with past GDM (through, e.g., death or nonparticipation) or that there is only a proportion of women with GDM who will actually progress to AGT. In those with AGT, however, a higher proportion of older women with past GDM had diabetes rather than IGT/IFG, suggesting that an additional process (e.g., reduced insulin secretory capacity) (11,12) has led to a greater transition to diabetes. Whether this is genetically determined due to the experience of GDM itself (13), excess obesity, or some other reason is unclear.

Interestingly, the prevalences of diabetes and IGT/IFG here were comparable regardless of whether women had been screened for GDM. The high risk of developing future diabetes among women with GDM, found in this study, supports recommendations for screening all pregnant women for diabetes. Furthermore, it emphasizes the need for interventions to reduce the risk of progression to type 2

diabetes in this group and for regular postpartum screening for diabetes.

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