National, state and territory trends in gestational diabetes mellitus in Australia, 2016-2021: Differences by state/territory and country of birth

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Abstract

Objective: To examine trends of gestational diabetes mellitus (GDM) in Australia by state/territory and country of birth.

Methods: A cross-sectional study was undertaken from 2016 to 2021 using data from the National Diabetes Services Scheme (NDSS) and Australian Bureau of Statistics. The trends were assessed using Average Annual Percentage Changes (AAPCs) and the Cochrane–Armitage test.

Results: Nationally, the age-standardised incidence of GDM was 9.3% (95%CI; 9.1–9.4) in 2016 and 15.7% (95%CI; 15.4–15.9) in 2021, representing AAPC of +10.9%. The highest increase was in the Northern Territory, from 6.7% (95%CI; 5.1–8.3) in 2016 to 19.2% (95%CI; 16.9–21.6) in 2021, AAPC=+24.6%. In Southeast Asian-born women, the incidence of GDM rose from 12.2% (95%CI; 11.7–12.7) in 2016 to 22.5% (95%CI; 21.9–23.2) in 2021 (p_{-trend}<0.001).

Conclusions: The incidence of GDM has risen in Australia, particularly in the Northern Territory and Victoria, as well as among those born in Southeast Asia and South and Central Asia.

Implications for public health: This increase in GDM incidence in Australia underscores the pressing need for location and culturally responsive GDM prevention interventions. The lack of information on some risk factors of GDM (e.g. high body mass index) in the NDSS registry requires further investigation.

Key words: diabetes, country of birth, gestational, trends, health inequity

Introduction

Gestational diabetes mellitus (GDM), characterised by glucose intolerance, is diabetes that first appears during pregnancy.[1] In 2021, 20 million pregnant women had GDM worldwide.[2] In Australia in 2021-22, 19.3% of pregnant women were diagnosed with GDM,[3] an increase from 5.2% in 2011-12. GDM increases the risk of adverse pregnancy and birth outcomes such as preeclampsia, macrosomia, caesarean birth, birth asphyxia, and preterm birth.[4,5] Whilst GDM resolves after childbirth, the lifetime risk of women experiencing type 2 diabetes (T2DM) and hypertension is up to 22 and 1.85 times higher, respectively, compared with their GDM-free counterparts.[6] GDM may be attributable to multiple modifiable and non-modifiable factors such as overweight or obesity, geographic location, age,[7] and country of birth.[8]

The Australian Institute of Health and Welfare reported an increase in the incidence of GDM between 2000/1 and 2016/17 in Australia, varying across states/territories, with a significant rise in Tasmania (from 2.7% to 13.5%), followed by the Australian Capital Territory (ACT) (from 4.8% to 17.1%).[7] The increase in GDM incidence over that time was partly due to the implementation of universal screening with a 75 gm oral glucose tolerance test and endorsement by the Australasian Diabetes in Pregnancy Society (ADIPS) in 2014 of new diagnostic criteria change in line with the International Association of Diabetes and Pregnancy Study Groups (IADPSG). These changes included lower fasting glucose and the introduction of a one-hour glucose measurement.[9,10] Importantly, following the introduction of the new testing guideline in 2014, GDM incidence increased by 74% from 2014 to 2016.[11] Other contributing factors may have included the concurrent rise in the prevalence of obesity in pregnant women

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from 20.7% in 2012 to 24% in 2021,[12] along with increasing proportions of migrant women at increased risk of GDM birthing in Australia.[13,14] There is a lack of updated comprehensive evidence demonstrating the trends of GDM across states/territories and ethnicity since 2016. Understanding the incidence by ethnicity and across states/territories can guide the prevention of GDM at the population level targeted to those at increased risk and inform service delivery for health promotion, prevention and management. This has the potential to decrease adverse pregnancy outcomes and decrease the risk of long-term T2DM and cardiometabolic diseases for women and their children.[15]

This study aims to examine the trends of GDM by state/territory and country of birth as a proxy measure of ethnicity in Australia, utilising population-wide data from 2016 to 2021.

Methods

Study design and area

A nationwide cross-sectional study in Australia from 2016 to 2021.

Data source, study population and sampling procedure

Data on women with GDM were obtained from the National Diabetes Services Scheme (NDSS), based on enrolments between 2016 and 2021. The dataset contains sociodemographic characteristics of women that include address (postcode), year of GDM diagnosis, country of birth and age. NDSS is a government-initiative program administered by Diabetes Australia since 1987 to provide people with diabetes mellitus access to management (e.g. subsidised glucose strips) and information and education materials. NDSS is Australia's most comprehensive data source, capturing up to 90% of all types of diabetes cases, including GDM.[16]

Denominator data on the number of women who gave birth in Australia between 2016 and 2021 in each state/territory, year, and country of birth were obtained using open-source data published by the Australian Bureau of Statistics (ABS).[17] The area-level socioeconomic status and remoteness data were drawn from the 2016 ABS report. We used the Socioeconomic Index for Areas (SEIFA), which was determined using the Australian Census-based Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) approach based on postcode.[18]

Variables of the study

Outcome variable

The outcome variable was incident GDM, as reported to NDSS. The ascertainment of GDM was based on the 2014 diagnosis guideline, which recommended universal screening with a 75-gm oral glucose tolerance test.[9] This guideline was implemented across most states and territories by mid-2016.[7] There was a temporary change to the GDM diagnosis recommendations by professional societies during the COVID-19 pandemic to mitigate the risk of transmission dependent on contagion risk, meaning that uptake of these changes was variable. Changes that were recommended included a two-step diagnostic process at 24-28 weeks gestation in areas with moderate-high risk of contagion (initial fasting glucose and, if between 4.7 and 5 mmol/L, followed by an oral glucose tolerance test (OGTT)) and for areas at high risk of transmission or unable to maintain social distance, fasting glucose only >5.1 mmol/L was diagnostic of GDM.[19] Similarly, there were alternative strategies recommended for early diagnosis of women at increased risk of GDM depending on contagion risk.

Measurement of sociodemographic characteristics

Country of birth, as the only measure collected by the NDSS, was used as a proxy indicator for ethnicity and is widely used in previous reporting.[20,21] Country of birth was then broadly classified into ten major groups based on the Australian Standard Classification of Cultural and Ethnic Groups (ASCCEG), which groups geographical areas with similar social and cultural characteristics.[22] Australians, whilst usually a part of Oceania in the ASCCEG, were classified separately for this study. The ten groups were: Australian, Oceanian, Americans, North African and Middle Eastern, Northwest European, Southeast European, North East Asian, Southeast Asian, Southern and Central Asian, and Sub-Saharan Africa. Further data stratification was done to categorise individuals born in the ten most common countries who gave birth in Australia: Australia, India, the Philippines, China, Bangladesh, Pakistan, Nepal and Vietnam. Due to generally shared cultural practices, the New Zealand and United Kingdom-born individuals were merged with Australia-born.

The socioeconomic status of individuals was categorised into quintiles, with the first and the fifth quintiles reflecting the most and least disadvantaged groups, respectively.[18] The remoteness of areas was determined based on the Australian Statistical Geography Standard (ASGS) remoteness structure. Data were linked to women's residential areas using their postcodes.

Data processing and analysis

Direct age standardisation was applied to account for differences in the age structure of populations in each year, using 5-year age bands from 15-49. We considered the number of women who gave birth (stratified by 5-year age bands) nationally and across states/territories as a denominator population. The standard population was based on the 2016 census report on reproductive-aged women, reported in 5-year age bands. Due to a small frequency of women giving birth over 45 years of age in our sample, we combined all women aged greater than 40 years into a single age band.

Joinpoint regression was used to quantify trends over time and drive Average Annual Percentage Changes (AAPCs) of rates, with corresponding 95% confidence intervals (CIs). Cochran–Armitage tests were used to drive p-values for trends ($p_{-trends}$) to denote the statistical significance of each trend over time and across ordinal variables. The crude incidence of GDM across countries of birth groups was estimated by dividing the number of GDM cases by the corresponding number of births in each country of birth group.

Results

Sociodemographic characteristics of women birthing in Australia from 2016-21

Overall, 1,845,182 women who gave birth in Australia from 2016 to 2021 were included. The majority (35.8% in 2016 and 37.3% in 2021) of women over the study period were aged between 30-34 years. Most women (64.3% in 2016 and 64.9% in 2021) were Australian-born. The majority of women lived in Australia's major cities at the start (72%, 2016) and end (71%, 2021) of the study (Supplementary Table 1). Over time, the largest proportion of women was from the

New South Wales (NSW), while the least was from the Northern Territory (NT) (Supplementary Table 2).

Trends of GDM overall in Australia, across states and territories, and sociodemographic characteristics

Crude rates of GDM

The national crude incidence of GDM significantly increased from 8.9% (95%CI; 8.8, 9.0) in 2016 to 14.8% (95%CI; 14.7, 14.9) in 2021, with AAPC of +11.1 (95%CI; 8.0–14.6). The most significant increase in the incidence of GDM by state/territory was observed in NT: 5.3% (95%CI; 4.6, 6.0) in 2016 to 16.8% (95%CI; 15.6, 18.0) in 2021. The second highest rise was in the state of Victoria (7.2% (95%CI; 7.1, 7.4)) to 14.4% (95%CI; 14.2, 14.7)), followed by the Australian Capital Territory (ACT) (from 11.2% (95%CI; 10.4, 12.1)) to 22.4% (95%CI; 21.4, 23.6)) (Table 1).

The crude incidence of GDM increased over time in all quintiles of socioeconomic position (Supplementary Fig. 1). Significant reductions in the crude incidence of GDM were observed as the area-level socioeconomic status of women increased. GDM incidence decreased from 12.5% (95%CI: 12.2–12.6) to 9.6% (95%CI: 9.5–9.7) when comparing areas of most with least disadvantaged (p_{-trend}<0.001; Supplementary Table 3).

Age-specific rates of GDM

The age-specific rate of GDM increased in all age groups over time (Supplementary Fig. 2). The crude incidence of GDM was higher in women aged ≥40 vs 15-19 years: 17.8% [95%CI; 17.6–18.9] vs 4.9% [95%CI; 4.7–5.1] (p_{-trend}<0.001; Supplementary Table 3). The age-specific rate of GDM increased from 4.0% to 7.1% in women aged 15-19 years; 5.2 to 9.1% in 20-24 years; 7.1 to 12.4% in 25-29 years; 9.3 to 14.9% in 30-34 years; 12.6 to 19.1% in 35-39 years; and 12.9 to 23.1% in ≥40 years (Supplementary Table 4).

Age-standardised rates of GDM in Australia and across states and territories

Nationally, the age-standardised incidence of GDM in women has significantly risen from 9.3% (95%CI; 9.1–9.4) to 15.7% (95%CI; 15.5–15.9) between 2016 and 2021, representing an AAPC of +10.9% (95%CI; 8.9–13.1) (Table 2). The most significant increase in the incidence of GDM was observed in the NT, from 6.7% (95%CI; 5.1–8.3) in 2016 to 19.2% (95%CI; 16.9–21.6) in 2021, with an AAPC of +24.6% (95%CI; 19.3–32.3). Victoria had the second greatest increase with an AAPC of 16.5% (95%CI; 13.3–20.2), and the smallest increase was observed in NSW with an AAPC of +6.5 (95%CI; 1.1–12.6) (Table 2).

Table 1: Crude incidence of gestational diabetes mellitus per 100 in women aged between 15-49 by state/territory in Australia, 2016-2021.

States/Territories	Year						
	2016	2017	2018	2019	2020	2021	AAPC (2016-21)
NSW (n=603,919)	10.0 (9.8–10.2)	10.1 (9.9–10.3)	10.0 (9.8–10.1)	11.1 (10.9–11.2)	11.5 (11.3–11.7)	14.0 (13.8–14.2)	+6.8 (-0.18–14.8)[a]
Vic (n=536,312)	7.2 (7.1–7.4)	7.6 (7.4–7.8)	9.3 (9.1–9.5)	10.4 (10.2–10.6)	13.4 (13.2–13.6)	14.4 (14.2–14.7)	+16.4 (11.5–22.4)[a]
Qld (n=370,247)	9.0 (8.8–9.3)	9.7 (9.4–9.9)	9.9 (9.7–10.2)	10.7 (10.5–10.9)	11.7 (11.4–11.9)	14.5 (14.2–14.7)	+9.4 (3.2–16.6)[a]
SA (n=115,672)	9.2 (8.8–9.6)	10.2 (9.7–10.7)	11.1 (10.6–11.5)	11.1 (10.6–11.5)	13.4 (12.9–13.9)	14.5 (14.0–15.0)	+9.4 (6.8–12.3)[a]
WA (n=203,037)	6.8 (6.5–7.1)	7.4 (7.1–7.6)	8.1 (7.8–8.4)	8.7 (8.4–9.0)	10.2 (9.9–10.5)	11.8 (11.4–12.1)	+11.7 (9.3–14.5)[a]
ACT (n=33,161)	11.2 (10.4–12.1)	10.8 (10.1–11.6)	14.6 (13.7–15.6)	17.6 (16.6–18.6)	13.9 (13.0–14.9)	22.4 (21.4–23.6)	+14.4 (6.3–24.7)[a]
NT (n=23,050)	5.3 (4.6–6.0)	7.0 (6.2–7.9)	7.4 (6.6–8.3)	11.8 (10.7–12.8)	14.2 (13.1–15.3)	16.8 (15.6–18.0)	+26.7 (21.5–34.0)[a]
Tas (n=34,623)	8.2 (7.5–8.9)	8.6 (7.8–9.4)	10.0 (9.2–10.8)	11.7 (10.9–12.5)	10.5 (9.7–11.3)	12.2 (11.4–13.1)	+8.0 (3.3–13.4)[a]
Australia (n=1,845,182)	8.9 (8.8–9.0)	9.3 (9.2–9.4)	10.1 (10.0–10.2)	11.1 (11.0–12.3)	12.6 (12.5–12.7)	14.8 (14.7–14.9)	+11.1 (8.0–14.6)[a]

AAPC = Average Annual percent change; NSW = New South Wales; Vic = Victoria; Qld = Queensland; SA = South Australia; WA = Western Australia; ACT = Australian Central Territory; NT = Northern Territory; Tas = Tasmania.
[a]Indicates that the average annual per cent change significantly differs from zero at the alpha = 0.05 level.

Table 2: Age-standardised incidence of gestational diabetes mellitus per 100 in women aged between 15-49 by state/territory in Australia, 2016-2021.

States/Territories	Year						
	2016	2017	2018	2019	2020	2021	AAPC (2016-21)
NSW (n=603,919)	9.5 (9.2–9.8)	10.1 (9.8–10.4)	9.8 (9.5–10.1)	10.9 (10.6–11.2)	11.1 (10.8–11.4)	13.5 (13.1–13.8)	+6.5 (1.1–12.6)[a]
VIC (n=536,312)	7.7 (7.4–8.0)	8.5 (8.2–8.9)	10.7 (10.3–11.1)	11.9 (11.5–12.3)	14.5 (14.0–14.9)	16.1 (15.6–16.6)	+16.4 (13.3–20.2)[a]
Qld (n=370,247)	9.9 (9.4–10.3)	10.9 (10.4–11.4)	11.4 (10.9–11.9)	12.4 (11.9–12.9)	12.8 (12.3–13.3)	16.1 (15.5–16.6)	+9.3 (6.4–12.7)[a]
SA (n=115,672)	9.3 (8.5–10.0)	11.1 (10.2–11.9)	11.9 (11.0–12.8)	12.3 (11.4–13.2)	15.4 (14.4–16.4)	15.1 (14.1–16.0)	+10.2 (4.9–16.2)[a]
WA (n=203,037)	7.5 (7.0–8.0)	8.2 (7.7–8.8)	9.4 (8.8–10.0)	9.8 (9.2–10.4)	11.6 (11–12.2)	12.9 (12.2–13.6)	+11.6 (10.10–13.3)[a]
ACT (n=33,161)	10.8 (9.4–12.3)	11.6 (10.1–13.0)	13.0 (11.7–14.4)	17.5 (15.8–19.2)	13.5 (12.0–15.0)	20.1 (18.3–21.9)	+12.2 (5.0-21.0)[a]
NT (n=23,050)	6.7 (5.1–8.3)	7.4 (5.8–9.0)	10.7 (8.6–12.9)	14.3 (12.2–16.4)	16.2 (14.0–18.3)	19.2 (16.9– 21.6)	+24.6 (19.3– 32.2)[a]
Tas (n=34,623)	9.8 (8.2–11.3)	10.0 (8.4–11.6)	11.2 (9.4–12.9)	13.1 (11.3–15)	11.1 (9.5–12.7)	14.8 (12.8–16.8)	+7.6 (1.6–14.4)[a]
Australia (n=1,845,182)	9.3 (9.1–9.4)	10.2 (10.0–10.4)	11.0 (10.8–11.2)	12.3 (12.0–12.5)	13.4 (13.1–13.6)	15.7 (15.5–15.9)	+10.9 (8.9–13.1)[a]

AAPC = Average Annual percent change; NSW = New South Wales; VIC = Victoria; Qld = Queensland; SA = South Australia; WA = Western Australia; ACT = Australian Central Territory; NT = Northern Territory; Tas = Tasmania.
[a]Indicates that the average annual per cent change significantly differs from zero at the alpha = 0.05 level.

Trends of GDM nationally by country of birth

From 2016 to 2021, the crude incidence of GDM significantly increased in all groups, apart from those from North West Europe and the Americas. The greatest increase was noted in those from Southeast Asia and South and Central Asia. In women from Southeast Asia, the incidence of GDM was 12.2% (95%CI; 11.7–12.7) in 2016 and 22.5% (95%CI; 21.9–23.2) in 2021 ($p_{\text{-}trend}$ <0.001) (Table 3). In the subgroup analysis by country of birth, the increase was greatest in those from Vietnam, with a doubling in crude incidence, followed by those from the Philippines.

In women from South and Central Asia, the incidence rose from 14.4% (95%CI; 13.9–14.8) in 2016 to 24.0% (95%CI; 23.5–24.4) in 2021 ($p_{\text{-}trend}$<0.001). By country of birth, the women with the most marked increase within this group were those from India and Pakistan (Supplementary Table 5).

There was a small increase in GDM among Australian-born individuals, from 7.2% (95%CI; 7.1–7.3) to 9.0% (95%CI; 8.9–9.1) ($p_{\text{-}trend}$<0.001).

Discussion

Both the crude and age-standardised incidence of GDM showed a substantial increase from 2016 to 2021 overall in Australia, in each state/territory, all age groups, and each socioeconomic status. The significant change in the incidence of GDM was nearly threefold during the period in the Northern Territory (NT) and doubled in Victoria and the Australian Capital Territory. Furthermore, a significant increase in the incidence of GDM over time was observed in almost all ethnic groups, with the most marked rise in women born in Southeast and South and Central Asia. The risk of GDM over time was most marked in women from the most socioeconomically disadvantaged groups.

The consistent upward trend in the incidence of GDM in Australia and each state/territory aligns with the nationwide reports in Australia[7] and the United States.[23] The increasing trend could be ascribed to multiple risk factors, including the increasing prevalence of overweight or obesity among pregnant women, increasing age during pregnancy, and changing migration patterns with a higher proportion of people from ethnic groups at increased risk.

The increasing trends of GDM nationwide could be partly associated with the rising proportion of pregnant women with body mass index (BMI) in the overweight or obesity (BMI >25 kg/m^2) or obesity category (BMI >30 kg/m^2),[12] a significant risk factor for GDM.[24] Consistent with this study, GDM has previously been demonstrated to be higher in women from socioeconomically disadvantaged areas compared with the least disadvantaged areas.[25–27] This association has been reported to be significantly attributable to high BMI and other unhealthy lifestyle behaviours.[28] The ability to engage with a healthy diet with fresh fruit and vegetables and physical activity may be challenging for economically disadvantaged women.[29–31] Studies also indicated that lack of awareness about healthy lifestyle practices and adherence to lifestyle recommendations are associated with low income and educational status.[32,33]

Increasing age is a well-established risk factor for GDM, and there was a slight rise in the average age of women giving birth in Australia (from 31.3 years in 2011 to 32.2 years in 2021).[12,34] There was an upward trend in the incidence of GDM in all age groups, with the highest and fastest rate of change in women ≥40 years. However, this is a small proportion of women aged ≥40 (4.4%) and is not likely to contribute significantly to the increased incidence.

Since 2016, the proportion of migrant women giving birth in Australia from high-risk regions, such as South and Central Asia and South-East Asia, has increased.[13,14] Women from these regions have an elevated risk of GDM in their home and destination countries.[35] Independent of other behavioural-related risk factors caused by migration, being born in all these regions of Asia is a risk factor for GDM due to genetic susceptibility.[36] Women from South Asia are more likely to be diagnosed with GDM with the Australasian Diabetes in Pregnancy Society (ADIPS) guidelines endorsed in 2014 compared to other women.[21] Sociocultural expectations may also influence healthy lifestyle practices. For example, South Asian women, including those who migrate to countries like Australia, may experience higher expectations to focus primarily on housework and family-related responsibilities, limiting the opportunity to engage in health promotion activities, such as physical activity.[30,37,38] Other socio-cultural factors affecting the prevention of GDM may include an inability to participate in physical activity facilities (e.g. mixed-sex sports facilities).[37] Structural barriers to physical activity include lack of money, time, language, and environmental insecurity.[37,38] Moreover, the high cost of a healthy diet, lack of awareness of healthy eating guideline recommendations, and other cultural food preferences, such as high-fat foods, are also barriers affecting adherence to healthy diet recommendations.[30] For migrant women, inadequate utilisation

Table 3: Trends of crude incidence of GDM per 100 in Australia from 2016-2021 as defined by the Australian Standard Classification of Culture and Ethnic Groups, ABS, Australia.

Country of birth by region	Year						
	2016	2017	2018	2019	2020	2021	P_{trend}
Australian	7.2 (7.1–7.3)	7.4 (7.3–7.6)	8.0 (7.9–8.1)	8.8 (8.6–8.9)	5.2 (5.1–5.3)	9.0 (8.9–9.1)	<0.001
Oceania	8.8 (8.3– 9.3)	8.7 (8.2–9.2)	9.7 (9.2–10.2)	9.9 (9.4–10.5)	12.2 (11.6–12.9)	13.4 (12.8–14.1)	<0.001
North Africa and the middle east	9.3 (8.7–9.9)	10.1 (9.5–10.7)	11.9 (11.2–12.5)	12.6 (11.9– 13.3)	13.3 (12.6–14.1)	15.6 (14.9–16.4)	<0.001
North-east Asian	11.1 (10.6–11.6)	11.8 (11.3–12.3)	12.7 (12.2–13.3)	14.8 (14.2– 15.3)	15.6 (15.0–16.3)	17.8 (17.1–18.5)	<0.001
Northwest European	9.2 (8.8–9.7)	8.8 (8.3–9.3)	9.9 (9.4–10.5)	9.4 (8.9–9.9)	8.1 (7.7–8.7)	8.5 (8.0–8.9)	<0.001
South and east European	7.6 (6.9–8.4)	8.0 (7.3–8.8)	8.5 (7.7–9.3)	8.9 (8.1–9.7)	9.7 (8.9–10.6)	11.1 (10.3–12.1)	<0.001
America	11.2 (10.4–12.1)	11.4 (10.6–12.3)	11.1(10.3–11.9)	12.6 (11.7–13.5)	10.5 (9.7–11.3)	11.3 (10.5–12.1)	>0.8
South and central Asian	14.4 (14– 14.8)	16.9 (14.5–17.4)	18.4 (17.9–18.9)	21.0 (20.5–21.4)	22.1 (21.6– 22.5)	24.0 (23.5–24.4)	<0.001
South-east Asian	12.2 (11.7–12.7)	13.5 (13.0–14.1)	15.5 (14.9–16.0)	17.3 (16.8–17.9)	19.1 (18.5– 19.8)	22.5 (21.9–23.2)	<0.001
Sub-sharan African	7.9 (7.3–8.6)	8.7 (8.0–9.3)	9.4 (8.8–10.1)	11.2 (10.4– 11.9)	12.7 (11.9– 13.5)	14.5 (13.7–15.4)	<0.001

of reproductive healthcare services, meaning less opportunity to engage with preventive health practices can lead to increased risks, contributing to adverse pregnancy outcomes, such as GDM.[39,40]

The significant rise in the incidence of GDM in some parts of Australia, such as the NT and Victoria, may be due to the high screening efforts, a higher prevalence of pregnant women with overweight or obesity, and the population composition across states and territories. The significant upward trend of GDM in the NT is consistent with a previous study conducted in the same jurisdiction from 1987 to 2016.[41] Significant efforts have been in place in the NT since 2011 to increase awareness, screening, identification, and improved models of care to manage diabetes during pregnancy.[42] There is also a high proportion of Aboriginal and Torres Strait Islander women in the NT compared with other states/territories and are known to be at increased risk of GDM.[7,43] Factors contributing to this risk include genetic, epigenetic, and rapidly rising BMI in women of reproductive age.[12,44] There are additional barriers to adopting healthy nutrition and physical activity behaviours in the NT due to the remoteness of many areas. For example, the environment limits accessibility to affordable healthy foods, and there is often a lack of culturally appropriate physical activity programs, an absence of functional physical activity centres, and women often have competing priorities associated with familial and other aside personal conditions that affect their capacity to engage in healthy lifestyle activities.[45] Further, preventive healthcare services are often inaccessible.[46]

The marked rise in the trend of GDM in Victoria is consistent with a previous study conducted in the state from 2010 to 2017.[47] The higher increase in the incidence of GDM in Victoria compared with other states/territories could be associated with the higher proportion of migrant women who gave birth (such as from South/Central and Southwest Asia) who are at increased risk of GDM compared with other states/territories.[12,43] However, a detailed analysis to understand the obesity-attributable GDM incidence over time is needed in the future.

Our data included 2020-21, meaning during and after the lockdowns associated with the COVID-19 pandemic period. During this time, there were recommended changes in screening and diagnosis of GDM that could be considered to reduce the risk of COVID-19 transmission, including changing from universal screening to a two-step process if the contagion risk of COVID-19 is moderate-high.[19] The uptake of these changes was variable, and screening and diagnostic practices varied across jurisdictions and health services.[48] Studies report inconsistent impacts of this change over the relevant time period, with both decreases and no significant difference reported compared with the pre-COVID-19 screening.[49–51]

Considering the consistent upward trends in GDM and the significant associated lifetime risk of cardiometabolic complications to mothers and children and maternal mental health disorders,[52,53] understanding the groups at highest risk of GDM and tailoring equitable services will be crucial to informing federal and state/territory governments in their efforts to combat the rapidly rising rates of GDM. Increasing trends in the incidence of GDM up to 2016 could be partly associated with the newly introduced guideline in 2014. However, this study is from 2016, when most health services adopted the new guidelines.[7,54]

A more detailed understanding of other risk factors (e.g. age, obesity, socioeconomic status) contributing to the higher risk of GDM for women from at-risk ethnic backgrounds and an understanding of why some states/territories have a higher incidence of GDM than others is required. Tailored intervention programs may be applicable, with evidence showing that culturally tailored interventions effectively reduce the risk factors of diabetes.[55] Additionally, understanding the social and economic determinants of health and how to mitigate them could provide insights into reducing the rising incidence of GDM across states/territories and ethnicities.

Strengths and limitations of the study

The large, contemporary, and representative sample of pregnant women across all states and territories of Australia used in this study provides current trends in GDM for policymakers and health promotion experts. No other reports have assessed GDM across states and territories since 2016.

However, caution should be taken when utilising our findings due to some limitations. Data on GDM were sourced from a single registry with voluntary participation, NDSS, which may affect the incidence of GDM. However, NDSS is reported to be the most comprehensive national data source for all types of diabetes, covering up to 90% of the eligible population.[16] In addition, NDSS as a data source helps to estimate the incidence of GDM nationally, unlike other data sources such as the National Perinatal Data Collection and National Hospital Morbidity Database that report women with all other forms of diabetes together.[7] Another limitation is that studies have demonstrated differences in the risk of GDM by singleton compared with multiple pregnancies[56,57]; however, our study did not examine this variable as it was unavailable in our dataset.

Variable practices in GDM screening and diagnosis during the COVID-19 pandemic may have contributed to the observed disparities in the incidence of GDM across years and states/territories.[48] The unavailability of screening criteria in the NDSS data limited our ability to examine the impacts. Country of birth in the NDSS is completed by health practitioners or individuals where it may be self-reported but previously shown to be a reliable measure in Australia.[58] Country of birth, whilst generally used as an objective marker of ethnicity in Australia,[20,21] has limitations as an assessment of ethnicity. For example, it does not include Australian-born women from ethnic backgrounds at risk of GDM. This would, however, only decrease any differences between groups. It is generally the only reported objective criterion widely used in Australia.[20,21] As stated in a recent commentary report in Australia,[59] the broad national standard aggregation approach of ethnicity we used in this study could also neglect the important dissimilarities between cultural practices and norms within broader geographical territories that predict health outcomes. We have not reported GDM in Aboriginal and Torres Strait Islander women, as reporting of GDM to NDSS for this community, particularly in remote areas, is not always well collected across all states and territories. Further, we were unable to examine the overweight or obesity-attributable incidence of GDM over time, as our data source does not contain individual BMI measurements.

Conclusions

The incidence of GDM has significantly risen nationally and in all states/territories between 2016 and 2021 in Australia. The most notable increases were observed in the Northern Territory, followed by Victoria. While there have been increases across all ethnic backgrounds (except for Americans), the greatest change was seen in women from Southeast Asians and South and Central Asians. Implementing tailored prevention strategies that are culturally responsive and addressing core social determinants of health (e.g. socioeconomic status) may help alleviate the burden of GDM in Australia.

Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this study.

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Ethical approval

The study was approved by the Monash University Human Research Ethics Committee (*Ref: 37523*).

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Appendix A Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.anzjph.2024.100202.