

# GESTATIONAL DIABETES AMONG ABORIGINAL AUSTRALIANS: PREVALENCE, TIME TREND, AND COMPARISONS WITH NON-ABORIGINAL AUSTRALIANS

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**Objective:** This paper investigates the prevalence, trends, and risk factors of gestational diabetes mellitus (GDM) in the Aboriginal population in Australia, and provides comparisons to the non-Aboriginal population.

**Design:** A retrospective population analysis of all deliveries (230,011) that took place in the state of South Australia between 1988 and 1999, inclusive. Data were obtained from the Pregnancy Outcome Unit of the Department of Human Services in South Australia, and include information on the demographical characteristics and medical status of both mothers and babies.

**Main Outcome Measures:** Gestational diabetes mellitus prevalence rate among Aboriginal mothers, as compared to their non-Aboriginal counterparts.

**Results:** The age-standardized GDM rate for Aboriginal mothers was found to be more than 2.5 times higher than that for non-Aboriginal mothers; there have been no significant changes, nor any decrease (as some previous studies have suggested), in this trend over the time period considered in this study.

**Conclusions:** Clearly, the prevalence of GDM, however it is measured or defined, is still significantly higher in the Aboriginal population of Australia, as compared to the country's non-Aboriginal population. Researchers in the health field should target appropriate public health programs, such as universal screenings for GDM conditions, and health promotion procedures, toward the Aboriginal community. (*Ethn Dis.* 2003;13:55–60)

**Key Words:** Australian Aboriginal, Aboriginal Health, Gestational Diabetes Mellitus, Nutritional and Metabolic Diseases, Obesity, Women's Health

## INTRODUCTION

Diabetes mellitus is a significant health problem among the Aboriginal population in Australia. This group experiences a dramatically higher prevalence of this disease, estimated to be about 2.5 times higher than that of the non-Aboriginal population.<sup>1–3</sup> In particular, gestational diabetes mellitus (GDM), along with its implications on birth outcomes, is a great source of concern for Aboriginal Australians, as indicated in several studies and brief reports based on routinely collected data from the States and Territories of Australia.<sup>4–9</sup> Nevertheless, the prevalence of GDM, its development over time, and the associated risk factors in the Aboriginal community, have not been often and comprehensively investigated. In addition, no comparative analysis has been undertaken between the prevalence and trend of GDM in the Australian Aboriginal community, and those of other native communities in Canada, New Zealand, and the United States, which experience a significantly higher prevalence of GDM, and the associated higher risk of adverse health conditions for mothers and babies.<sup>10–14</sup>

Of the few studies that considered GDM in Aboriginal communities in Australia and the disease's trend over time, Kim and Humphery<sup>15</sup> reported a decrease in prevalence of GDM in an Aboriginal community in far North Queensland between 1992 and 1996. Their findings contradict the current belief that the prevalence of GDM is increasing in Australia.<sup>16,17</sup>

The objective of the present study is to examine GDM prevalence and its trend over the last 12 years among Aboriginal people, and to make comparisons with the non-Aboriginal popula-

tion, using the rich population-based data of confinements in the state of South Australia. Generally speaking, data collection for Aboriginal people in South Australia is nationally known to be of a high quality, in terms of identification of Aboriginality.<sup>18,19</sup>

Specifically, this study aims to answer the following questions:

- On the basis of such a large data set from South Australia, what would be a reliable national estimate of GDM prevalence in Australian Aborigines, taking into account other estimates of GDM across different states in Australia?
- To what extent is the GDM prevalence rate in Aboriginal Australians higher than for the rest of the Australian population, and how does it compare to the rates in Aboriginal communities of other countries?
- Do the South Australian data confirm the trend of a decreasing prevalence of GDM in the Aboriginal community, as reported by Kim and Humphery?<sup>15</sup>

## METHODS

All deliveries (230,011,  $N[\text{Abor.}] = 4843$  and  $N[\text{non-Abor.}] = 225,168$ ) that took place in South Australia between 1988 and 1999, inclusive, were analyzed retrospectively. The data were obtained from the Pregnancy Outcome Unit of the Department of Human Services in South Australia.<sup>20</sup> The data include all mothers' and babies' demographic characteristics and medical status. For a subset of cases only (all women with DM or GDM from 1988 to 1995, inclusive,  $N = 4121$ ; and a 2-for-one random sample of women without diabetes,  $N = 7144$ , matched by year), full information is available on an individual basis for a variety of factors, including

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*Nevertheless, the prevalence of gestational diabetes mellitus, its development over time, and the associated risk factors in the Aboriginal community, have not been often and comprehensively investigated.*

mother's age, type of hospital, diabetes status (DM, GDM, or none), multiplicity of birth, gestational age, baby's sex, birth outcome and birth weight. In this data collection, the criterion used for diabetes mellitus was having a previous diagnosis of diabetes. For GDM, the criterion was either that of ADIPS, the Australasian Diabetes in Pregnancy Society (blood glucose  $\geq 5.5$  mmol/L fasting, or  $\geq 8.0$  2-hour result), or of the World Health Organization (blood glucose  $\geq 7.8$  2-hour result, including groups with blood glucose  $> 11.0$ , and those with values between 7.8 and 11.0, labeled "glucose intolerant") for the 75 g oral glucose tolerance tests.<sup>20,22</sup> These criteria were first applied in screening during 1985 at Queen Victoria Hospital, in Adelaide, and gradually spread to other hospitals in the state, being essentially completed by the early part of the time period under study and completed by 1992. It is noteworthy that the data do not include actual OGTT results, and we are restricted to using the (possibly inconsistent) definitions already in use in South Australia during the 12-year period.

The GDM prevalence rate was calculated as the proportion of confinements in which the mother was identified as having GDM, over the total registered confinements. It is worth noting that, as a result of using all confinements (rather than all screened cases) as

a denominator in the calculation of GDM prevalence, the estimated rates here would be conservative. The term DM is used in this study to indicate any other sort of diabetes mellitus, either type 1 diabetes, or type 2, which is common for Aboriginal people. The DM rate was calculated as the proportion of confinements in which the mother was identified as having diabetes mellitus prior to gestation, over the total registered confinements.

A problem that usually arises in this context is related to the definition of GDM as "diabetes restricted to pregnant women in whom the onset or recognition of glucose intolerance first occurs during pregnancy."<sup>21</sup> In practice, this definition makes it impossible to distinguish between diabetes that is truly provoked by pregnancy, and pre-existing, but undiagnosed, diabetes. That is, mothers who are diagnosed as having GDM might actually be full diabetes cases who are coming into contact with medical services for the first time. For this reason, the World Health Organization tends to report, as does our study, the combined prevalence of GDM and DM, when considering diabetes in women of child bearing ages, particularly for multi-national reports, and for studies comparing populations of different ethnicities.<sup>22</sup>

Controlling for the mother's age is important when comparing the prevalence of GDM between our study's 2 populations, since Aboriginal mothers tend to be younger than non-Aboriginal mothers. Based on the age composition of all mothers in South Australia for 1988–1999, it was found that the mean age of Aboriginal mothers was 24 years, as compared with 28.5 years for non-Aboriginal mothers (similar to the reported national values of 24 and 28.6, respectively).<sup>23</sup> Age-standardized rates of GDM were computed using the direct standardization technique,<sup>24</sup> with the age composition of non-Aboriginal mothers in South Australia as the standard population.

A chi-squared test was performed to assess the significance of the difference in diabetes prevalence between the 2 populations, and this difference was also reported as an odds ratio. Logistic regression<sup>25</sup> was used with the subset of data for which we had full information, to identify the relative risk of GDM in the Aboriginal population, controlling for other potentially important factors (eg, age of mother, type of hospital, multiplicity of birth). Generalized linear models (Poisson regression) were used to examine the time trends in the 2 populations by using the computed GDM rates for each year from 1988 to 1999 for Aboriginal and non-Aboriginal people. SPSS version 10 was used to conduct the analysis, and the output for the logistic regression analysis is presented in Table 1, as an example of the other outputs.

## RESULTS

### Prevalence

Based on the chi-squared analysis, the following results were obtained:

- The rate of GDM among Aboriginal mothers was almost twice the value for non-Aboriginal mothers (4.29% and 2.43%, respectively, OR 1.83, 95% CI 1.81–1.84).
- Many of the Aboriginal mothers had pre-gestational diabetes conditions. The rate of diabetes in Aboriginal mothers was more than 5 times the rate in non-Aboriginal mothers (1.78% and 0.33%, respectively, OR 5.54, 95% CI 5.40–5.69).
- These differences in prevalence rates between Aboriginal and non-Aboriginal mothers are statistically significant with  $P$  values  $< .0001$ .
- The age-standardized GDM rate for Aboriginal mothers was computed to be 6.29%, more than 2.5 times higher than the non-Aboriginal rate (2.43%). A chi-squared test found this difference to be significant ( $P < .001$ ).
- For comparison purposes, the com-

**Table 1. Logistic regression (GDM/Aboriginality, age of mother, hospital type, sex and multiplicity of birth)**

		Variables in the Equation					
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1*	ABOR	.831	.125	44.199	1	.000	2.295
	MAGE	.084	.004	415.987	1	.000	1.088
	HOSP2	.711	.044	266.071	1	.000	2.037
	BSEX	-.049	.043	1.312	1	.252	.952
	MULTIPLE	.493	.112	19.372	1	.000	1.637
	Constant	-3.549	.129	754.397	1	.000	.029

\* Variable(s) entered on step 1: ABOR, MAGE, HOSP2, BSEX, MULTIPLE.

bined standardized rates of GDM and DM for South Australia during 1988–1999 were computed to be 9.27% for Aboriginal mothers, as compared to 2.77% for non-Aboriginal mothers. The Australian Aboriginal combined rate of 9.27% for GDM and DM is one of the highest in the world, apart from the 22% rate reported for the Pima and Papago communities of American Indians.<sup>21</sup>

Figure 1 presents a graphical summary of the above results.

**Risk Factors**

Logistic regression analysis determines the risk (measured by odds ratios) for GDM in the Aboriginal population, as compared to the non-Aboriginal population. This analysis was conducted on the subset of data from 1988–1995

only, since the data from 1996–1999 were only obtained in summary form. Significant factors included in the model were race, age of mother, type of hospital, and multiplicity (other potential factors, such as baby’s sex, were tested, but not found to be significant). The analysis was performed using SPSS software, and partial results are presented in Table 1. The following results were obtained:

- The risk of GDM for Aboriginal mothers was 2.3 times higher (95% CI: 2.0–2.6) than that for non-Aboriginal mothers ( $P < .0001$ ).
- The risk of GDM for mothers giving birth in teaching and city hospitals was 2.0 times higher (95% CI: 1.9–2.1) than the corresponding risk in country hospitals ( $P < .0001$ ).
- The risk of GDM was 9% higher

(that is, multiplied by 1.09, 95% CI: 1.08–1.10) for each additional year of the mother’s age ( $P < .0001$ ).

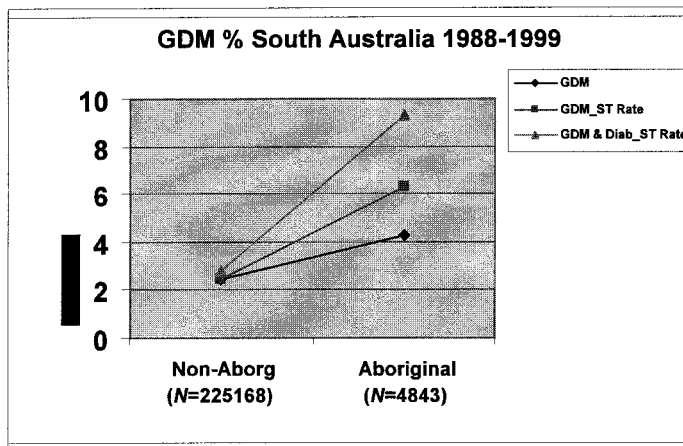
- The risk of GDM for mothers having multiple births was 1.6 times higher (95% CI: 1.4–1.9) than the corresponding risk in country hospitals ( $P < .0001$ ).

Age of the mother as a risk factor for GDM was further investigated, using a linear regression model weighted by the number of mothers in each age-group. Figure 2 summarizes the findings of this analysis, from which the following conclusions can be reached:

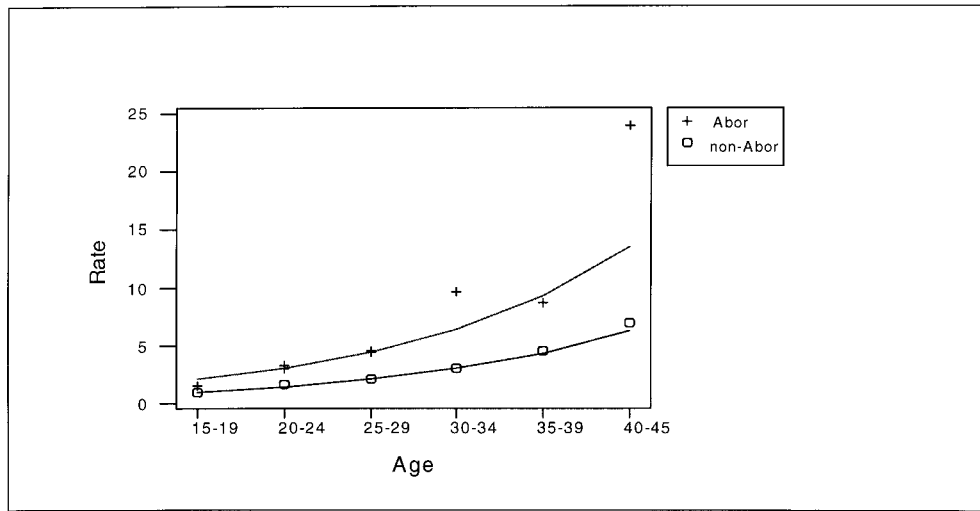
- The GDM rate increased constantly with the mother’s age, reaching its peak for mothers in the age group of 40 years and older (with a GDM level of 13% and 7% for Aboriginal and non-Aboriginal, respectively).
- For both Aboriginal and non-Aboriginal mothers, proceeding from one age group to the next one increased the potential rate of GDM by an average of 45% (exp [0.373],  $P$  value  $< .001$ ).
- Across all age groups, Aboriginal mothers exhibited GDM rates that were an average of 2.15 times higher than rates for non-Aboriginal mothers (exp [0.765],  $P$  value  $< .001$ ).

**Time Trends**

Figure 3 presents the time trend of GDM for the 12-year period of 1988–1999 for the Aboriginal, as compared to the non-Aboriginal, population. While the non-Aboriginal trend for GDM in South Australia reflects an increasing measured prevalence of GDM in recent years, a similar increasing trend cannot be observed in the Aboriginal series. The Aboriginal figures are, of course, based on much smaller numbers (4843 confinements for the time period, over 12 years, as compared to 225,168 in the non-Aboriginal population), which explains the varying sequence of increases and decreases noted in the time series. The Poisson generalized linear model fit to the rates in order to estimate the trend indicated an annual rate increase



**Fig 1. GDM rates and Aboriginality**



Aboriginal: rate= $\exp(0.37 + 0.37 \text{ age})$ ; non-Aboriginal: rate= $\exp(-0.40 + 0.37 \text{ age})$ .  
 $R^2=97\%$ ,  $S=10.8$ .

Fig 2. GDM rate % by age of mother and Aboriginality (weighted by sample size)

of approximately 4.7% in the GDM rate for the non-Aboriginal population ( $P<.0001$ ). However, the trend was less pronounced and non-significant (0.48%,  $P=.80$ ) for the Aboriginal population, reinforcing the trend's stability, as presented on the graph.

### DISCUSSION

We have examined the currently available information on the prevalence of GDM in the Aboriginal community in Australia, and based our conclusions on several current research

studies, as well as on the information obtained from a large, population-based data set from South Australia. It is apparent that the prevalence of GDM, however it is measured or defined, is significantly higher in the Australian Aboriginal community, as compared to the non-Aboriginal community, in concurrence with the findings of Yue et al.<sup>3</sup> This finding is also consistent with similar information about GDM in indigenous communities in other parts of the world.<sup>13,26</sup> Moreover, the same patterns are found for the risk of diabetes mellitus, and in the combined diabetes prevalence. Although a decreasing trend in GDM has been reported in other, much smaller, Aboriginal communities,<sup>15</sup> there was no significant change in the trend for South Australia.

The difference in the risk for GDM between Aboriginal and non-Aboriginal Australians, as reported here, is consistent with the differences reported for the overall prevalence of DM. Shannon et al<sup>17</sup> reported the DM rate for the Australian Aboriginal population to be approximately 2.5 times

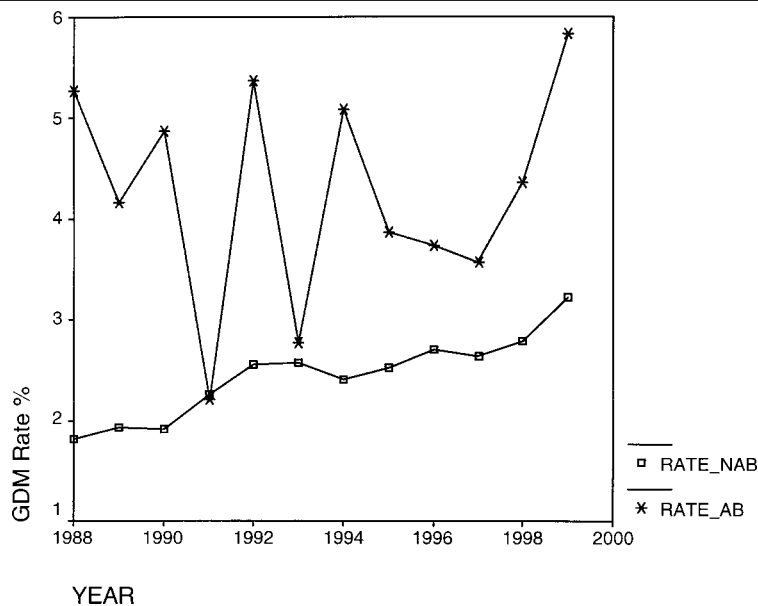


Fig 3. Aboriginal and non-Aboriginal GDM rate % in SA (1988-1999)

*It is apparent that the prevalence of GDM, however it is measured or defined, is significantly higher in the Australian Aboriginal community, as compared to the non-Aboriginal community, in concurrence with the findings of Yue et al.<sup>3</sup>*

higher than the rate for non-Aboriginal people (ranging between 7% and 19% in Aboriginal communities, and between 2% and 7% in non-Aboriginal communities). Moreover, the South Australian figures support King's<sup>21</sup> finding that the GDM prevalence and trend in a particular community generally reflect the underlying pattern of DM in that community.

It is interesting to note the higher rate of GDM in births at teaching and city hospitals. A possible conclusion to be drawn from this is that the identification, and therefore the screening, of GDM cases in teaching and city hospitals is about twice as high as that in country hospitals. However, there is no evidence that Aboriginal women are treated any differently than non-Aboriginal women in terms of hospital screenings; therefore, the relative rate of GDM is still a useful measure, demonstrating that Aboriginal women are more likely to suffer this condition and any associated complications. Further, it is impossible to draw any conclusions about the rate of GDM in rural versus urban populations, due to the standard Australian practice of transferring "difficult" cases to city hospitals, which tend to have better facilities.

Despite different protocols for mea-

suring GDM, it still may be of interest to compare the prevalence of GDM across different states in Australia, as well as across the Aboriginal communities of various countries. The prevalence and differences for Aboriginal people, as identified using the South Australia data, were generally similar to those found for other states, as reported in some other studies. For example, Yue et al.<sup>3</sup> reported that Aboriginal mothers are approximately 3 times more likely than Anglo-Celtic mothers to have GDM, based on data from New South Wales. Comparing the Aboriginal community in Australia with indigenous communities in Canada and New Zealand, the Aboriginal community in Australia seems to experience a somewhat lower level of GDM: 6.3%, based on South Australian data, as compared to 8.4% and 7.9% in Canada and New Zealand, respectively.<sup>12,27</sup>

The investigations of the time series demonstrate that the non-Aboriginal trend for GDM in South Australia is consistent with a reported national trend of increasing prevalence of GDM in recent years.<sup>17</sup> However, these results from South Australia cannot confirm the trend reported in a recent study by Kim and Humphery,<sup>15</sup> who found that Aboriginal people in a community in far north Queensland experienced a decrease in prevalence of GDM between 1992 and 1996. This finding differs from the experience across the entire state of South Australia.

These findings suggest that appropriate public health programs and health promotion procedures concerning gestational diabetes should be developed to target the Aboriginal community, and that ongoing research should be conducted on changes in prevalence rates over time. To this end, it would be very useful to have a common procedure for GDM diagnosis in Australia, in order to facilitate the study of this condition, and to conduct comparative analyses between communities.

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*Design and concept of study:* Ishak, Petocz

*Acquisition of data:* Ishak, Petocz

*Data analysis and interpretation:* Ishak, Petocz

*Manuscript draft:* Ishak, Petocz

*Statistical expertise:* Ishak, Petocz

*Acquisition of funding:* Ishak

*Administrative, technical, or material assistance:* Ishak