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Medical nutrition therapy for gestational diabetes mellitus in Australia: What has changed in 10 years and how does current practice compare with best practice?

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Abstract

Background: The present study aimed to report Australian dietetic practice regarding management of gestational diabetes mellitus (GDM) and to make comparisons with the findings from a 2009 survey of dietitians and with the Academy of Nutrition and Dietetics Evidence-Based Nutrition Practice Guidelines (NPG).

Methods: Cross-sectional surveys were conducted in 2019 and 2009 of dietitians providing medical nutrition therapy (MNT) to women with GDM in Australia. The present study compares responses on demographics, dietetic assessment and interventions, and guideline use in 2019 vs. 2009.

Results: In total, 149 dietitians (2019) and 220 (2009) met survey inclusion criteria. In both surveys >60% of respondents reported dietary interventions aiming for >45% energy from carbohydrate, 15%–25% energy from protein and 15%–30% energy from fat. Many variations in MNT found in 2009 continued to be evident in 2019, including the percentage of energy from carbohydrate aimed for (30%–65% in 2019 vs. 20%–75% in 2009) and the wide range in the recommended minimum daily carbohydrate intake (40–220 and 60–300 g). Few dietitians reported aiming for the NPG minimum of 175 g of carbohydrate daily in both surveys (32% in 2019 vs. 26% in 2009). There were, however, some significant increases in MNT consistent with NPG recommendations in 2019 vs. 2009, including the minimum frequency of visits provided (49%, $n = 61$ vs. 33%, $n = 69$; $p < 0.001$) and provision of gestational weight gain advice (59%, $n = 95$ vs. 40%, $n = 195$; $p < 0.05$).

Conclusions: Although many dietitians continue to provide MNT consistent with existing NPG, there is a need to support greater uptake, especially for recommendations regarding carbohydrate intake.

KEYWORDS

gestational diabetes, guidelines, medical nutrition therapy

Key points

- Consistencies continue a decade later in broad education topics covered for gestational diabetes mellitus.
- Variations in dietetic practice remain, especially regarding carbohydrate recommendations and frequency of review visits.

- Adherence to some Nutrition Practice Guidelines (NPG) (2016) recommendations remain low, especially regarding minimum carbohydrate intake.
- Adherence to NPG recommendations increased for the minimum frequency of visits provided and provision of gestational weight gain advice.
- There is a need to further increase medical nutrition therapy consistent with existing NPG, especially for recommendations regarding carbohydrate intake.

INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as diabetes diagnosed in the second or third trimester of pregnancy, without overt diabetes prior to gestation.[1] GDM increases the risk of a number of adverse outcomes, including caesarean delivery, large for gestational age infants, and neonatal hypoglycaemia.[2] Medical nutrition therapy (MNT) is recognised as first-line therapy in GDM management.[3] Evidence-based MNT has been shown to improve clinical outcomes in diabetes.[4,5] The Academy of Nutrition and Dietetics (A.N.D) first published evidence-based nutrition practice guidelines (NPG) for GDM in the USA in 2008.[6] Evaluation of implementation of these guidelines compared to usual MNT found less insulin use, and significantly lower follow-up glycated haemoglobin in non-diabetes specific clinics when NPG-based MNT was followed.[7] To our knowledge, the USA guidelines[8] are the only nutrition-specific published evidence-based guidelines for GDM that have been informed by a systematic review of scientific evidence. The 18 recommendations in this guideline are based on conclusion statements from the systematic review. Guideline recommendations are provided for the nutrition assessment process, frequency and duration of MNT visits, calorie prescription, macronutrient requirements, vitamin and mineral supplementation, meal and snack frequency, sweeteners and alcohol intake, nutrition monitoring, and evaluation.[3] The guideline advises that all women with GDM are referred to a dietitian for individualised MNT that includes initial education (group or individual for 60–90 min) followed by at least two individual review visits (30–45 min duration). Guideline recommendations also include provision of individualised calorie prescriptions (based on the Institute of Medicine maternal weight gain guidelines) and adequate macronutrients to support pregnancy (minimum of 175 g carbohydrate, 71 or 1.1 g protein kg^{-1} body weight).[3] The recommendations also advise that the amounts, types and distribution of carbohydrate be individualised according to blood glucose levels, physical activity and medications. Currently, Australian guidelines do not exist, and it is unknown whether the A.N.D NPGs are followed. Morrison *et al.*[9] conducted a national dietetic survey in 2009 highlighting variations in MNT, and also found that dietetic practice frequently did not align with the NPG.[6]

Subsequent to the first Australian GDM dietetic practice survey in 2009,[9] the World Health Organization diagnosis and classification of hyperglycaemia in pregnancy guidelines have been published[10] and widely implemented.[11] This has resulted in a substantial increase in GDM diagnosis and clinical populations,[11] with increased clinical workloads of up to 200%.[12] Furthermore, in 2016, the A.N.D NPG were updated.[8] This included changes to carbohydrate intake recommendations from a target of < 45% total energy intake in 2009[6] to 36%–65% in 2016.[8] MNT remains first-line therapy for women with GDM.[3] Given the recent changes in GDM diagnosis, clinical workload and the NPG, it is unclear how MNT for GDM is currently defined and implemented in Australia. Considering this evidence gap, a national survey of dietitians who provide MNT to women with GDM was updated and redistributed. The primary aim was to survey Australian dietitians on current dietetic practice in GDM management. Secondary aims were to identify changes in MNT for GDM subsequent to 2009 and to compare current MNT provided in Australia with the NPGs.

METHODS

Cross-sectional surveys of dietitians who provided MNT to women with GDM in Australia were conducted from March to June 2009, and from October to November 2018. A further recruitment round was conducted from June to July 2019 to increase the number of respondents, with results from 2018 and 2019 being pooled. Inclusion criteria were dietitians who worked in Australia and currently provided dietary advice to women with GDM. Survey invitations were sent electronically to all financial members of Dietitians Australia (DA) via the weekly newsletter. Email alerts with a survey link were also sent to those registered with the following DA national interest groups: Diabetes, Private Practice, and Paediatric and Maternal Interest Groups from October to November 2018. To increase the number and range of respondents, members of Dietitian Connection (https://dietitianconnection.com) were also invited to participate from June to July 2019 via their weekly newsletter and Facebook posts. The survey link was also posted on the

following Facebook groups: Dietitians in Private Practice and Australian Independent Dietitians-Nutritionists Group. The researchers had no direct contact details of participants.

The 2019 and 2009 surveys were 63-item and 55-item questionnaires, respectively, and included multiple-choice, open-ended questions and Likert scale responses. The present study reports findings from 30 questions asked in both 2019 and 2009 on demographics (10 items), dietetic assessment and GDM interventions (15 items), and practice guidelines and recommendations used (five items). The present study also includes findings from six additional questions on dietetic assessment and GDM interventions in the 2019 survey that were necessary to enable comparison of current MNT with the current NPG. All questions on macronutrient targets (including questions regarding recommended grams and percentage of total energy), carbohydrate frequency and timing, and fibre amounts were free-text responses. Responses from the current survey were analysed and compared with the 2009 survey results.

The first survey page contained the Participant Information statement. The survey was completed anonymously. As a result of the voluntary nature of the survey and the indirect contact between researchers and participants, participation in the online survey was taken as implied consent. This study was approved by the University of Newcastle Ethics Committee, (Approval Reference Number: H-2017-0388) and distribution of the survey was approved by DA and Dietitian Connection.

The survey was administered via the Qualtrics XM Platform, version October 2018 to November 2020 (https://www.qualtrics.com).

Macronutrient content of diets recommended by survey participants were categorised according to the American Diabetes Association criteria.[13] High, low, and very low carbohydrate diets were defined as >45%, 26%–45%, and <26% energy from carbohydrate respectively. High protein intakes was defined as >25% and moderate protein as <25% energy. High, low fat and very low-fat diets were defined as >30%, 10%–30%, and <10% total energy from fat.[13]

Data were compared using an independent samples *t*-test or chi-squared Fisher's exact test to assess differences between categorical variables, whereas analysis of variance was used to assess differences in continuous variables. Data analysis was conducted using Qualtric XM and QuickCals (https://www.graphpad.com/quickcalcs) (accessed July 2020). All survey responses were included in the analyses, including those by participants who did not complete the entire survey.

RESULTS

Of 152 dietitians who commenced the survey in 2019, 149 respondents met the inclusion criteria compared to 220 respondents in 2009. In total, 94 (63%) completed the survey in 2019, whereas 190 (86%) completed the survey in 2009. Table 1 summarises the demographics of survey responders in 2019 and 2009 and includes a comparison of completers vs. non-completers of the current survey.

As is evident from Figure 1, there continued to be consistency in key components of nutrition education provided by dietitians to women with GDM in 2019 compared to in 2009 (Figure 1).

Figure 1 also suggests a trend away from broad dietary advice to more targeted dietary advice, predominantly focusing on macronutrients (especially carbohydrate), weight gain, and physical activity. In 2019, consistent with the 2009 survey, more than 60% dietitians reported providing dietary advice aiming for macronutrient targets that align with a high carbohydrate (>45% energy), moderate protein (15%–25% energy), moderate fat (15%–30% energy) diet[13] with a high fibre content of 28 ± 4 g day^{-1} (mean ± SD). Furthermore, in 2019, most dietitians advised distributing carbohydrate over three main meals containing 30–45 g of carbohydrate, with multiple snacks (most commonly two to three) containing 15–30 g. Despite these consistencies, significant variations in macronutrient targets (by per cent energy), minimum and maximum carbohydrate targets (in g), and glycaemic index advice were reported by respondents in both 2019 and 2009 (Table 2).

When the 2019 survey participants were asked what the recommended carbohydrate amounts were based on (not asked in 2009), the most common responses were clinical experience (51.3%, $n = 78$), balance of good health for pregnancy (36.6%, $n = 51$), energy requirements (25%, $n = 38$), desired maternal weight gain (21.7%, $n = 33$), and lastly clinical guidelines for diabetes (19.1%, $n = 29$), with more than one answer allowed. When asked to specify the clinical guidelines used, a number were mentioned ($n = 26$), including local and state-wide guidelines. The most common GDM NPG specified by respondents in 2019 was the A.N.D NPG[8] ($n = 7/87$, 8.0%).

Figure 2 reports on common teaching tools used in education on carbohydrate distribution. In the category of 'other', the most common teaching tool reported was the use of household measures such as metric cups to explain recommended serve sizes. In both surveys, approximately one-third of dietitians reported that they would routinely teach carbohydrate portions or exchanges (counting intake in 10- or 15-g increments) to all women with GDM (33%, $n = 34$ vs. 35%, $n = 77$ in 2019 and 2009; $p = 0.80$). In both surveys, at least half of dietitians reported that they would teach carbohydrate portions or exchanges as appropriate according to clinical judgement, dependent on language skills and level of education, although significantly fewer chose this response in 2019 compared to in 2009 (50%, $n = 51$ vs. 62%, $n = 122$; $p < 0.05$).

Table 3 reports findings from both surveys compared to some of the key recommendations in NPG. Alignment

TABLE 1 Demographics of respondents

Percentage (*n*) respondents	2019 survey responders *n* = /149 (%) [A]	2019 survey completers *n* = /94 (%) [B]	2009 survey (*n* = /220) (%) [C]
Type of geographical location			
Metropolitan	93 (63)	60 (64)	121 (55)
Regional	30 (20)	20 (21)	62 (28)
Rural/remote	24 (16)	14 (15)	37 (16.5)
Other	1 (1)	0	1 (0.5)
Employment location			
Victoria	42 (28)	24 (25)	52 (24)
New South Wales	40 (27)	27 (28)	66 (30)
Queensland	31 (21)	22 (23)	44 (20)
Western Australia	18 (12)	9 (10)	32 (14.5)
South Australia	6 (4)	2 (2)	21 (9.5)*
Australian Capital Territory	5 (3)	4 (4)	1 (0.5)*
Northern Territory	5 (3)	4 (4)	1 (0.5)*
Tasmania	2 (1)	2 (2)	3 (1)
Employment sector (a)			
Public hospital	82 (55)	58 (44)*	115 (52)
Private practice	33 (22)	11 (8)	56 (26)
Community health centre	31 (20)	23 (18)	58 (26)
Specialist diabetes service/centre	20 (13)	17 (13)	28 (13)
Antenatal/obstetric Service	12 (8)	11 (8)	NA
Other	19 (13)	2 (2)**	25 (11)
Primary area of practice (a)			
Diabetes	59 (40)	43 (46)	127 (58)***
General clinical	37 (25)	21 (22)	101 (46)****
Community nutrition	26 (17)	12 (13)	53 (24)
Antenatal	16 (11)	11 (12)	30 (14)
Other	11 (7)	7 (7)	29 (13)
Years of diabetes experience			
Greater than 10 years	51 (34)	38 (41)	66 (30)
5–10 years	31 (21)	17 (18)	53(24)
1–5 years	51 (34)	31 (33)	79 (36)
Less than 1 year	16 (11)	8 (8)	22 (10)

Percentage (*n*) respondents	2019 survey responders *n* = /149 (%) [A]	2019 survey completers *n* = /94 (%) [B]	2009 survey (*n* = /220) (%) [C]
Professional membership	*n* = 149	*n* = 94	*n* = 220
Member of DA	145 (97)	90 (96)	213 (97)
APD	147 (99)	92 (98)	209 (95)
DA Diabetes Interest Group member	84 (65)	56 (60)	148 (69)*
Credentialed diabetes educators	16 (24)	17(18)	20 (9)

Abbreviations: APD, Accredited Practising Dietitian; DA, Dietitians Australia.

(a) Could choose more than one option.

[A] is the reference group, for [B] versus [A], and [C] versus [A].

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; ****$p < 0.0001$.

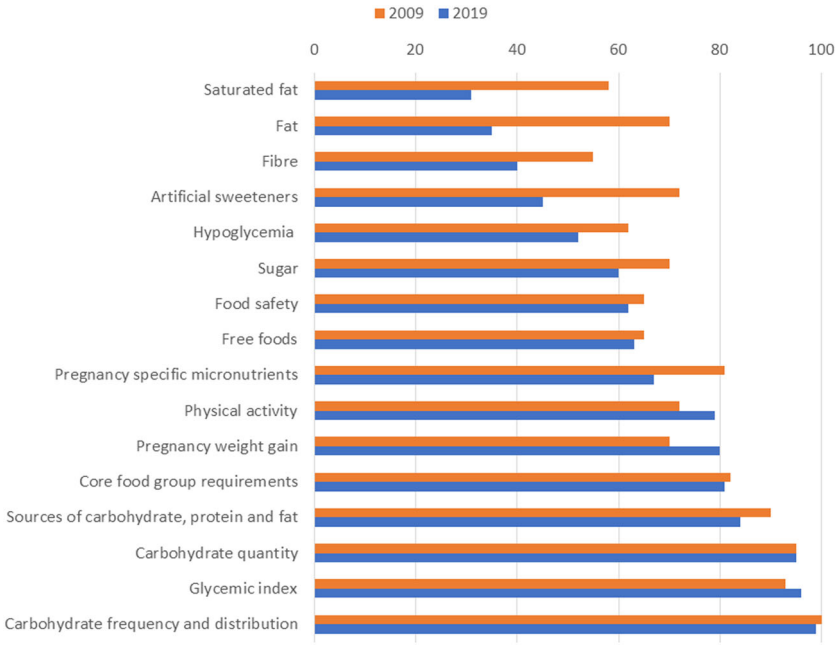

FIGURE 1 Topics covered in dietetic education with clients with gestational diabetes mellitus.

to specific NPG recommendations within the NPG ranged widely from 32% to 100% of respondents in 2019 vs. 13% to 98% in 2009. Alignment was highest for recommendations regarding dietary fibre intake and glycaemic index in both surveys. Concurrently, alignment remained low in both surveys for the recommendation to aim for a minimum carbohydrate intake of 175 g day^{-1}. Despite low numbers of dietitians in both surveys recommending a minimum carbohydrate intake of 175 g day^{-1} in line with NPG (Table 3), 96% ($n = 80$) of respondents in the 2019 survey recommended a percentage of total energy from carbohydrate that was in line with the NPG (36%–65%). By contrast, a minority of dietitians in the 2009 survey ($n = 7$, 7%) reported aiming for a carbohydrate target recommended in the 2008 USA NPG of <45% of total energy from carbohydrate. However, there were significant increases in NPG alignment in 2019 for some areas, including frequency of visits, provision of maternal weight gain advice, and routine weighing of women at clinic visits.

Most respondents rated their confidence in providing dietary advice to women with GDM, using a four-point Likert scale, as confident or very confident (86%, $n = 88$ vs. 83%, $n = 163$ in 2019 and 2009; $p = 0.62$).

DISCUSSION

The present study describes current MNT for GDM provided by dietitians in Australia. The findings were compared with the previous 2009 survey by Morrison *et al.*[9] and with the Academy of Nutrition and Dietetics Nutrition Practice Guidelines.[8] As found in 2009,

TABLE 2 Macronutrient targets aimed for in dietetic interventions [a]

Recommendation[a]	2019 survey *n* (%) (range)	2009 survey *n* (%)
Carbohydrate (% energy)		
Percentage of energy target (range)	30–65	20–75
High carbohydrate diet (>45% energy)	51 (62)	54 (50)
Low carbohydrate diet (<45% energy)	20 (24)***	7 (7)
Inclusive of low and high carbohydrate diets (26%–65%)	11 (13)***	45 (42)
Inclusive of low and very low carbohydrate (<26%–45%)	0	2 (2)
Very low carbohydrate diet (<26% energy)	0	0
Fibre per day (g) (mean ± SD) (range)	28 ± 4 (10–40)[b]	29 ± 4 (15–45)
Carbohydrate, g (% respondents) (range)		
Minimum carbohydrate intake per day (g)	149 ± 34 (40–220)	145 ± 36 (60–300)
Maximum carbohydrate intake per day (g)	213 ± 36 (150–280)	NA
Breakfast, 30–45 g	58/87 (67) (10–60)	NA
Lunch and dinner, 30–45 g	54/87 (62) (0–60)	NA
Snacks, 15–30 g	60/87 (69) (0–30)	NA
Glycaemic index advice	*n* = 103	*n* = 195
Choose low GI where possible	24 (23)	38 (20)
At least 1 low GI CHO at each meal & snack	23 (22)****	85 (44)
Include at least 1 low GI CHO at each meal	18 (18)	44 (23)
Avoid high GI foods	19 (18)*	14 (7)
All carbohydrate food should be low GI	19 (18)***	11 (6)
Protein	*n* = 75	*n* = 91
Percentage of energy target (range)	15–40	10–40
High protein diet (>25% energy)	17 (23)	10 (11)
Moderate protein diet (15%–25% energy)	49 (65)	59 (65)
Range (low and moderate protein diets, 10%–25%)	8 (11)	22 (24)
Range (moderate to high, 15%–40% energy)	0	13 (14)
Fat	*n* = 76	*n* = 98
Percentage of energy target (range)	10–40	7–45
High fat diet (>30% energy)	7 (9)	4 (4)
Moderate fat diet (15%–30% energy)	56 (74)	60 (61)
Low fat diet (<15%)	0	5 (5)
Range encompassing low and moderate fat diets (7%–30%)	0	6 (6)
Range encompassing moderate and high fat diets (20%–40%)	13 (17)	19 (19)

Recommendation[a]	2019 survey *n* (%) (range)	2009 survey *n* (%)
Saturated fat	*n* = 64	*n* = 73
Percentage of energy target (range)	2–15	5–15
Low saturated fat (≤10% energy)	62 (97)	68 (93)

Abbreviations: a, as defined by Evert et al.[13]; b, the minimum of the range was used for respondents who provided an answer as a range versus single figure. The mean was not significantly different to when the maximum of the range was used; NA, question not asked.

2019 versus 2009 for each recommendation; CHO, carbohydrate; GI, glycaemic index.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; ****$p < 0.0001$.

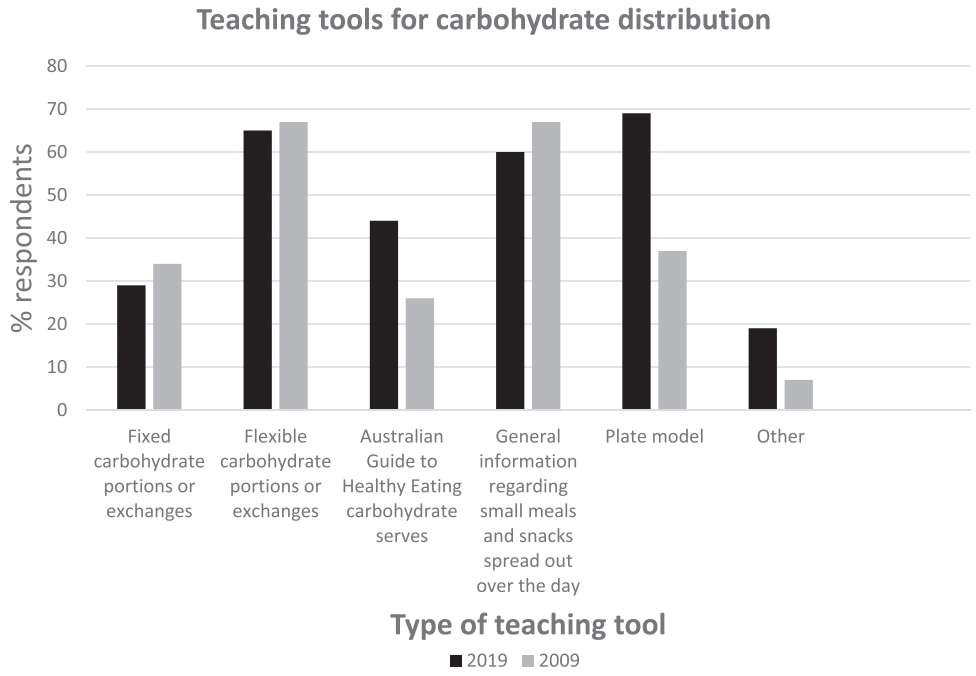

FIGURE 2 Teaching tools used in education regarding carbohydrate distribution (% respondents).

consistencies continue a decade later in broad education topics covered for women with GDM, including core food groups, food sources of macronutrients, carbohydrate intake (frequency, distribution, quantity and glycaemic index), and pregnancy weight gain. Variations remained for interventions provided by dietitians, especially in relation to carbohydrate recommendations (mean and range of minimum and maximum daily intake recommended, and percentage of total energy) and frequency of review appointments. There was also variable alignment to the 2016 NPG depending on the recommendations. Adherence remained low for some recommendations, especially regarding minimum carbohydrate intake. Low carbohydrate diets have gained popularity in many countries as evidenced by much media attention and research activity.[14–16] This may have impacted on dietetic practice and consequently the responses in this survey. However, little is known about how dietetic practice is influenced by popular trends in nutrition. More research is needed in this area. Furthermore, although not specific to GDM, a recent Cochrane Systematic review has confirmed that the efficacy of low carbohydrate diets is not superior to carbohydrate-balanced diets for glycaemic control and weight management in type 2 diabetes.[17] Adherence to the NPG recommendation on total percentage energy from carbohydrate is easier to achieve in the revised NPG. This is supported by the high adherence rate found in the 2019 survey. This is likely a result of the wide range in the recommendations within the updated guidelines (36%–65%)[3] compared to the 2008 NPG recommendations of <45% of total energy. Given the wide range in recommended percent energy from carbohydrate, an important consideration for dietitians is the safety concerns related to lower carbohydrate diets and higher risk of micronutrient inadequacies, particularly in thiamine, folate, calcium, and iodine, because they are found in

TABLE 3 Comparison of medical nutrition therapy to evidence-based nutrition practice guidelines (AND, 2016)

Recommendation	2019 survey Number of respondents *n* (%)	2009 survey Number of respondents *n* (%)
MNT		
All women with GDM referred to a dietitian	107/129 (83)	168/218 (77)
Visit frequency of 1 initial[e#], and 1 or more reviews[a]	109/125 (87)***	144/209 (69)
Visit frequency of 1 initial and 2 or more reviews[b]	61/125 (49)***	69/209 (33)
Visit frequency of 1 initial, and 1 review	48/125 (38)	75/209 (36)
Provides maternal weight gain advice	61/103 (59)*	77/195 (40)
Gestational weight gain advice according to IOM[c]	77/83 (93)****	13/97 (13)
Macronutrients		
Carbohydrate ≥175 g day^{-1}	36/112 (32)	26/108 (26)
Fibre ≥28 g day^{-1}	75/112 (67)	88/119 (74)
Provides advice regarding glycaemic index	103/103 (100)	192/195(98)
Advises smaller meals, and multiple snacks	82/109 (75)	NA
Micronutrients		
Provides dietary advice on pregnancy-specific micronutrients	75/112 (67)*	178/220 (81)
Nutrition monitoring and evaluation	*n* = 136	*n* = 209
Checks progress including: SMBG, food intake, appetite, and weight changes [d]	109/125 (87)***	144 (69)
Routine weighing by service reported	70/95 (74)*	116/195 (60)

Abbreviations: A.N.D, Academy of Nutrition and Dietetics; GDM, gestational diabetes mellitus; IOM, Institute of Medicine; MNT, medical nutrition therapy; NA, question not asked; SMBG, self-monitored blood glucose.

[a]*n* = 11 respondents in the 2019 survey did not provide an average number of visits per patient with GDM (and so were excluded from analysis), but instead indicated that it depended on individual factors such as patients' blood glucose levels, weeks of gestation, inadequate weight gain, and dietary over-restriction.

[b]Best practice according to AND guidelines, 2016.

[c]Institute of Medicine Maternal weight gain guidelines (2009).

[d]Number (%) respondents indicating at least one review is provided to each woman with GDM where nutrition monitoring and evaluation could have occurred.

[#]Either group or individual visit.

2019 versus 2009 for each recommendation.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; ****$p < 0.0001$, 2019 versus 2009 for each recommendation.

carbohydrate rich foods such as breads, cereals, milk, and yoghurt.[18,19] Maternal diets already commonly fail to meet micronutrient requirements.[20,21] Restriction of these nutrient dense carbohydrate rich foods may further increase the risk of such deficiencies.[22] Inclusion of adequate amounts of nutrient dense, fibre rich sources of carbohydrate may need more reinforcement in MNT for GDM.

There was a significant increase in the number of dietitians providing the number of visits consistent with NPG recommendations between 2009 and 2019, although more than half reported a frequency less than that recommended. The greatest improvements in NPG adherence were for recommendations related to maternal weight gain advice and monitoring.

Consistent with our findings, two other similar surveys[23,24] also found significant variation in clinical practice among dietitians. In the current survey, the variations in advice given to women with GDM were particularly evident in MNT regarding carbohydrate intake. This is of concern given that carbohydrate intake is a central focus of MNT for GDM. It is possible that the variations in clinical practice found in this survey simply reflect clinical experience and individualised patient-centred MNT focusing on addressing the individual needs in the context of social, cultural and personal preferences. The NPG clearly stipulate that MNT for women with GDM needs to be individualised, with the aims of achieving and maintaining glycaemic targets and appropriate weight gain,

at the same time as meeting the nutritional requirements of pregnancy. Adjusting MNT according to individual requirements would result in variations in practice. The wide range in percentage energy from carbohydrate recommended in the updated NPG also allows scope for evidence-based variations in practice.[8] Dietitians have the challenge of providing individualised care in the context of navigating the limitations in dietetic staffing and in the current evidence to guide practice in this clinical area.[25]

However, although, individualisation of MNT may explain the variations in MNT found in these surveys, it is not possible to determine this because of the survey design. Dietitians were asked to state what MNT they usually advise and not how advice differs between individuals. For example, dietitians were asked 'What amounts of carbohydrate do you usually recommend?'[3] It is also possible that the limited MNT review visits reported limits individualisation of MNT as a result of limited opportunities for adjusted MNT according to ongoing evaluation of appetite, dietary intake, weight, and glycaemic control. Future research in this area may benefit from alternative methodology because it was not possible to explore the reasons for the apparent deviations from best practice found in this survey given the anonymous structured survey design. Qualitative research such as open- ended questions and face to face interviews may be warranted.

Many changes have occurred in the clinical management of GDM in the 10 years between surveys, which likely impacted on MNT provided to women with GDM. These include an increase in universal screening and a change in the diagnostic criteria, and an increase in those diagnosed before 24 weeks.[10–12] All these factors have resulted in an increase in the total number of women with GDM[26] and also appear to have resulted in an increase in the number of women who may have milder degrees of GDM.[27,28] Consequently, more women are managed with MNT alone, in which dietitians play a pivotal role. These changes in the clinical landscape suggest an opportunity to explore new models of care such as dietitian led GDM clinics.

There are likely to be many barriers to the uptake of the NPG in Australia. Identifying these barriers is the first step in developing tailored implementation strategies.[29-32] Lack of dietetic staffing has been reported as one of the greatest barriers to GDM guideline implementation in several studies given the frequency of visits recommended (one initial visit and two or more reviews).[33–35] Given the rising rates of GDM globally and concurrent increases in clinical workload, this is not surprising.[11,12] However, despite these challenges, several Australian studies have developed models of care aimed at increasing provision of evidence-based MNT for GDM.[36–38] These studies successfully increased the proportion of women with GDM receiving the frequency of MNT consistent with NPG recommendations in their services. Although dietetic staffing was increased in these services, additional strategies included staff training, development of clinical pathways, audit and feedback processes, and identification of profession specific clinical champions. These findings suggest that a multi-pronged approach could increase effectiveness. Such an approach could be considered by other GDM services.

A lack of familiarity with, and consequently utilisation of, clinical guidelines is another commonly reported barrier to clinical guideline implementation.[31] The lack of utilisation is evident in the finding that only 19% of respondents reported using any clinical guideline to guide their carbohydrate intake recommendations. The lack of familiarity with the NPGs in particular is evident in that only 8% of respondents in the 2019 survey reported use of this guideline to guide their practice. Similarly, the low number of respondents recommending the minimum carbohydrate intake of 175 g day^{-1} in line with these guidelines also suggests a lack of familiarity with these guidelines. Given the NPGs are American, they may require local endorsement and adaptation to the Australian context, as well as training to increase awareness and subsequent implementation. Targeted professional development opportunities are clearly needed to increase familiarisation and implementation of the NPG.

Another commonly reported barrier to guideline implementation is the lack of credibility of the evidence.[30,31] In GDM, MNT has been clearly shown to reduce blood glucose levels, medication use, macrosomia, and infant birthweight.[39] Although the NPG are based on the best available evidence at that time, there are still substantial inconsistencies within the body of evidence.[3] Furthermore, there is a lack of evidence on the most optimal, sustainable, and acceptable MNT for GDM management.[40] Because respondents were not asked to report on their level of confidence in the current evidence to guide practice, this potential barrier could not be confirmed. However, these guidelines, based on a rigorous systematic review, are the best available evidence at the time of writing.[3] Given the time and resources required to develop evidence-based guidelines, the development of Australian specific guidelines would be difficult to justify. Strategies to increase implementation of and confidence in the NPGs appear to be the best next steps, including adaptation to the Australian context.

The present study has several strengths. Both surveys were widely distributed via a range of online platforms, including DA, Dietitian Connect and Facebook groups. Furthermore, through use of many of the same survey questions, this study uniquely captured dietetic practice in GDM at two time-points that were 10 years apart.

A significant limitation of the present study was the substantial drop-out rate in the 2019 survey, with only 63% of respondents completing it, perhaps as a result of the length of the survey. It is therefore unknown whether these findings are truly representative of all dietetic practice in GDM in Australia. An additional limitation is that it was not possible to assess responses according to employment sectors, and primary areas of practice where dietitians worked in more than one sector/area because

more than one response could be selected. A further limitation is that it was not possible to calculate a response rate because the number of dietitians providing dietary advice to women with GDM in Australia is not known (personal communication, Dietitians Australia).

However, many findings from the 2019 survey are similar to findings by Morrison *et al.*[9] Furthermore, respondents from both surveys were from a range of geographical locations and employment sectors, including representation from public and private, generalist, and specialist services, and had varying years of diabetes experience. Of note, there were no significant differences in the demographics of completers versus noncompleters in the 2019 survey.

In conclusion, variations in approaches to MNT provided by dietitians for women with GDM in Australia observed in 2009 continue to be seen 10 years later. This is despite updated NPGs. Although these variations may reflect individualisation of MNT, there are likely multiple barriers to MNT best practice in GDM. Strategies to address barriers to implementation of NPG need urgent consideration, including increasing staffing and provision of targeted training opportunities. Such strategies should be prioritised given the rising rates of GDM both in Australia and globally and also because of evidence of the vital role of MNT in optimising maternal and neonatal outcomes in GDM pregnancies.

AUTHOR CONTRIBUTIONS

Melinda Morrison and Clare E. Collins were responsible for the conception and design of the original 2009 survey. Robyn A. Barnes, Melinda Morrison, Lesley MacDonald-Wicks, Clare E. Collins, Carmel E. Smart, Jeff R. Flack, and Glynis P. Ross were responsible for adaption of the original survey for the 2019 survey. Robyn A. Barnes and Melinda Morrison were responsible for data analysis for the 2019 and 2009 surveys, respectively. Robyn A. Barnes, Melinda Morrison, Lesley MacDonald-Wicks, Clare E. Collins, Carmel E. Smart, Jeff R. Flack, and Glynis P. Ross were responsible for interpretation of the data. Robyn A. Barnes was responsible for writing and editing the manuscript. Melinda Morrison, Lesley MacDonald-Wicks, Clare E. Collins, Carmel E. Smart, Jeff R. Flack, and Glynis P. Ross were responsible for critical revision of the manuscript. Supervision was provided by Lesley MacDonald-Wicks, Clare E. Collins, Carmel E. Smart, Jeff R. Flack, and Glynis P. Ross. All authors approved the final version of the manuscript submitted for publication.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

ETHICS STATEMENT

This study was approved by the University's Human Research Ethics Committee, Approval Reference Number: H-2017-0388.

TRANSPARENCY DECLARATION

The lead author affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned have been explained.

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