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REVIEW

# Gestational diabetes mellitus: Challenges for different ethnic groups

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## Abstract

Ethnicity is defined as "belonging to a social group that has a common national or cultural tradition". Membership of certain ethnic groups has long been associated with increased risk of gestational diabetes mellitus (GDM). Studies that examined ethnic differences amongst women with GDM were often conducted in western countries where women from various ethnic backgrounds were represented. The prevalence of GDM appears to be particularly high among women from South Asia and South East Asia, compared to Caucasian, African-American and Hispanic communities. For some, but not all ethnic groups, the body mass index is a risk factor for the development of GDM. Even within a particular ethnic group, those who were born in their native countries have a different risk profile for GDM compared to those born in western countries. In terms of treatment, medical nutrition therapy (MNT) plays a key role in the management of GDM and the prescription of MNT should be culturally sensitive. Limited studies have shown that women who live in an English-speaking country but predominantly speak a language other than English, have lower rates of dietary understanding compared with their English speaking counterparts, and this may affect compliance to therapy. Insulin therapy also plays an important role and there appears to be variation as to the progression of women who progress to requiring insulin among different ethnicities. As for peri-natal outcomes, women from Pacific Islander countries have higher rates of macrosomia, while women from Chinese backgrounds had lower adverse pregnancy outcomes. From a maternal outcome point of view, pregnant women from Asia with GDM have a higher incidence of abnormal glucose tolerance test results post-partum and hence a higher risk of future development of type 2 diabetes mellitus. On the other hand, women from Hispanic or African-American backgrounds with GDM are more likely to develop hypertension post-partum. This review highlights the fact that management needs to be individualised and the clinician should be mindful of the impact that differences in ethnicity may have on the clinical characteristics and pregnancy outcomes in

women affected by GDM, particularly those living in Western countries. Understanding these differences is critical in the delivery of optimal antenatal care for women from diverse ethnic backgrounds.

**Key words:** Gestational diabetes mellitus; Ethnicity; Perinatal outcomes; Medical nutrition therapy; Prevalence



**Core tip:** The prevalence of gestational diabetes mellitus (GDM) is increasing world-wide, and studies have shown that optimal management of GDM improves pregnancy outcomes. This review summarises the differences in prevalence, clinical profile, management and pregnancy outcomes among women from various ethnic backgrounds who have GDM. Ethnicity is an important consideration in women affected by GDM, particularly in an antenatal service based in a Western society. There are particular challenges in individualising and tailoring medical nutritional therapy and insulin therapy. Also women from certain ethnic groups are at a higher risk of increased foetal and maternal morbidity and mortality. Understanding these challenges is important in providing optimal antenatal care for women of diverse ethnic backgrounds.

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## INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as glucose intolerance first recognized during pregnancy[1]. GDM has been reported to affect between 1.4% to 12.3% of pregnancies[2], and its prevalence is increasing and parallels the rising incidence of type 2 diabetes mellitus worldwide[3,4]. Risk factors for developing GDM in pregnancy include obesity, previously GDM, glycosuria, family history, ethnicity and hypertension[5,6]. Arguably, one of the strongest non-modifiable risk factor for GDM relates to the woman's ethnicity.

The Oxford Dictionary defines ethnicity as "belonging to a social group that has a common national or cultural tradition"[7]. In particular, ethnic groups that are considered high-risk include Hispanic, African-Americans, Native American, South or South East Asian, Pacific Islander or Indigenous Australian[8]. It is also recognised that women with GDM from these and other ethnic groups may differ with regards to peri-natal and maternal outcomes[9-12].

In this review we discuss the differences amongst women from various ethnic groups in terms of prevalence, diagnosis, treatment of GDM and pregnancy outcomes. Because of the variance in the diagnosis and management of GDM around the world, it is difficult to compare women with GDM between countries. In order to delineate ethnic differences in terms of GDM prevalence, metabolic profiles of the women and pregnancy and long-term outcomes, studies were often conducted in the same country (or under the same health care system) where the diagnostic criteria, screening process, treatment regimen and delivery of health care are uniform for all women[13-16] (refer A Table 1).

## DIAGNOSTIC CRITERIA

There are numerous diagnostic criteria for GDM currently being utilized in various parts of the world, as shown in Table 2. Many countries have based their GDM diagnostic criteria on the 1999 World Health Organisation (WHO) Criteria[17], while in Australasia and the United States, they have a adopted different glucose cut-offs to diagnose GDM based on the oral glucose tolerance test (OGTT)[18,19]. Findings from the Hyperglycaemia and Adverse Pregnancy Outcomes study has put impetus on revising the diagnostic criteria for GDM, and the International Association of Diabetes in Pregnancy Study Group (IADPSG) had subsequently recommended new threshold glucose levels on the 75 g OGTT for diagnosing GDM[20,21]. In 2013, the WHO adopted the IADPSG guidelines and revised the cut-offs for fasting plasma levels to $\geqslant$ 5.1 mmol/L, (92 mg/dL), 1-h glucose level to $\geqslant$ 10.0 mmol/L (180 mg/dL) and 2-h glucose level to $\geqslant$ 8.5 mmol/L (153 mg/dL) following 75 g OGTT[22]. It is expected that the 2013 WHO diagnostic criteria may standardise the diagnosis of GDM worldwide, but to date the implementation of this new criteria has been slow internationally.

There is preliminary data reflecting on the impact the new diagnostic criteria may have on the prevalence of GDM amongst different ethnic groups. A Singaporean study demonstrated that the proportion of women diagnosed with GDM in the Asian population using the 2013 WHO Criteria would be lower[23]. The prevalence could drop from 30.9% to 18.9% in women of Chinese ethnicity, and from 33.5% to 28.1% among the South Asian population[23]. On the other hand, in a predominantly Anglo-European population in Australia, the prevalence of GDM will increase from 9.6% to 13.0%[24]. The reason for this divergence is that there are differences between ethnic groups in the glycaemic profiles on the OGTT from which GDM is diagnosed. In a cohort of over 850 women diagnosed with GDM from a multi-cultural community in south western Sydney, Australia, from the 75 g OGTT, those from South-East Asia had the lowest fasting glucose levels (4.95 ± 0.65 mmol/L) but the highest 2-h glucose level (8.75 ± 1.17 mmol/L). In contrast, Pacific Islanders had the highest fasting levels (5.71 ± 1.19 mmol/L) but the lowest 2-h levels (7.73 ± 1.27 mmol/L)[25].

**Table 1 Large studies highlighting the prevalence of gestational diabetes mellitus in women of different ethnicities living within a geographic region**

| Ref. | Year | City/region | Number of Women with GDM by ethnicity | Rate of GDM by ethnicity |
|---|---|---|---|---|
| Beischer *et al*[27] | 1979-1998 | Melbourne, Australia | 66 Indian subcontinent | 15% Indian subcontinent |
| | | | 91 Chinese | 13.9% Chinese |
| | | | 60 Egypt and Arab countries | 7.2% Egypt and Arab countries |
| | | | 132 Other Asian | 10.9% Other Asian |
| | | | 95 Vietnamese | 7.3% Vietnamese |
| | | | 143 United Kingdom and Northern Europe | 5.2% United Kingdom and Northern Europe |
| | | | 270 Mediterranean | 7.3% Mediterranean |
| | | | 1008 Australian and New Zealand | 4.3% Australian and New Zealand |
| Solomon *et al*[63] | 1990-1994 | The Nurses Health Study Ⅱ: 14 states in the United States | 655 White | 4.7% White |
| | | | 12 African-American | 10.6% African-American |
| | | | 17 Hispanic | 7.6% Hispanic |
| | | | 26 Asian | 10.5% Asian |
| Sullivan *et al*[64] | 1997 | Sydney, Australia | 730 Vietnamese | 5.3% Vietnamese |
| | | | 7226 Australian | 1.6% Australian |
| Savitz *et al*[28] | 1995-2003 | New York City, United States | 398 North African | 7.2% North African |
| | | | 1018 Sub-Saharan Africa | 5.9% Sub-Saharan Africa |
| | | | 3512 East Asia | 6.2% East Asia |
| | | | 1027 South-East Asia and Pacific Islands | 8.6% South-East Asia and Pacific Islands |
| | | | 4758 South Central Asia | 14.3% South Central Asia |
| | | | 5038 Non-Hispanic Caribbean | 6.8% Non-Hispanic Caribbean |
| | | | 8767 Hispanic Caribbean | 4.9% Hispanic Caribbean |
| | | | 2780 Mexico | 6.3% Mexico |
| | | | 1133 Central American | 4.9% Central American |
| | | | 4189 South American | 6.6% South American |
| | | | 6387 African-American | 34.3% African-American |
| | | | 9846 Non-Hispanic White | 3.6% Non-Hispanic White |
| Chu *et al*[29] | 2005-2006 | Up to 19 states in the United States | 5326 Japanese | 3.45% Japanese |
| | | | 32460 Asian Indian | 8.03% Asian Indian |
| | | | 25530 Chinese | 6.44% Chinese |
| | | | 25785 Filipino | 6.9% Filipino |
| | | | 11561 South Korean | 3.9% South Korean |
| | | | 21721 Vietnamese | 6.14% Vietnamese |
| | | | 20718 Other Asian | 5.07% Other Asian |
| | | | 5761 Pacific Islander | 5.17% Pacific Islander |
| | | | 1873925 White non-Hispanic | 3.82% White non-Hispanic |
| | | | 394091 Black non- Hispanic | 3.54% Black non- Hispanic |
| | | | 677392 Hispanic | 3.63% Hispanic |
| | | | 14617 American Indian | 5.13% American Indian |
| Kim *et al*[32] | 2007-2009 | California, United States | 20129 Asian and Pacific Island | 11.9% Asian and Pacific Island |
| | | | 316 American Indian | 7.6% American Indian |
| | | | 3371 Black American | 5.6% Black American |
| | | | 52256 Hispanic | 8.4% Hispanic |
| | | | 1483 Other | 6.6% Other |
| | | | 18806 Non-Hispanic White | 5.4% Non-Hispanic White |

GDM: Gestational diabetes mellitus.

## ETHNICITY AND THE PREVALENCE OF GDM

Specific ethnicities of women have long been considered as a risk factor for developing GDM. At-risk ethnic groups identified in the literature, are Aboriginal women in Australia, Middle Eastern (Lebanese, Syrian, Iranian, Iraqi or Afghanistan) women and Pacific Islanders[2,8,26,27]. Table 1 outlines some large population studies describing the prevalence of GDM among different ethnic groups who resided in western societies.

Among Asian women, the prevalence for GDM varies greatly. For instance, a study conducted in New York showed the prevalence of South-Asian (Indian, Sri Lankan, Pakistani, Fijian Indian) women having GDM are generally higher than the risk of South-East Asian (Cambodian, Vietnamese, Laotian, Thai, Filipino, Malaysian) women and the East-Asian (Chinese, South Korean, Taiwanese and Japanese) women. The prevalence of GDM in women who were born in Asian countries varied from 3.0% to 21.2%[28]. Many studies have shown Asian women had a much higher risk of GDM than women of United States Caucasian or Australian descent (Table 1). The highest risk appears to belong to women from South Asia and their adjusted relative risk is quoted by Savitz *et al*[28] to be as high as 7.1 (95%CI: 6.8 to 7.3).

Interestingly, studies have demonstrated that women who migrated from their native countries to a western society had a higher rate of GDM compared

**Table 2 Diagnostic criteria for gestational diabetes mellitus prior to recommendations by the International Association of Diabetes in Pregnancy Study Group in 2010**

| | ADA-NDDG[65] | ADIPS[19] | NZSSD[66] | WHO (1999)[17] | CDA[67] | EASD[62] |
|---|---|---|---|---|---|---|
| Glucose load (g) | 100 | 75 | 75 | 75 | 75 | 75 |
| FPG (mmol/L) | 5.3 | 5.5 | 5.5 | 7 | 5.3 | 6 |
| 1-h Glc (mmol/L) | 10 | - | - | - | 10.6 | - |
| 2-h Glc (mmol/L) | 8.6 | 8 | 9 | 7.8 | 9 | 9 |
| 3-h Glc (mmol/L) | 7.8 | - | - | - | - | - |
| Abnormal results to diagnose GDM | 2 or more | 1 or more | 1 or more | 1 or more | 1 or more | 1 or more |

ADA-NDDG: American Diabetes Association National Diabetes Diagnostic Group; ADIPS: Australian Diabetes in Pregnancy Society; NZSSD: New Zealand Society for the Study of Diabetes; WHO: World Health Organization; CDA: Canadian Diabetes Association; EASD: European Association for the Study of Diabetes; FPG: Fasting plasma glucose; Glc: Glucose; GDM: Gestational diabetes mellitus.

to women of a foreign ethnicity but who were born in western countries[28]. However this trend did not apply to Japanese and South Korean women[29]. Table 3 summarises two large studies showing the prevalence of GDM amongst women of various ethnic groups who were born in western countries compared with those born in their native countries. Again the data seems to suggest women born in South Asian and Pacific Islander countries who have migrated to the United States had the highest rate of GDM than United States born women from the same ethnicity[29].

The demographic profiles of migrant mothers also varied among different ethnic groups. Studies had shown that Vietnam-born pregnant women with GDM who moved to Australia were more likely to be older, underweight and pregnant for the first time[30]. Similarly, Shah *et al*[31] found that United States Caucasian and Asian women with GDM were more likely to be over the age of 35 and have a higher education level. Compared with other Asian groups, Japanese and South Korean women have the lowest risk of GDM[12,29,32].

## BODY MASS INDEX

Body mass index (BMI) has long been considered as a risk factor associated with the development of GDM[33]. Ethnic origin also appears to be a factor with a twofold higher rate in obese Hispanic women compared to African-American and Caucasian women[34]. Women with GDM from Pacific Islands had the highest pre-pregnant BMI (34.5 ± 8.0 kg/m$^2$), while those from South East Asia had the lowest (23.7 ± 4.8 kg/m$^2$)[25]. As BMI increases, the sensitivity of BMI to identify GDM in each racial/ethnic group decreases while the specificity increases. In a retrospective study of 24325 patients presenting at the University of San Francisco using a BMI of ⩾ 25 as a screening tool classified 76.8% of African-Americans with GDM in this category but only 24.9% of Asian women. Using a BMI cut-off of > 21.0 identified 91.5% of African-American women with GDM, 90.1% of Hispanic, and 79.8% of United States Caucasian, but only 68.4% of Asian women. African-Americans were shown to have the highest increased risk (OR: 5.1) of GDM when BMI > 25.0 was used as a screening tool, compared with US Caucasians (OR: 3.6), Hispanics (OR: 2.7) and Asians (OR: 2.3)[31].

Women from Asia were shown to have GDM during pregnancy despite having a BMI that is within or below normal range[30,32,35]. Therefore the role of BMI as a screening tool or risk factor for GDM in women from Asia is certainly questionable[31]. Hunsberger *et al*[15] found that Asian women had the greatest risk of having GDM compared to other ethnicities regardless of whether their BMI was greater or less than 26 kg/m$^2$. This population tend to have more visceral or central fat, which is a known risk factor for insulin resistance and cardiovascular disease[36]. Hence we would recommend screening pregnant Asian women for GDM regardless of their BMI.

A recent study on the interaction between maternal age and BMI showed the odds ratios for GDM development were significantly higher in women older than 30 years if they were Caucasian, older than 25 years if they were African and older than 20 years if they were South-Asians. This study also found that Africans and South-Indians were at higher risk of developing GDM irrespective of BMI[37].

## MANAGEMENT OF GDM

Medical nutritional therapy (MNT) is the cornerstone in the management of GDM. The goal of MNT is to provide adequate calories and nutrients to meet the needs of pregnancy and consistent with maintaining normoglycaemia[5]. Yet there is very little consensus on a specific recommended dietary approach in the treatment of GDM[6,38,39]. A recent review of 6 randomised controlled trials in 250 women with GDM suggested that a diet higher in complex carbohydrate and fibre, low in simple sugar and saturated fat may be effective in preventing postprandial hyperglycaemia and avoid worsening insulin resistance and excess foetal growth[40]. Yet studies comparing low-glycaemic index (GI) with a high-GI or conventional high-fibre diet showed no difference in birth weight or adverse pregnancy outcomes[41,42]. Similarly a 2013 Cochrane Review assessing 11 different types of dietary advice for women with GDM was unable to conclude on which was the most suitable dietary advice. The specific diets analysed were low-and high-

**Table 3 Studies comparing the prevalence of gestational diabetes mellitus among different ethnicities in women born in Western countries with women born in foreign countries**

| Ref. | Year | City/Region | Rate of GDM in ethnic groups born in Western country | Rate of GDM in ethnic groups who migrated from their native country to a western country |
|---|---|---|---|---|
| Savitz, Janevic, Engel, Kaufman and Herring[28] | 1995-2003 | New York City, United States | 1.7% North African | 7.5% North African |
| | | | 3.1% Sub-Saharan Africa | 5.9% Sub-Saharan Africa |
| | | | 5.6% East Asia | 6.3% East Asia |
| | | | 4.3% South-East Asia and Pacific Islands | 8.9% South-East Asia and Pacific Islands |
| | | | 6.8% South Central Asia | 14.5% South Central Asia |
| | | | 3.4% Non-Hispanic Caribbean | 7.1% Non-Hispanic Caribbean |
| | | | 4.4% Hispanic Caribbean | 5.3% Hispanic Caribbean |
| | | | 4.0% Mexico | 6.4% Mexico |
| | | | 3.4% Central American | 5.1% Central American |
| | | | 3.1% South American | 7.0% South American |
| Chu, Abe, Hall, Kim, Njoroge and Qin[29] | 2005-2006 | Up to 19 states in the United States | 4.91% Japanese | 3.27% Japanese |
| | | | 5.54% Asian Indian | 8.81% Asian Indian |
| | | | 4.64% Chinese | 6.25% Chinese |
| | | | 5.95% Filipino | 7.31% Filipino |
| | | | 5.31% South Korean | 4.92% South Korean |
| | | | 5.16% Vietnamese | 6.2% Vietnamese |
| | | | 4.39% Other Asian | 6.21% Other Asian |
| | | | 5.82% Pacific Islander | 8.38% Pacific Islander |

GDM: Gestational diabetes mellitus.

carbohydrate, high-monounsaturated fat, fibre-enriched diet, low-, moderate-, and high-GI, and energy-restricted and unrestricted. Overall there were no significant differences seen in the rates of macrosomia, large-for-gestational age deliveries or caesarean section[39].

To achieve treatment goals, dietary plans should be prescribed by an accredited dietitian and should be culturally appropriate and tailored to the individual[5]. The ability to adjust the amount and type of carbohydrate by training patients in "carbohydrate counting" is important to achieve target blood postprandial glucose levels[38]. However, the amount of carbohydrate intake varies greatly between different ethnic and cultural groups. For instance, in South East Asia, rice is the staple food and this may pose major challenges for women from this background to curtail their rice intake. The diet for South-Asians is similarly heavily reliant on carbohydrate, and multiple sources of carbohydrate are often included at any one meal (*e.g.*, lentil, dhal, rice in combination)[43].

On the other hand, some women from the Middle East typically have a large meal in the afternoon with relatively smaller meals consumed at breakfast and dinner. They also have a tendency to delay breakfast till mid-morning and have dinner very late in the evening. Ramadan, an annual month of fasting observed by people of the Muslim faith, has significant impact on the timing of carbohydrate intake and meal portions. Ironically, it is the month where food consumption increases dramatically for Muslim communities as the daytime fasting is broken each evening with large banquets among family and friends which can last until dawn[44]. Although pregnant women are exempted from observing Ramadan, many pregnant women with GDM still choose to observe the important religious ritual with their family.

For Pacific Islanders, they also tend to have large servings of carbohydrate at main meals and multiple sources of carbohydrate at the one meal (taro, yam, cassava, green bananas, bread and rice)[45]. All these factors should be taken into consideration when prescribing MNT. An overly regimental dietary recommendation will therefore result in poor compliance to therapy and suboptimal glycaemic control.

Health literacy among women from different ethnic groups may be highly variable, and this could have a significant impact on management of GDM. A study of women with GDM in the United Arab Emirates showed they had little understanding of carbohydrate knowledge, but not significantly different to women who did not have GDM. Moreover 22% of women with GDM were not reviewed by a dietitian for nutrition counselling and 65% attended a dietitian only once or twice[46]. Furthermore, migrants in a Western society may also face huge challenges in managing their GDM. This could be related to language difficulty or their inability to adapt to an unfamiliar health system. A cross-sectional study conducted in Melbourne Australia showed that women coming from Vietnam had the poorest English skills and lowest education levels, with the greatest risk of misunderstanding GDM[47]. Women with a history of GDM were shown to have poor diet quality as determined by the Australian Recommended Food Score, and in particular women who spoke a language other than English had significantly poorer knowledge than those who spoke English only[48].

There were few studies that examined compliance to therapy for women with GDM. In an Australian study looking at failure-to-attend (FTA) rates of women with GDM, women who FTA more than once during their pregnancy had higher BMI, greater incidence of previous GDM and were more likely to be from non-Caucasian backgrounds[49]. Apart from language barriers,

women from non-Caucasian backgrounds may need greater resources and time from clinicians to help them understand their condition better in order to improve their adherence to treatment recommendations.

## INSULIN THERAPY

The glycaemic targets set for the management of GDM may also differ between countries, and hence it would be difficult to compare the proportion of women requiring insulin therapy across different regions. From a database in south western Sydney, women from South-East Asia had the lowest prevalence for insulin therapy (37.2%), compared with Anglo-Europeans (56.7%)[25]. Despite having the highest 2-h glucose level on OGTT, women from South-East Asia also had the lowest need for rapid-acting insulin for the management of post-prandial hyperglycaemia. In that cohort, Pacific Islanders had the greatest need for insulin therapy, with 65% failing MNT. These women also had higher glycosylated haemoglobin (5.9% ± 0.9%, 41 ± 10 mmol/mol) at the time of diagnosis of GDM compared to women from South East Asia (5.4% ± 0.4%, 36 ± 4 mmol/mol)[25]. In a similar study conducted in Hawaii, women from Pacific Islands had the highest rate of commencement of insulin therapy (27.5%), while women from Chinese heritage had the lowest (11.1%)[11]. The higher percentage Pacific-Islanders requiring insulin before 20 wk of gestation in that study suggested that there could be a larger subset of Pacific-Islander women with previously undiagnosed type 2 diabetes.

## FOETAL AND PERINATAL OUTCOMES

There is good evidence that treatment of women with GDM leads to better obstetrics and peri-natal outcomes[50]. GDM increases risks of adverse perinatal outcomes including large for gestational age, shoulder dystocia, surgically assisted delivery and hypertensive disorders in pregnancy[20]. In a 2013 systematic review commissioned by the United States Preventative Services Task Force and the National Institute of Health Office of Medical Applications of Research showed that treating GDM will result in a reduction in rates of preeclampsia, shoulder dystocia and macrosomia, but the benefits on preventing neonatal hypoglycaemia and averting long-term adverse metabolic outcomes of offspring are yet to be established[51].

Among Asian subgroups, Cambodian and Laotian women with GDM had increased odds of macrosomia when compared with Japanese women with GDM. However, South East Asian women had lower rates of foetal macrosomia when compared with United States Caucasian women but preterm delivery with preeclampsia occurred more often when compared with Japanese and United States Caucasian women[52]. Pacific Islanders have a higher rate of macrosomia than Asian or Caucasian women, but Asian neonates born with macrosomia had comparatively higher levels of NICU admission, need for intravenous dextrose treatment for hypoglycaemia and respiratory distress, although the overall numbers were small[10].

However another study from Ontaria Canada showed that mothers of Chinese heritage had a significantly lower risk of adverse outcome at delivery compared to South Asian mothers. Chinese women also had a lower risk of adverse maternal outcomes compared with the general population[53]. Several recent studies suggest infants born to mothers of non-Caucasian nationalities have lower adverse outcomes. A retrospective cohort study of 1865 adolescent women of different ethnicities born in a Californian University found that African-American, Hispanics and Asians had significantly lower rates of Caesarian delivery and low Apgar scores, while Asians and African-Americans had decreased rates of preterm delivery[54]. There is no evidence to suggest any increase in peri-natal mortality for a particular ethnic group within a health care system. In a study of neonates admitted to intensive care unit, the mortality of 9813 infants of Australian-born mothers was not different to the 2166 infants born from migrant mothers[55].

## MATERNAL OUTCOMES

GDM represents relative beta-cell dysfunction which is caused by insulin resistance, revealed in response to the metabolic stress experienced during pregnancy[56,57]. Women from particular ethnic groups who have GDM may be more susceptible to developing diabetes in the future[2]. In particular, it appears that women with GDM from an Asian background who live in western societies are more likely than Anglo-European women to subsequently develop diabetes[30,58]. Moreover a recent meta-analysis showed that women from ethnic groups other than "non-Hispanic white" had a higher rate of GDM recurrence of 56% compared with 39% in "non-Hispanic white" women who experienced GDM[59].

A study of three ethnic groups of European, South Asian and Afro-Caribbean found that women who had a history of GDM had a range of metabolic abnormalities including beta-cell dysfunction with variable insulin resistance despite normal fasting blood glucose levels postpartum[60]. Similarly a study in the United Kingdom of 221 women with GDM or impaired glucose tolerance (IGT) showed Asian women were shown to have significantly higher rates of persisting glucose intolerance compared with Afro-Caribbean or Anglo-European women post-partum. Use of insulin in Asian women during pregnancy was also associated with postpartum IGT[14]. Development of type 2 diabetes mellitus in all ethnic groups was 3.5 times greater in women using insulin[58].

An Australian study found that all ethnic groups living in a multicultural region with a high percentage of foreign-born residents all had a high rate of post-GDM diabetes or IGT[2]. After a mean follow-up of 5.5 years, the study found that South Asians had the highest rate of either diabetes or IGT at 69%, more than the other

ethnic groups combined. South Asians and South-East Asians with either diabetes or IGT were also shown to have significantly lower BMI than Middle-Eastern or South European counterparts[2].

A recent large retrospective analysis of women who delivered at Massachusetts General Hospital between 1998 and 2007 showed that women with GDM were 2.45 times more likely to develop hypertension compared to women without GDM. Furthermore, African-American and Hispanic women with GDM had a higher risk of developing hypertension and Asian women had a lower risk compared to United States Caucasian women subsequent to pregnancy[61].

## CONCLUSION

The increased risk of pregnant women developing GDM who belong to specific ethnic groups is widely acknowledged in the literature. This review highlights the major challenges in the provision of diabetes education and delivering MNT for GDM in an antenatal service where women may come from diverse ethnic and cultural backgrounds. Treatment involving MNT needs to be individually tailored and culturally sensitive, and insulin use may be more prevalent among some ethnic groups. Clinicians should appreciate that a "one size fits all" approach may not be appropriate in managing these women with GDM.

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