Original Article

Impact of using the international association of diabetes and pregnancy study groups criteria in South Auckland: prevalence, interventions and outcomes

Alec J. EKEROMA,[1] Gokilavani S. CHANDRAN,[1] Lesley MCCOWAN,[1] David ANSELL,[2] Carl EAGLETON[3] and Tim KENEALY[4]

[1]*Department of Obstetrics and Gynaecology, Faculty of Medical and Health Sciences, University of Auckland,* [2]*Department of Obstetrics and Gynaecology, Middlemore Hospital,* [3]*Department of Medicine, Middlemore Hospital, and* [4]*Integrated Care South Auckland Campus, Middlemore Hospital, Auckland, New Zealand*

Introduction: Adopting the modified International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria for diagnosing gestational diabetes mellitus (GDM) will increase the prevalence of GDM resulting in increased resource utilisation and an unknown effect on clinical outcomes.
Aims: To determine the prevalence of GDM by the modified IADPSG criteria and compare characteristics and pregnancy outcomes between women with GDM by IADPSG-additional, those with GDM by the New Zealand Society for the Study of Diabetes (NZSSD) criteria and those with a normal oral glucose tolerance test (OGTT).
Methods: All women who delivered at Counties Manukau District Health Board (CMDHB) for a 12-month period from July 2012 to June 2013 had demographic, pregnancy and laboratory data obtained from hospital databases and clinical records.
Results: Of the 6376 (85%) of eligible women screened for GDM, 381 (6%) had GDM by NZSSD criteria and an additional 238 (4%) by the modified IADPSG-additional criteria, a relative increase of 62%. Women with GDM by NZSSD criteria had similar characteristics compared to women with GDM by IADPSG-additional. The outcomes between the two groups were also similar with the exception of a higher induction of labour (IOL) rate in women with GDM by NZSSD and a higher mean birthweight in the GDM by IADPSG-additional.
Conclusion: Adopting the modified IADPSG criteria will result in a 62% increase in the number of GDM cases with a significant impact on workload and resources. Currently, there is insufficient evidence to support the introduction of the IADPSG criteria for our service.

Key words: Australasian Diabetes in Pregnancy Society, gestational diabetes mellitus, international association of diabetes and pregnancy study groups, New Zealand Society for the Study of Diabetes, pregnancy outcomes.

Introduction

Gestational diabetes mellitus (GDM) has been defined by the World Health Organization (WHO) as glucose intolerance of variable severity with onset or first recognition during pregnancy.[1] The detection and diagnosis of GDM is important as the condition poses considerable risks to the mother and baby in the form of pre-eclampsia, preterm delivery, polyhydramnios, traumatic or caesarean delivery, maternal depression, macrosomia,[2] shoulder dystocia and neonatal complications.[3–5] Early detection and treatment may prevent some of these complications.[6–8]

The prevalence of GDM varies between 1 and 22% in different populations due to differences in ethnic composition, age and prevalence of obesity.[9,10] In addition, GDM rates vary considerably between studies due to the multiple diagnostic criteria being used internationally.[11,12] In 2010, the International Association of Diabetes and Pregnancy Study Groups (IADPSG) introduced a new diagnostic criteria[13] based on the

Correspondence: Senior Lecturer Alec J. Ekeroma, c/o Pacific Women's Health Research Unit, Department of Obstetrics and Gynaecology, Middlemore Hospital, University of Auckland, Private Bag 93311, Auckland, New Zealand.
Email: alec@pacifichealthresearch.org.nz

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analysis of the Hyperglycaemia Adverse Pregnancy Outcome (HAPO) study,[14] which showed a close association between elevated individual oral Glucose Tolerance Test (OGTT) values and birthweight over the 90th centile, caesarean section and neonatal hypoglycaemia. The IADPSG criteria has been adopted by several professional societies and countries[11] although some have argued against its adoption on the basis of insufficient evidence[15] and increasing cost as more women are diagnosed with GDM.[16]

The diagnostic criteria for New Zealand (NZ), which were determined by the NZ Society for the Study of Diabetes (NZSSD) and has remained unchanged since 1991, uses a 75-g OGTT with a cut-off fasting plasma glucose (FPG) of ≥ 5.5 mmol/L and 2-h of ≥ 9.0 mmol/L.[17] The Australasian Diabetes in Pregnancy Society (ADIPS) recommended the use of the same test but with a cut-off at 2 h of ≥8.0 mmol/L for the diagnosis of GDM.[18] In comparison, the full IADPSG criteria (5.1/10.0/8.5 mmol/L for 0, 1, 2 h) and the modified IADPSG criteria are based on the fasting and 2-h values only.

The lack of consensus and uncertainty in the diagnostic criteria led the NZ Ministry of Health in 2013 to fund the development of a practice guideline (to be released late 2014) to inform diagnosis and management of GDM in NZ. The concern remains that a change in the criteria to treat women with mild hyperglycaemia in pregnancy would increase the GDM numbers in NZ[19] with unknown benefits to the women and their babies.[15]

Screening of all pregnant women for GDM, between 24- and 28-week gestation, has been a policy in NZ for many years.[17] The screening is performed using a glucose challenge test of 50 g (polycose test) and the cut-off of ≥ 7.8 mmol/L is considered abnormal.

Counties Manukau District Health Board (CMDHB) provides health services to the population of South Auckland, which has a large number of Pacific, Māori and Indian women who have high rates of type 2 diabetes mellitus and obesity.[8] Of the 8520 women who delivered babies in CMDHB in 2011–2012, 5357 (63%) were from those high-risk ethnic groups.[19] The screening rate for GDM in CMDHB in 2011 was 73%, and the GDM prevalence rate was 7.1%.[19] The number of women with GDM seen in the CMDHB service in 2011–2012 was 407, which was a 55% increase from six years earlier.[19]

The aims of our study were to determine the impact of adopting a modified IADPSG criteria on the prevalence of GDM in CMDHB and to estimate the implications for resources and workload, intervention rates and maternal and neonatal outcomes.

Materials and Methods

We designed a retrospective observational study of all women who delivered a baby at any of the CMDHB facilities over a 12-month period from July 2012 to June 2013. The total number of women who gave birth during this period was 7898, which was a similar number of women in comparable studies.[12]

Ethics approval was obtained from the University of Auckland Human Participants Ethics Committee, reference UAHPEC 011006.

Pregnancy and birth outcome data for all women birthing at Middlemore Hospital and three smaller hospitals in the CMDHB area are collected prospectively into two electronic databases, namely Healthware and Concerto. The data are entered at source by clerical and clinical staff. All laboratory results are captured in Concerto.

The required data were sourced from the two databases by the Decision Support Department of CMDHB. The data required included maternal characteristics of ethnicity, age, body mass index (BMI) at first antenatal visit, deprivation index and parity. The NZ deprivation index is an important descriptor of the study population as it measures the level of socioeconomic deprivation from 1 to 10 with 10 being the most deprived.[20] Deprived populations have high rates of diabetes.[21] Screening and diagnostic data including gestation screened were obtained. The interventions of interest were induction of labour (IOL) and caesarean deliveries (planned and emergency). Maternal outcomes of interest were pre-eclampsia and preterm delivery (defined as <37 weeks of gestation). Neonatal outcomes of interest were birthweight, Apgar score (at five minutes), admission to the neonatal intensive care unit (NICU) and intra-uterine growth restriction (IUGR) defined as estimated fetal weight below the 5th centile.

The women's National Health Index number was used initially to link and collect relevant data from the two database sources. Data were downloaded into an Excel spreadsheet for data cleaning and then all data were de-identified. One of the authors cross-checked for completeness of data, and where required, the electronic databases were searched and more data downloaded manually.

Definitions

Ethnicity was self-reported at booking. Definitions of GDM used were based on the 75 g OGTT and were for the modified IADPSG fasting plasma glucose (FPG) of ≥5.1 mmol/L and 2-h of ≥8.5[22] (as the one-hour level was not measured), the NZSSD of ≥5.5 and ≥9.0[17] and the ADIPS criteria of ≥5.5 and ≥8.0 mmol/L. Those women who met the NZSSD criteria were treated for GDM at Middlemore Hospital.

Macrosomia was defined by ethnic-specific values as recommended by Simmons *et al.*[17]

Statistical analysis

The main comparison being made is between the non-GDM subjects (by all criteria) and those additional subjects identified by the modified IADPSG criteria who were not captured by the NZSSD criteria. The main

outcome variable was the result of the OGTT. Statistical analysis was carried out using SPSS software version 22 (SPSS Inc., Chicago, IL, USA), and a two-tailed $P \leq 0.05$ was considered significant. Continuous variables are expressed as mean (SD) and categorical data expressed as percentage. Differences in characteristics and outcomes

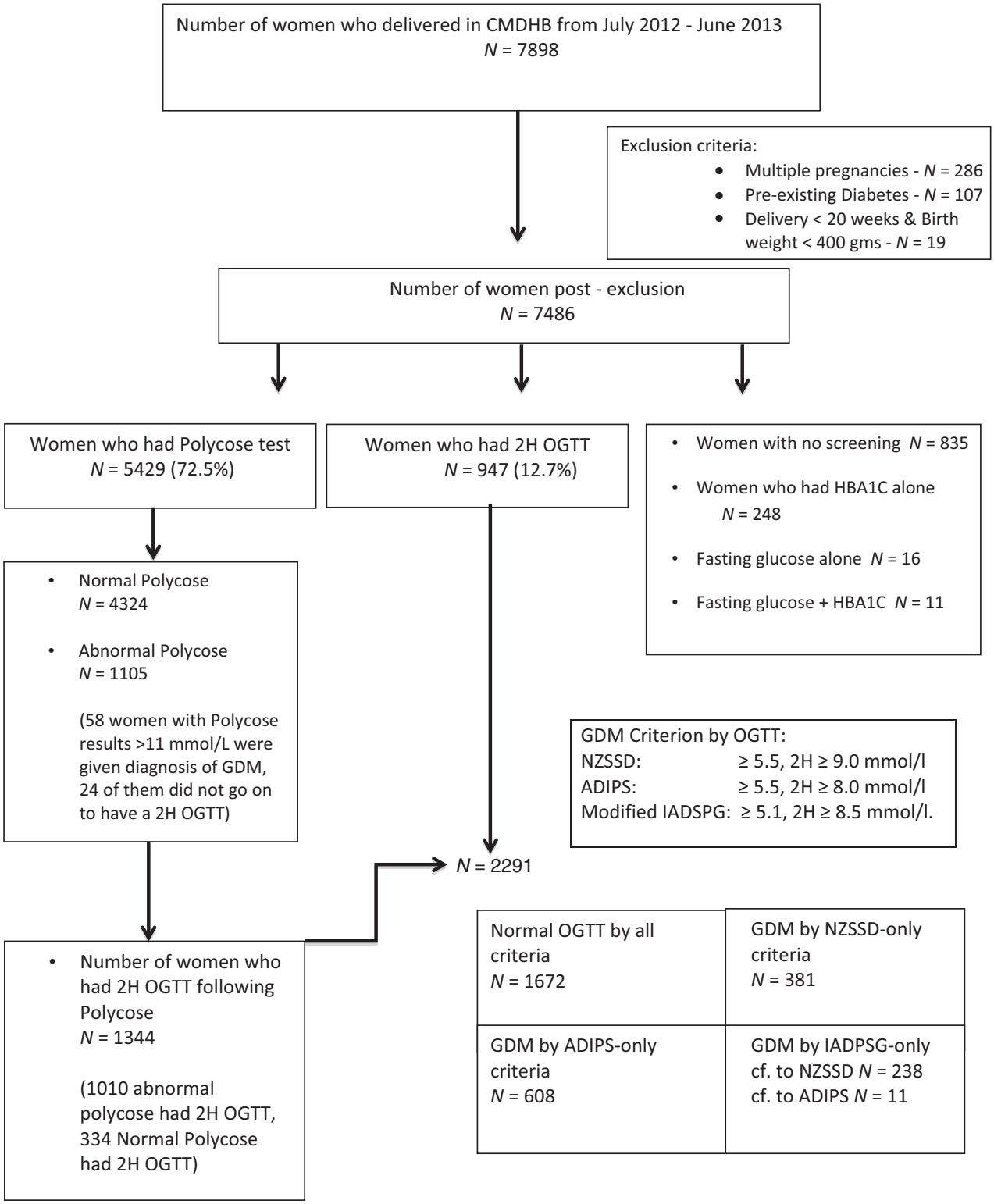

Figure 1 Data collection procedure and result of study.

between the two GDM groups were compared using *t*-test, where continuous data were normally distributed and chi-squared tests for categorical variables. A multivariable logistic regression model was used to explore associations with macrosomia.

Results

In 12 months from July 2012 to June 2013, 7898 women delivered in CMDHB facilities. After exclusions (Fig. 1), 7486 women were left and of these, 835 (11.2%) did not have any screening and another 275 (3.7%) did not have screening polycose performed for screening. The screening rate, therefore, was 85.1%. Women who had a polycose screening test (5429, 72.5%) followed by an OGTT and those who proceeded directly to an OGTT (947, 12.7%) totalled 2291 and comprised the study population. Women with risk factors for GDM as determined by clinical staff proceeded directly to an OGTT and as only 35% of our study population booked in the first trimester, all OGTTs were performed in the second and third trimesters. It is uncertain why 334 women with a normal polycose subsequently had an OGTT. Of the 1010 women with a positive polycose, 175 (17%) had GDM by NZSSD and 301 (30%) by the modified IADPSG criteria (Table 1).

Of the 2291 women, 1910 (83%) had a normal OGTT by the NZSSD criteria and were, therefore, not treated for GDM. Women with GDM by IADPSG totalled 619 (27%) which included all the women with GDM by NZSSD (381, 17%). These figures give a GDM prevalence of 6.0% for all screened women using the NZSSSD criteria and 10% using the IADPSG criteria, a relative increase in GDM of 238 or 62%.

Characteristics

The characteristics of the 2291 women who had an OGTT are listed in Table 2. Those with GDM by the NZSSD compared to those with a normal OGTT were significantly older (31.7 vs 30.0 years, $P < 0.0001$), more parous (1.7 vs 1.4, $P < 0.0002$) and ethnically different ($P < 0.0001$) with more Indian and Asian in ethnicity (18% vs 11%; 16% vs 12%). The incidence of GDM,

Table 1 Polycose screening status of women with GDM by NZSSD, modified IADPSG and ADIPS criteria

	NZSSD *n* (%)	Modified IADPSG *n* (%)	ADIPS *n* (%)
Positive polycose (*n* = 1010)	175 (17)	301 (30)	327 (32)
Negative polycose (*n* = 334)	24 (7)	48 (14)	50 (15)
No polycose (*n* = 947)	182 (19)	270 (29)	231 (24)
Total (*n* = 2291)	381	621	608

Table 2 Characteristics of the 2291 women who had a GTT and GDM by NZSSD, IADPSG and zcriteria. IADPSG-All is the total of GDM by NZSSD and by IADPSG-additional

Characteristics	Total *n* = 2291	Normal OGTT *n* = 1672 (73%)	GDM NZSSD *n* = 381 (16%)	GDM IADPSG-additional *n* = 238 (10%)	GDM ADIPS *n* = 608 (27%)	IADPSG -All *n* = 619 (27%)	NZSSD vs Normal *P* value	IADPSG-additional vs NZSSD *P* value	IADPSG-additional vs Normal *P* value
Age in years (±SD)	29.7 (±5.8)	30.0 (±5.7)	31.7 (±5.5)	31.4 (±5.8)	31.5 (±5.4)	31.6 (±5.6)	*<0.0001*	*0.45*	*<0.0001*
Ethnicity									
Maori	327 (14)	258 (15)	35 (9)	34 (14)	61 (10)	69 (11)	<0.0001	0.06	0.82
Pacific	928 (41)	675 (40)	151 (40)	102 (43)	211 (35)	253 (41)			
European/Other	463 (20)	352(21)	65 (17)	46 (19)	117 (19)	111 (18)			
Asian	289 (13)	199 (12)	60 (16)	30 (13)	117 (19)	90 (15)			
Indian	284 (12)	188 (11)	70 (18)	26 (11)	102 (17)	96 (16)			
Deprivation*	7.7 (±2.8)	7.7 (±2.7)	7.7 (±2.7)	7.8 (±2.8)	7.4 (±2.9)	7.8 (±2.7)	*0.94*	*0.58*	*0.56*
Parity†	1 (0–11)	1 (0–11)	2 (0–11)	1 (0–11)	2 (0–11)	2 (0–11)	*0.0002*	*0.94*	*0.001*
BMI (kg/m^2) at booking‡	31.2 (±9.7)	30.7 (±9.1)	31.8 (±10.8)	32.9 (±11.7)	30.5 (±9.8)	32.2 (±11.1)	*0.067*	*0.27*	*0.004*

Results are number (%) or mean (±SD).
*3 missing data.
†142 (6.2%) missing data.
‡Median and range.

amongst women who had an OGTT, was higher in Indian women (Fig. 2).

Outcomes

Women with a normal OGTT ($n = 1672$) had an IOL rate of 21%, an elective caesarean rate of 9% and an emergency caesarean rate of 19% (Table 3). Women with GDM by NZSSD compared to women with a normal OGTT had a higher rate of induction (52% vs 21%, $P < 0.001$) and a higher caesarean delivery rate (35% vs 28%, $P < 0.006$). Conversely, women with GDM by IADPSG-additional only had an IOL and caesarean delivery rate that was not significantly different to those of women with a normal OGTT, but the mean birthweight was significantly increased (3669 g vs 3540 g, $P < 0.04$) in women with GDM by IADPSG-additional.

The percentage of babies weighing ≥4000 g was significantly higher in women with GDM by IADPSG-additional, whereas it was lower in women with GDM by NZSSD. This difference persisted even when macrosomia was defined by higher weight cut-offs for Pacific/Māori followed by European and then Asian/Indian as recommended by Simmons *et al.*[17] A multivariable logistic regression (Table 4) found that BMI, gestation, ethnicity and GDM by IADPSG-additional were independently associated with macrosomia.

Discussion

The decision as to whether the IADPSG criteria for diagnosing GDM should be adopted in NZ is important as the recent debate about the benefits of adopting the IADPSG and its impact on resources has been confusing.[15,23] This is the first NZ study into a large multi-ethnic population cohort to determine the prevalence of GDM using the proposed IADPSG.

We found that the screening rate in our population with a high deprivation index (7.7/10) was one of the highest in the country at 85%, an improvement from 72% two years earlier.[19] The national average for GDM screening in NZ was about 50% in 2005 with a range between DHBs from 20 to 89%.[17] ADIPS recommended universal screening for GDM, but there are no published screening rates.[24] The false-negative rate of the polycose test was 7% and 14% by the NZSSD and IADPSG criteria respectively, which corroborates findings from other studies.[25] The prevalence of GDM by both criteria (NZSSD 6%, IADPSG 10%) in the screened population was similar to that of other population studies.[26] The ADIPS criteria identified a similar proportion of cases as the modified IADPSG. This was not surprising as the glycaemic cut-offs are very similar.

We found that the modified IADPSG criteria increased the prevalence of GDM by 238 (62.3%) cases corroborating findings by others.[12] It has been shown that using the full IADPSG would diagnose about one in three pregnancies as having GDM[14], with no demonstrable benefit.[15] These extra women with GDM, if treated similarly to the current GDM cases, would have a huge impact on current resources,[19,25] with an estimated three new specialist-led GDM clinics and three extra women undergoing IOL per week.

Women with GDM by IADPSG-additional were older, more parous and had a higher BMI compared to women with a normal OGTT. The NZSSD criteria also found advanced maternal age and parity as significant and in addition identified Indian ethnicity as significant associations with GDM. One in four Indian women who had an OGTT was affected with GDM. Others have found previous GDM, advanced maternal age and a BMI ≥35 kg/m^2 as strong independent predictors for GDM.[18]

The IOL rate for GDM by NZSSD was only 52%, consistent with the ADIPS guidelines that pregnancy may continue to 40-week gestation as long as fetal monitoring was normal.[27] Women with GDM by IADPSG-additional had a similar IOL rate to the women with a normal

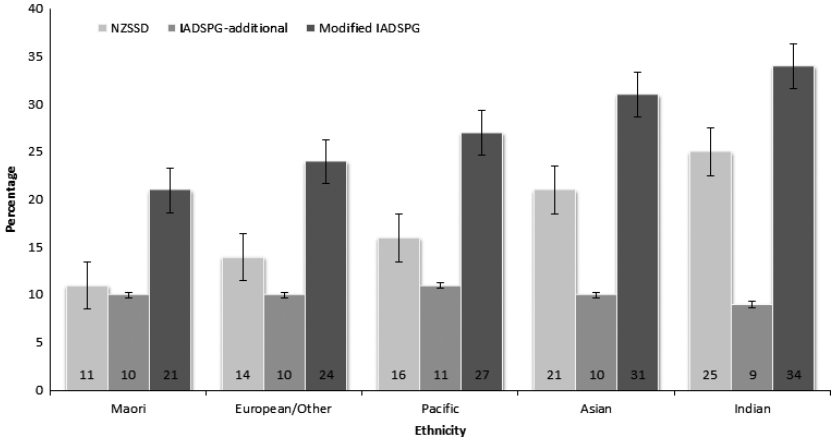

Figure 2 Percentage of GDM by ethnicity using different NZSSD and IADPSG criteria.

Table 3 Pregnancy outcomes of 2291 women with normal OGTT versus GDM by NZSSD, IADPSG and ADIPS criteria. IADPSG-All is the total of GDM by NZSSD and by IADPSG-additional

Outcomes	Total *n* = 2291 (%)	Normal OGTT *n* = 1672 (%)	GDM NZSSD *n* = 381 (17%)	GDM ADIPS *n* = 608 (27%)	GDM IADPSG-additional *n* = 238 (10%)	IADPSG-All *n* = 619 (27%)	NZSSD vs Normal *P* value	IADPSG-additional vs NZSSD *P* value	IADPSG-additional vs Normal *P* value
Induction	608 (27)	355 (21)	200 (52)	256 (42)	53 (22)	253 (41)	*<0.001*	*<0.001*	*0.72*
Mode of delivery									
Normal vaginal	1457 (64)	1099 (66)	217 (57)	339 (56)	141 (59)	358 (58)	*0.006*	*0.71*	*0.07*
Instrumental	154 (7)	111 (7)	30 (8)	50 (8)	13 (5)	43 (7)			
Elect caesarean	231 (10)	149 (9)	51 (13)	84 (14)	31 (13)	82 (13)			
Emer caesarean	448 (20)	312 (19)	83 (22)	135 (22)	53 (22)	136 (22)			
Birthweight in grams	3536 (±626)	3540 (±611)	3436 (±625)	3485 (±625)	3669 (±698)	*3526* (±664)	*0.82*	*0.004*	*0.04*
Birthweight ≥4000 g Macrosomia*	474 (21) 128 (6)	347 (21) 85 (5)	64 (17) 15 (4)	102 (17) 38 (6)	63 (26) 28 (12)	127 (43) 43 (7)			
Apgar at 5 mins	>9	>9	>9	>9	>9	>9	*0.77*	*0.47*	*0.10*
Other outcomes									
Pre-eclampsia	140 (6)	96 (6)	29 (8)	45 (7)	15 (6)	44 (7)	*0.17*	*0.54*	*0.73*
Stillbirths	11 (1)	10 (1)	0 (0)	1 (0)	1 (0)	1 (0)	*0.13*	*0.21*	*0.73*
IUGR	28 (1)	20 (1)	6 (2)	7 (1)	2 (1)	8 (1)	*0.55*	*0.43*	*0.63*
Pre-term	117 (5)	79 (5)	22 (6)	33 (5)	16 (7)	38 (6)	*0.39*	*0.63*	*0.19*
NICU admission	148 (6)	102 (6)	31 (8)	46 (8)	15 (6)	46 (7)	*0.15*	*0.40*	*0.90*

Data are number (%) or mean (±SD); elect, elective; emer, emergency.

*Macrosomia (as defined by Simmons *et al.*, 2008): Pacific/Maori ≥ 4700 g, European/Others ≥ 4400 g, Asian/Indian ≥ 4000 g.

Table 4 Multivariable logistic regression analysis of macrosomia in women with GDM by both NZSSD and IADPSG-additional

Variable	Multivariable logistic regression OR (95% CI)	*P*-value
Age	1.04 (1.00 to 1.08)	0.060
Parity	1.01 (0.88 to 1.16)	0.885
BMI	1.02 (1.01 to 1.04)	0.007
Gestation	1.55 (1.33 to 1.81)	0.0001
GDM by NZSSD	1.01 (0.56 to 1.88)	0.924
GDM by IADSPG-(not-NZSSD)	2.31 (1.43 to 3.73)	0.001
Ethnicity		0.001
European	1	
Asian	1.36 (0.74 to 2.49)	0.317
Indian	1.20 (0.66 to 2.19)	0.550
Maori	0.26 (0.11 to 0.62)	0.002
Pacific	0.50 (0.29 to 0.86)	0.013

OGTT, and yet, they had a similar caesarean delivery rate to those with GDM by NZSSD. The Maternal-Fetal Medicine Units (MFMU) Network showed that treatment of similar women significantly reduces the risk of caesarean delivery, probably due to a reduction in mean birthweight.[28]

We found that the mean birthweight was 129 g higher and the proportion of babies with macrosomia was greater in women with GDM by IADPSG-additional criteria than in women diagnosed by NZSSD criteria (who were treated). This finding compares well with those of two randomised control trials, where the mean birthweight differences between the treated and control groups were significant at 106g[29] and 147g.[30] The difference in birthweight in our study was not associated with any adverse maternal or fetal outcomes.

The multivariable logistic regression confirmed the strong association of BMI, ethnicity and untreated mild hyperglycaemia in GDM by IADPSG-additional on the prevalence of macrosomia. This suggests that known and treated GDM controlled the birthweight, whereas unknown, untreated GDM did not. A planned randomised controlled trial in NZ may further clarify some of these findings.

Limitations in our study are its retrospective nature and the non-availability of a wider set of variables, including weight gain in pregnancy. In addition, the rate of GDM by IADPSG would have been higher if the one-hour OGTT value were included.

Conclusions

High screening rates can be achieved even in low socio-economic multicultural populations. Adopting the IADPSG criteria would result in a 62% increase in the number of GDM cases, which will incur a significant impact on service workload and resources. The benefits of treating the extra patients may be limited to lower birthweights, but the advantage of this is not clear. Our findings do not support the introduction of the IADPSG criteria in our service until long-term studies show benefits.

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