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DIABETES AND PREGNANCY (M-F HIVERT AND CE POWE, SECTION EDITORS)

Ethnic Disparities in Gestational Diabetes

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Abstract

Purpose of Review Ethnicity has long been described as a major risk factor for the development of gestational diabetes mellitus (GDM), and it is widely recognised that women from ethnicities other than Europids are at higher risk of developing GDM. There are also described differences between ethnicities in key GDM pregnancy outcomes. This review describes some of the factors that relate to the ethnic disparities in GDM.

Recent Findings The global prevalence of GDM has been steadily increasing and estimated to be 16.2% from the International Diabetes Federation extrapolation. Reported prevalence rates may understate the true prevalence, due to factors of access and attitudes to GDM diagnosis and screening in low resource settings for foreign-born women and indigenous populations. Other factors may relate to genes associated with specific ethnicities, obesity, body composition and gestational weight gain.

Summary Various factors such as access to screening, body composition, genetics and gestational weight gain may result in ethnic disparities in the prevalence and outcomes of GDM.

Keywords Gestational diabetes · Ethnicity · Prevalence · Lifestyle · Differences · Weight

Introduction

Gestational diabetes mellitus (GDM) has traditionally been defined as "any degree of glucose intolerance with onset or first recognition in pregnancy" [1, 2]. The World Health Organisation (WHO) now designates GDM as a subset of and distinct from the broader term hyperglycaemia in pregnancy (HIP) [3, 4, 5••]. GDM is said to occur late in pregnancy as a transient condition with less severe hyperglycaemia, differing from diabetes in pregnancy (DIP) where diabetes is overt in pregnancy and likely to continue after birth. However, recent literature suggests there may also be an entity related to early-onset GDM which may be distinct from DIP and a separate subset of HIP [6], as GDM typically appears in the second or third trimester. GDM exhibits a large proportion of HIP, with estimates that it represents 75–90% of all HIP cases [7]. The term GDM in this review will imply cases of hyperglycaemia that exclude DIP, unless such a delineation is not evident.

Ethnicity has long been recognised as a major risk factor to the development of GDM [8], and women from many ethnic groups have been recommended to be screened as soon as feasible, and have the screening repeated at 24–28 weeks of gestation [1, 2]. Specific ethnicities of high risk cited include Hispanic, African, Native American, South or East Asian, Pacific Islands or Indigenous Australians [1, 9, 10]. However, in reality, this is all ethnic groups besides those of Anglo-European descent ("Europids") [11].

The Concept of Ethnicity

The Oxford Dictionary defines *ethnic* as "relating to a population subgroup (within a larger or dominant national or cultural group) with a common national or cultural tradition" [12]. It is felt to be a social construct to group individuals

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who share a similar sense of traits and potentially outlook on healthcare. However, the word is problematic as it often has variable meanings, and the boundaries of ethnic groups have become more narrowly defined for research purposes [13]. For example, in 1997, the United States' Office of Management and Budget released a directive recommending the classification of data into five racial (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Pacific Islander, White) and two ethnic categories (Hispanic or Latino, or Not Hispanic or Latino) [14]. Prior to this, the terms American Indian or Alaskan Native, Asian or Pacific Islander, Black not of Hispanic origin, Hispanic and White not of Hispanic (NHW) origin were the broad categories. When looking at the epidemiology data around GDM, many large US-based studies have used broad classifications such as "Black not Hispanic" or "White not Hispanic", despite obvious heterogeneity within groups [15–18]. Despite this, commentators recognise that it is still useful to use ethnic classifications in medical research, as they represent the social history which potentially underpins a person's health [19–21].

Beyond ethnic differences in GDM, pregnant women from one ethnic group who live in a country outside of their country of birth may further predispose them to developing GDM [22–24]. For example, Kim et al. showed that the relative risk of developing GDM was higher among foreign-born mothers compared to US-born women, across almost all ethnic groups aside from East Asian (Chinese, Japanese and Korean), both in adjusted and unadjusted models for BMI, age and parity [16].

Prevalence and Screening

The prevalence of GDM relating to various ethnic groups varies considerably. The International Diabetes Federation (IDF) Atlas 8th edition estimates that the global prevalence of HIP between 20 and 49 years of age to be 16.2%, affecting 21.3 million births [7]. Of these, 86.4% are predicted to be due to GDM with 7.4% due to DIP and 6.2% due to diabetes detected prior to pregnancy. Regional prevalence ranges from 10.4% in Africa to 24.2% in South East Asia (comprising of seven countries—India, Bangladesh, Nepal, Sri Lanka, Mauritius, Bhutan and the Maldives) [25]. However, these groupings hide substantial variation within ethnic groups. For example, a large retrospective study in New Jersey differentiating between South Asians showed that Bangladeshi women had the highest rate of GDM, followed by Indians, Sri Lankans and Pakistanis [18].

The landmark Hyperglycaemia and Adverse Pregnancy Outcomes (HAPO) study was published in 2008, and the International Association of Diabetes and Pregnancy Study Groups (IADPSG) developed screening strategy based on the HAPO study outcomes [2, 26]. Based on this, the World Health Organisation has updated its diagnostic criteria for classification of GDM [5••]. Prior to HAPO, there was no standard agreement on which screening strategy was to be used, and even within a country, it was not uncommon for varying screening strategies to be used [27]. Since then, there has been an explosion of GDM-related literature, particularly around the impact of the changed diagnostic criteria and increased prevalence [28, 29]. Several large epidemiological studies have also highlighted the range of differences in GDM between ethnic groups. Table 1 summarises the largest epidemiological studies in the past 5 years since the widespread adoption of the HAPO recommendations through the IADPSG diagnostic criteria.

HAPO also highlighted the varying patterns of hyperglycaemia in different ethnic groups. Overall 55% of women were diagnosed based on the fasting plasma glucose (FPG), 33% were diagnosed on the 1-h value and only 12% at 2 h. However, among the various ethnic groups, GDM was diagnosed on the FPG in 24% of women in Bangkok but 74% of women in Barbados, this pattern was reversed at the 1-h value (76 v 32%); however, women from Belfast had the lowest (25%) and Hong Kong had the highest (65%) diagnostic rate at the 2-h value [39].

The widespread uptake of the IADPSG and WHO recommendations has meant comprehensive screening programs have been implemented with increased diagnosis and improved access to perinatal care for women with GDM [27, 38, 40]. Most GDM prevalence studies applying these recommendations describe an increase in prevalence, with studies in North India and United Arab Emirates reporting as much as a fourfold increase to representing over one-third of the population [41, 42]. However, when looking at data recorded in Table 1, it appears that the crude prevalence rates, even for the high-risk ethnicities, are below that of the estimated 16.2% by the IDF. This is due in part to a gradual adoption of the IADPSG criteria, with only 4 of the 11 studies mentioned applying the newer criteria, or variants thereof. There are however many other factors influencing prevalence estimates and Fig. 1 summaries the various factors that influence the prevalence estimates of GDM.

Most of the large prevalence studies are focused in the geographic regions of North America, Europe and Asia Pacific, and hence there are inaccuracies when estimating GDM in ethnicities outside of these regions. Many factors impact on the ability of low or limited-resource settings to be able to implement the IADPSG and NICE screening guidelines [2, 29, 43, 44•]. For example, some West African and Sub-Saharan African countries which have no estimation of GDM as screening is not systematically performed due to resource limitations and selective screening strategies are used [45–47]. Many limited-resource countries use risk factor-based screening, and Ogu et al. describe an underestimation of GDM prevalence in the Niger Delta due to using selective risk-based screening compared with universal screening [47].

Table 1 The largest recent GDM epidemiology studies by ethnicity

Authors	Location	Year	Sample size	Glycaemic criteria	Population prevalence	Ethnic prevalence breakdown	Other key findings	Reference
Sanchalika and Teresa	New Jersey, United States of America	1999–2002	327,069	ICD-9 codes	4%	Sri Lankan 12.5% Bangladeshi 12.4% Indian 11% Pakistani 10.4% Non-Hispanic White 3.5%	Indians and Sri Lankan women had higher levels of formal education (≥ 16 years) Sri Lankan women were more likely to be aged ≥ 30 years Indian and Pakistani had higher OR of SGA at 10%ile, Bangladeshi and Indian highest OR of SGA at 5%ile. All South Asian women had lower odds of having a baby weighing > 5000 g than NHW.	[18]
Bardenheier et al.	19 States, United States of America	2000–2010	75,212–2000 119,229–2010	ICD-9 codes	2000–3.71% 2010–5.77%	Largest relative increase in prevalence was highest among Hispanics (66%)		[30]
Yeung et al.	Alberta & British Columbia, Canada	2004–2010	12,036	Canadian Diabetes Association Clinical Practice Guidelines 2008	5.7%	Alberta: Chinese 11% South Asian 8.4% General population 4.2% British Columbia: South Asian 13.9% Chinese 13.5% General population 5.7%		[31]
Nishikawa et al.	London, United Kingdom	2004–2012	53,264	Not stated	2.31%	South Asian 4.6% East Asian 3.7% Black 3.0% White 1.5%		[32]
Kim et al.	California, United States of America	2007–2009	1,228,265	Not stated	7.8%	11.9% Asian and Pacific Island 8.4% Hispanic 7.6% American Indian 6.6% Other 5.6% Black American 5.4% Non-Hispanic White	2.0% of women with GDM were underweight, 32.4% were normal weight, 29.2% were overweight, and 36.5% were obese (19.6% class I, 10.0% class II obese, 7.9% class III)	[33]
Pu et al.	California, United States	2007–2012	24,195	WHO 2013	Not stated	Using age-adjusted prevalence rates 19.3% Asian Indian 19.0% Filipino 18.8% Vietnamese 15.3% Chinese 13.3% Hispanic 12.9% Korean 9.7% Japanese 7.0% Non-Hispanic white 4.9% Non-Hispanic black		[34]
Tsai et al.	Hawaii, United States	2009–2011	4735	Not stated	10.9%	13.1% Filipina 12.1% Hawaiian/Pacific Islander 12.1% Asian Pacific Islander 11.0% Other Asians 7.4% White		[35]

Table 1 (continued)

Authors	Location	Year	Sample size	Glycaemic criteria	Population prevalence	Ethnic prevalence breakdown	Other key findings	Reference
Chang et al.	Hawaii, United States	2010–2012	15,156	ICD-9 codes	8.3%	13.7% Other Pacific Islanders 12.6% Samoan 9.3% Native Hawaiian 8.5% Micronesian 5.8% White		[36]
Piffer et al.	Trento, Italy	2010–2015	29,025	IADPSG 2010	4.2%	Foreign 6.3% (African 9.5%, Asian 10.5%) Italian 3.5%		[22]
McDonald et al.	Melbourne, Australia	July 2012–June 2013	4610	ADIPS 1999	13.2%	Categorised by country of birth: 7.4% Europe and North America 12.1% West and Central Asia 10.0%Australia or New Zealand 10.6% Africa 10.8% Latin America 15.2% Oceania 21.6% Southeast Asia 31.2% East Asia		[37]
Wong, Lin & Russell	Liverpool. Australia	February to December 2015	1725	WHO 2013 compared with ADIPS 1998	WHO 29.6% ADIPS 14.8%	ADIPS1999 v WHO 2013: South Asians: 44.4%/22% Others: 37%/16.7% Pacific Islands: 31.9%/17.7% Middle East 37%/14.3% Australian/European: 24.8%/8.9% East/South East Asian: 22.3%/19.7%		[38]

Abbreviations: ADIPS, Australian Diabetes in Pregnancy Society; GDM, gestational diabetes mellitus; IADPSG, International Association of the Diabetes and Pregnancy Study Groups; ICD, International Classification of Diseases; SGA, small for gestational age; WHO, World Health Organisation

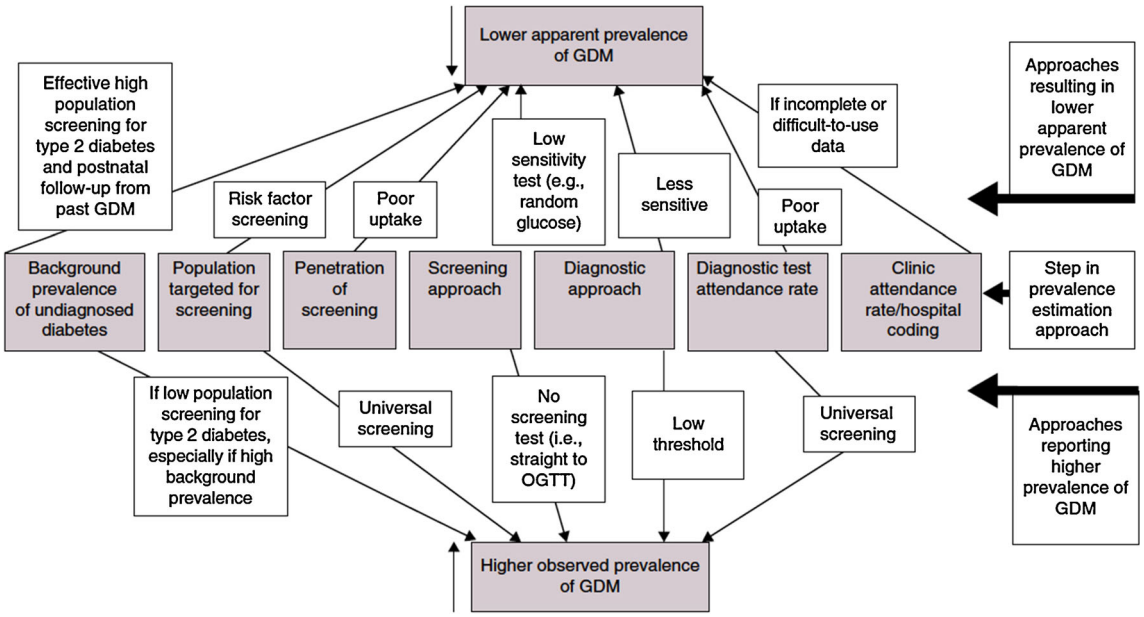

Fig. 1 Difficulties in comparing prevalence data in GDM with different approaches. GDM: gestational diabetes mellitus; OGTT: oral glucose tolerance testing. (From Simmons D. Epidemiology of Diabetes in Pregnancy. In: McCance D, Maresh M, Sacks DA, editors. A Practical Manual of Diabetes in Pregnancy. 2nd Edition. Copyright © 2018 by John Wiley & Sons, Inc. Reprinted by permission of John Wiley & Sons, Inc.) [11]

Similarly, Nakabuye et al. reported that 23.8% of GDM cases were missed through the current selective screening strategy employed in Nsambaya Uganda [48]. Other authors from Asian cohorts have suggested the use of alternate strategies such as fasting plasma glucose [49] or the "two-step" [50] approaches as being more appropriate in developing countries.

Authors of studies in high-resource settings have also questioned the benefits of using a comprehensive screening strategy with recent studies in Finland and Denmark reporting that use of comprehensive screening over risk factor-based screening increased the rate of diagnosis of mild GDM with little consequence in health outcomes while placing substantial demands on hospitals and healthcare resources [40, 51, 52].

Utz and De Brouwere reported barriers to GDM screening and management in the low and lower-middle income countries of Africa, South Asian and Latin America include lack of standard comprehensible guidelines; lack of knowledge and training in screening and managing GDM; limited access to care with some settings only having 15% women attending public facilities; prohibitive costs in relation to testing, equipment, medication and hospitalisation; and unavailability of specific equipment, medications and health care providers [44•]. Compounding the problem is the lack of awareness of patients, providers and the general community to GDM and inertia to change established behaviours. This often results in non-adherence to dietary modifications, medications, performance of regular blood glucose monitoring and attendance of appointments [53]. The prevalence estimates of indigenous populations of Australian and Canadian Aborigines, American Indian and Inuit are likely understated due to low screening rates and similar factors discussed above [54–56].

Genetic Predisposition

There has been a growing interest in the genetics of GDM. A number of gene variants were identified that may predispose to GDM, largely based on their known association with type 2 diabetes (T2D). To date, candidate studies and genome-wide association analysis (GWAS) have identified eight genes associated with development of GDM–CDK5 regulatory subunit associated protein 1 like 1(*CDKAL1*), glucokinase (*GCK*), insulin-like growth factor 2 mRNA binding protein 2 (*IGF2BP2*), insulin receptor substrate 1 (*IRS1*), potassium voltage-gated channel subfamily J member 11 (*KCNJ11*), potassium voltage-gated channel subfamily Q member 1 (*KCNQ1*), melatonin receptor 1B (*MTNR1B*) and transcription factor 7 like 2 (*TCF7L2*) [57–59]. Of these, using the unbiased approach of GWAS, only *CDKALI* (odds ratio 1.518; $p = 6.65 \times 10^{-16}$) and *MTNR1B* (odds ratio 1.454; $p = 2.49 \times 10^{-13}$) have been shown to have strong GDM association in a study of Korean women with 468 affected and 1242 controls [60].

The methylthiotransferase *CDKALI* rs7754580 has been associated in a study of 1146 Han Chinese women with reduced gestational insulin sensitivity ($p = 0.011$) and increased disposition ($p = 0.0002$) [61]. Another hypothesis exploring the genetic susceptibility of GDM is that abnormal changes in the melatonin signalling pathway occur in patients with

GDM, as melatonin receptors are expressed in pancreatic beta-cells and are part of a signalling system that may reduce insulin secretion. Variants in the single-nucleotide polymorphism rs10830963 in *MTNR1B* have been associated with GDM susceptibility [62]. Li investigated 350 GDM patients and 480 controls concluded that both *MTNR1B* (genotype OR 1.22, $p_{adjusted} = 0.039$; allele OR 1.21, $p_{adjusted} = 0.032$) and *MTNR1A* (genotype OR 1.36; $p_{adjusted} = 0.011$; allele OR 1.45, $p_{adjusted} = 0.003$) were associated with women of Han Chinese ethnicity who had GDM [63]. Whereas a study of 750 Mexican women (408 cases and 342 controls) showed that *MTNR1B* rs1387153 was associated with GDM ($p = 0.00022$) [64].

Lin et al.'s meta-analysis of 16 studies involving 4853 cases and 10,631 controls showed that the *TCF7L2* rs7903146 polymorphism was associated with increased risk of GDM in Europid, Hispanic and Asian subgroups, with Asians who are TT allele homozygous having the highest risk (OR 3.08, $p = 0.002$) [65]. Another large recent analysis conducted using DNA collected from offspring of predominantly Europid ethnicity from three large cohort studies (1160 DNA trios) including 1367 HAPO participants, demonstrated that the polymorphic variation in foetal paternally transmitted genes *IGF2* rs10770125 ($p = 3.2 \times 10^{-8}$) and *INS* rs2582 ($p = 3.6 \times 10^{-5}$) may result in elevated glucose intolerance in the mother in late pregnancy [58]. Studies in non-pregnant populations have shown there is substantial overlap between genetic variations association with T2D and metabolic quantitative traits [66]. In the GDM literature to date, there have been two genes identified through GWAS, *HKDC1* ($p_{meta\text{-}analysis} = 1.022 \times 10^{-22}$) that has been associated with 2 h-glucose post oral glucose tolerance test and *BACE2* ($p_{meta\text{-}analysis} = 6.30 \times 10^{-16}$) associated with fasting c-peptide in a meta-analysis of HAPO sample and two other cohorts [67].

Body Composition and Gestational Weight Gain

Obesity is on the rise across the world, with the rates nearly tripling since 1975 and an estimated 40% of adult women aged 18 and over are reported as being overweight or obese [68]. Studies show that the absolute risk of having GDM was more than two times higher among mothers who had a body mass index (BMI) of ≥ 25 kg/m^{2}and the risk of women rising to eightfold if severely obese [16, 69]. However, Makgoba et al. demonstrated the influential role ethnicity plays in stratifying risk according to BMI, where women of a normal BMI from African, Caribbean and South Asian ethnicities had a 2.52, 1.21 and 3.0 odds ratio of developing GDM compared with Europids. This trend increased exponentially with increasing body mass levels [70]. Although obesity is strongly associated with risk of developing GDM, it is not a reliable predictor of developing GDM in East Asian women. A large study conducted in London showed that only 13% of East Asian women who develop GDM were in the obese range when BMI was measured and calculated at the first booking appointment, compared with one-third of White and South Asian, and half of the Black women [32].

Widespread immigration of Asian and African ethnicities, which traditionally have a greater proportion of women who are underweight or normal weight [71] to countries with higher rates of overweight and obese weight such as the US, has meant obesity rates among those (migrated) ethnic groups are rising dramatically [72], placing pregnant women in these groups at greater risk of GDM [73]. The ethnicities with the highest average female adult weight were those from Polynesia and Micronesia, averaging above 30 kg/m^2 [71].

Maternal obesity, excessive gestational weight gain (GWG) and presence of GDM all contribute to a metabolic state during pregnancy that can have lasting sequelae for the child, long into adulthood. This adverse metabolic state caused by obesity and GDM in utero may have effect on the central nervous regulatory centres of metabolism and weight control, and lead to increased insulin, glucose, protein and/or leptin levels during the early critical stages of a child's development [74].

Both maternal undernutrition and overweight conditions have been implicated in foetal programming, with long-term health implications for the child [75]. Being underweight is also associated with poor pregnancy outcomes, including increased mortality, delivery complications, preterm birth and intrauterine growth retardation [76, 77]. East Asian women have some of the highest rates of moderate or severely underweight [71]. In Japan, 1 in 5 women of childbearing age (20–30s) are underweight, defined by BMI < 18.5 kg/m^2 [78]. However, the risk of GDM occurs at a much lower BMI in Asian women compared to women of other ethnicities, as seen in the Kaiser Permanente cohort analysis [73]. In fact, being underweight at age 20 was found to be positively associated with GDM in Japanese women [79].

Aside from obvious ethnic differences in BMI and weight, the parameters of subcutaneous fat and serum leptin levels have been described to be more likely retained after delivery in South Asians compared with Europeans. These likely contribute to the increase risk of GDM in subsequent pregnancies as they increase the risk of retaining weight and subcutaneous fat which leads to excess adiposity and obesity when entering the next pregnancy [80].

Treatment

Treatment of GDM has traditionally consisted of lifestyle measures aimed at reducing hyperglycaemia of women through dietary counselling, physical activity and glucose monitoring, prior to the initiation of medical management [81].

Medical Nutritional Therapy (MNT) or diet has been associated in GDM with improved foetal outcomes, and prevention of macrosomia [82]. The standard nutritional advice for pregnant women is largely based on the Institute of Medicine (IOM) reports on "Nutrition During Pregnancy" published in 1990 [83], the 2009 report on weight gain in pregnancy [84] and the 2006 "Dietary Reference Intakes: The Essential Guide to Nutrient Requirements" [85]. These guidelines recommend the appropriate amount of gestational weight gain (GWG) should be calculated for each woman based on prepregnancy weight and height. Modern recommendations recommend a balanced approach to macro and micronutrient intake and a modest increment in daily caloric intake of 340 to 450 kcal/day in the latter two trimesters [86].

Despite MNT being the main treatment option for GDM, there are substantial differences in the knowledge or way this is applied in various cultures. Ali et al. showed that women with GDM from the United Arab Emirates (UAE) had no significant difference in food knowledge compared to women without GDM, and overall had poor awareness of the carbohydrate content in food and drink [87]. Paradoxically, a study in Japan noted that high carbohydrate intake was associated with a lower risk of glucose intolerance as seen with a positive glucose challenge test (GCT). They also noted that rice accounted for only 30.3% of the carbohydrate intake of Japanese women, and a 60% total energy intake from carbohydrates was associated with a halving of the risk of a positive GCT compared with those who had a carbohydrate intake of 49% [88]. In Singapore, the Growing Up in Singapore Toward Healthy Outcomes (GUSTO) trial showed that a higher dietary protein intake was associated with a higher risk of GDM [89].

A challenge in the prescription and adherence to MNT is the impact of cultural traditions that surround food and meal times [90]. For example, many women of the Islamic faith will observe fasting during the month of Ramadan, despite being excused by their faith from participating while pregnant [91]. Furthermore, there are large variations in the amount of carbohydrate intake between cultural groups, for instance South Asians and Pacific Islanders will traditionally consume large amounts of carbohydrates in different forms at each meal. This poses a challenge for clinicians in trying to limit the carbohydrate intake for women in these ethnic groups [92].

GWG has been a topical issue, as many women are gaining excess weight during pregnancy resulting in adverse pregnancy outcomes and there are ethnic differences in the amount of weight gained during pregnancy [93]. Recently, there has been a push for women with GDM to gain less weight than the recommended by the 2009 IOM guidelines [84, 94]. Previously, a large multi-ethnic population study in Washington State concluded that the IOM recommendations decreased adverse maternal outcomes, and decreased the odds ratio of small for gestational age and large for gestational age (LGA) infants [95]. This was echoed in a Korean study where the BMI cut-offs were lower [96]. However, a recent randomised control trial of 606 women in Norway aimed at limiting GWG through lifestyle intervention showed no measurable benefit in obstetric or neonatal outcomes despite a small decrease in GWG [97]. A large systematic review of over 1.3 million pregnancies published in 2017 concluded that weight gain above and below the IOM recommendations were associated with adverse maternal and infant outcomes [98].

The recommendations of physical activity for GDM treatment are likely based on assumptions that physical activity has a direct impact on insulin sensitivity and glucose homeostasis [99, 100], as well as the WHO guidelines for physical activity for the general adult population [101]. However, few studies have defined specific recommendations for physical activity in the treatment of GDM women and its effect on varying ethnicities [102]. The GUSTO trial in Singapore in fact showed that sedentary behaviour was not associated with increased risk of GDM, but that high levels of physical activity had a protective effect against women developing GDM but specifically in women with BMI ≥ 23 kg/m^2 [103].

Outcomes

GDM is recognised to be associated with poor perinatal and foetal outcomes such as macrosomia, LGA infants, pre-eclampsia, hypertensive disorders in pregnancy, shoulder dystocia and caesarean section [5]. Pregnant mothers with GDM are also at risk postpartum complications of developing overt diabetes and having GDM in subsequent pregnancies [104]. As described above, the epigenetic environment is often unfavourable for the child who is at risk of developing obesity, diabetes and metabolic syndrome in adulthood [105, 106]. Appropriate treatment of GDM has been shown to reduce the incidence of adverse foetal outcomes of macrosomia, pre-eclampsia and shoulder dystocia [107].

Ethnic differences in perinatal outcomes have been reported in the past by several authors [108, 109]. More recently, Sanchalika and Teresa reported that Bangladeshi, Indian and Pakistani women with GDM had a lower rate of preterm birth and LGA than Non-Hispanic white females, but higher small for gestational age (SGA) infants [18].

Development of diabetes post GDM has been quoted as occurring in between 2.6% in Europid and 70% in the Sioux in a 2002 meta-analysis [110], and 9.6 times the general population at 25.8% at 25 years [111]. Moses et al. found that the Australian prevalence of diabetes in a predominantly Europid population followed for up to 25 years after GDM pregnancy was twice the general prevalence at 10.3% [112]. A systematic review showed that overall there was a 48% rate of GDM recurrence, but that the NHW recurrence rate of 39% which was significantly lower than that of other ethnicities at 56% [113].

Interestingly, Khan et al. recently published a cohort study of more than 40,000 Ontario singleton pregnancies who had GDM and showed a lower rate of GDM-associated adverse outcomes in 2106 refugees and 16,232 immigrants from various countries were compared with 22,564 non-immigrant women [114]. Overall, they had lower rates of preeclampsia, preterm birth, macrosomia, respiratory distress syndrome and neonatal hyperbilirubinaemia, despite being of significantly lower socio-economic status than the non-immigrant group. The authors put this down to a "healthy immigrant effect" and are self-selected to be healthy individuals, but were somewhat surprised that this effect applied to refugee women [114].

Conclusion

There appear to be many factors which contribute to the ethnic differences in prevalence and outcomes in GDM including screening strategies in different countries, genetics, body composition, gestational weight gain and cultural attitudes and practices. With a move toward global adoption of the IADPSG guidelines, low-resourced countries are not currently able to meet the increased demands placed on them through the lowered screening OGTT thresholds, nor the follow-up required to manage the increased prevalence of GDM. A deeper understanding of these factors and focusing further research on strategies that may help narrow the gap between how GDM can be managed among different ethnicities will likely result in lower prevalence rates and better outcomes.

Compliance with Ethical Standards

Conflict of Interest Lili Yuen, Vincent W. Wong, and David Simmons declare they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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