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ORIGINAL RESEARCH

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Exploring the diets of mothers and their partners during pregnancy: Findings from the Queensland Family Cohort pilot study

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Abstract

Aim: Modifiable behaviours during the first 1000 days of life influence developmental trajectories of adult chronic diseases. Despite this, sub-optimal dietary intakes during pregnancy and excessive gestational weight gain are common. Very little is known about partners' dietary patterns and the

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influence on women's pregnancy dietary patterns. We aimed to examine dietary intake during pregnancy among women and their partners, and gestational weight gain patterns in the Queensland Family Cohort pilot study.

Methods: The Queensland Family Cohort is a prospective, observational study piloted at a Brisbane (Australia) tertiary maternity hospital from 2018 to 2021. Participant characteristics, weight gain, dietary and nutrient intake were assessed.

Results: Data were available for 194 pregnant women and their partners. Poor alignment with Australian Guide to Healthy Eating recommendations was observed. Highest alignment was for fruit (40% women) and meat/alternatives (38% partners) and lowest for breads/cereals (<1% women) and milk/alternatives (13% partners). Fewer women (4.4%–60.3%) than their partners (5.4%–92.3%) met guidelines for all micronutrient intakes from food alone, particularly folic acid, iodine, and iron. Women were more likely to meet daily recommendations for fruit, vegetables, dairy, bread/cereals, and meat/alternatives when their partners also met recommendations. Women with a higher pre-pregnancy body mass index were more likely to gain above recommended weight gain ranges.

Conclusions: In this contemporary cohort of pregnant women and their partners, sub-optimal dietary patterns and deficits in some nutrients were common. There is an urgent need for evidence-informed public health policy and programs to improve diet quality during pregnancy due to intergenerational effects.

KEYWORDS
birth cohort, dietary intake, dietary guidelines, maternal health, gestational weight gain, pregnancy

1 | INTRODUCTION

The Developmental Origins of Health and Disease paradigm confirms that modifiable lifestyle behaviours during the first 1000 days of life contribute to developmental trajectories of many adult chronic diseases.[1] Antenatal nutrition status, maternal dietary patterns (such as fruit and vegetable intake), and gestational weight gain contribute to both short- and long-term maternal and child health outcomes, including risk of pregnancy and delivery complications, and risk of postpartum obesity, Type 2 diabetes mellitus, and cardiovascular disease.[1–5] Furthermore, there is emerging evidence that paternal risk factors, such as dietary patterns unaligned with those recommended in dietary guidelines and obesity are also associated with adverse metabolic and cardiovascular outcomes in their offspring.[6,7]

Despite this, women commonly report sub-optimal dietary intakes during pregnancy. Only 10%–40% of pregnant women meet current recommendations for fruit and vegetable intake.[8–12] Less than 1% achieve recommenced breads and cereal intakes and extremely low numbers meet pregnancy Nutrient Reference Values for folate, iodine, calcium, zinc, and fibre from food alone.[9–12] Furthermore, only 40%–50% of women consume the recommended nutrient supplements (iodine, folic acid) pre-pregnancy with minimal change once pregnancy is confirmed.[13] It is notable that very few studies with low sample sizes have documented paternal and/or partner dietary patterns during pregnancy and how this potentially influences maternal dietary intake.[14,15] Current evidence is limited in Australia and internationally, but is critical to inform family-based health promotion strategies and targeted interventions.[13]

A recent systematic review and meta-analysis of >1 million pregnant women identified that less than a third gained weight within the Institute of Medicine recommendations[3] with approximately one in two and one in four women having excessive or suboptimal gestational weight gain respectively in pregnancy.[3] Similar patterns have been observed in Australia.[16–21] In addition to total gestational weight gain, the pattern of weight gain across each trimester can impact pregnancy outcomes, such as the development of gestational diabetes mellitus.[22] However, few studies document these patterns across trimesters during pregnancy.

Substantial changes in demographics and characteristics of pregnant women in Australia have occurred over the last three decades relating to advanced maternal age, obesity, ethnic minority background, and pre-existing medical conditions.[23] Thus, the goal of this study was to describe pregnancy dietary intake and gestational weight gain patterns in a contemporary cohort of women birthing at a tertiary Queensland perinatal centre, and dietary intakes of their partners. We utilised data from women and their families collected as part of the Queensland Family Cohort Pilot Study,[24] which will inform further data collection in the main Queensland Family Cohort study, a large birth cohort study based at the Mater Mothers' Hospitals in Brisbane.[24]

Specific aims of the current analysis were to examine (i) dietary intake during pregnancy of women and their partners, including dietary nutrient and food group intake, how these health behaviours compare with Australian Dietary Guidelines and NRVs, and explore the relationship between women's and partner's dietary intake, and (ii) to describe gestational weight gain of women across pregnancy and alignment with current guidelines.

2 | METHODS

This study was approved by the Human Research Ethics Committee of Mater Research Institute—UQ Human Research Ethics Committee (HREC/16/MHS/113).

Women who were 12–24 weeks pregnant and booked to give birth at the Mater Mothers' Hospitals from 2018 to 2020 were eligible to participate, with their partners also invited to participate. Informed consent was obtained from both the pregnant women and their partners (without the necessity of being a biological parent).

Maternal and partner characteristics were collected at 22 weeks via questionnaire and included socio-demographic (education, income, ethnicity) information, age, parity, and pre-pregnancy height and weight (to calculate body mass index [BMI]). The following pre-existing medical conditions were assessed based on questions about self-reported medical history and crosschecked with medication use at 22 weeks: arthritis, asthma or other breathing conditions, blood pressure or other heart conditions, anticoagulants, cancer, hypercholesterolemia, hormones to aid conception or for medical conditions, depression, anxiety, diabetes mellitus, or epilepsy.

Information about maternal and partner dietary intake over the previous 3–6 months was self-reported at 24 weeks' gestation using the Australian Eating Survey (AES) semi-quantitative food frequency questionnaire (FFQ).[25] The AES is a 120-item semi-quantitative FFQ. The frequency options within the AES ranged from "Never" up to "≥4 times/day", but varied depending on the food, with some drinks items up to "≥7 glasses/day". Standard portion sizes were derived for AES items using data from the National Nutrition Survey.[26] Nutrient intakes were computed using data in the AUSNUT 2011–13 database.[27] A measure of diet quality, the Australian Recommended Food Score (ARFS), was calculated as an AES sub-scale with a maximum score of 73.[25,28] A sub-set of 70 AES food items are used to calculate the ARFS. It comprises eight sub-scales from core food groups of vegetables, fruit, grains, meats, non-meat proteins, dairy with total score ranging from 0 to 73. For most items, AES frequency response options are collapsed into two categories "once per week or more" or "less than once per week or never".[25] Percentage of total energy intake from the five core food groups (nutrient-dense) and from non-core foods (energy-dense, nutrient-poor, discretionary) was calculated. All dietary data were based on food intake, and did not include nutrient supplements, thus supplemental micro-nutrients were not included in analysis.

Participant food group and nutrient intakes were compared to recommendations outlined in the Australian Guide to Healthy Eating (AGHE) with food group intake (serves/day) calculated using the standard AGHE serve sizes[29] and national Nutrient Reference Values, including Estimated Average Requirements; Adequate Intakes; Acceptable macronutrient distribution range,[30] respectively.

Maternal weight was self-reported at 22 weeks' gestation (including self-reported pre-pregnancy weight), and formally measured at 24-, 28- and 36-week gestation, and finally at 6 weeks postpartum. Total gestational weight gain was determined based on self-reported pre-pregnancy weight and measured weight at 36 weeks' gestation.

Participant characteristics, gestational weight gain and dietary intake, and alignment with guidelines, were described as means with standard deviations or as number of participants with percentages. Cumulative gestational weight gain was compared across women's pre-pregnancy BMI categories using one-way analysis of variance. Women's and partner's food group intakes were compared to the AGHE food group servings specifications.[29] Women and partners were said to meet a food group if their intake either met or exceeded the AGHE values, except for the "extras" category, which was reported as the percentage of total energy derived from

AGHE core and discretionary food groups. Nutrient values for each participant were compared to the Nutrient Reference Values. Associations of maternal characteristics and dietary quality with alignment of gestational weight gain to Institute of Medicine guidelines[31] were explored using chi-square tests or analysis of variance. Associations of maternal and partner characteristics with adherence to dietary guidelines were explored using χ^2 tests or *t* tests.

3 | RESULTS

Data from 194 pregnant women and their partners (98.5% male) were available (Table 1 and Figure 1). The mean age of pregnant women was 33.7 (*SD* 4.5) years and 34.5 (*SD* 6.3) years for partners. The mean baseline gestation week was 22.4 (*SD* 2.0) weeks. Approximately 30% of women in the cohort were overweight or obese (17.8% and 13.0%, respectively) with almost 60% of their partners overweight or obese (42.3% and 17.6%, respectively). Twice as many women as men reported a pre-existing chronic condition based on their medication use.

As shown in Table 2, percentage of total energy from macronutrients of carbohydrate, protein, and fat for pregnant women and their partners were similar. Greater than 60% of women and 40% of partners consumed long-chain omega 3 fatty acids (LC n3) at or above the recommended guidelines. Women's mean dietary fibre intake was 24.8 g/day and partner's 28.9 g/day. Low proportions of women met micronutrient intake recommendations, particularly folic acid (4%), iodine (15%), and iron (<1%) from food and beverages. A larger proportion of their partners met micronutrient recommendations; however, calcium (40%) and folic acid (50%) intakes were lower than the proportion meeting iron and zinc recommendations (each 92%).

Poor alignment with the AGHE was observed, with very low proportions of participants meeting the five core food group intake recommendations (Table 2). Furthermore, only 41.4% of women met daily fruit and 28.4% vegetable intake recommendations, while around 31.5% and 15.0% of their partners met these, respectively. Fewer than 1% of women and 20% of partners met the recommended intake of serves for breads, cereals, and grains core food group. Approximately, one-third of kilojoules were consumed from non-core food groups by

TABLE 1 Characteristics of pregnant women ($n = 194$[a]) and their partners ($n = 194$[a]) participating in the Queensland Family Cohort Pilot Study

	Pregnant women		Partners	
Characteristics	***n***	**Value**	***n***	**Value**
Age (years), mean (*SD*)	194	33.7 (4.5)	194	34.5 (6.3)
Gestational age at study entry (weeks), mean (*SD*)	178	22.4 (2.0)	-	-
Born in Australia or New Zealand, *n* (%)	185	115 (62.2)	192	126 (65.6)
Education level, *n* (%)	183		188	
Up to year 12		8 (4.4)		23 (12.2)
Certificate/diploma		138 (75.4)		134 (71.3)
Postgraduate degree		37 (20.2)		31 (16.5)
Total weekly household income after tax, *n* (%)	143		-	
AUD ≤ $1000		23 (16.1)		-
AUD > $1000		120 (83.9)		-
Nulliparous, *n* (%)	115	13 (11.3)		-
BMI (kg/m^2)[b], mean (*SD*)	185	24.4 (5.1)	187	26.7 (4.6)
BMI category[b], *n* (%)	185		187	
Underweight		12 (6.5)		3 (1.6)
Normal weight		116 (62.7)		72 (38.5)
Overweight		33 (17.8)		79 (42.3)
Obesity		24 (13.0)		33 (17.6)
Pre-exsting chronic condition, *n* (%)	183	37 (20.2)	147	16 (10.9)

[a]Number of participants varies due to missing data.
[b]Pre-pregnancy BMI for pregnant women.

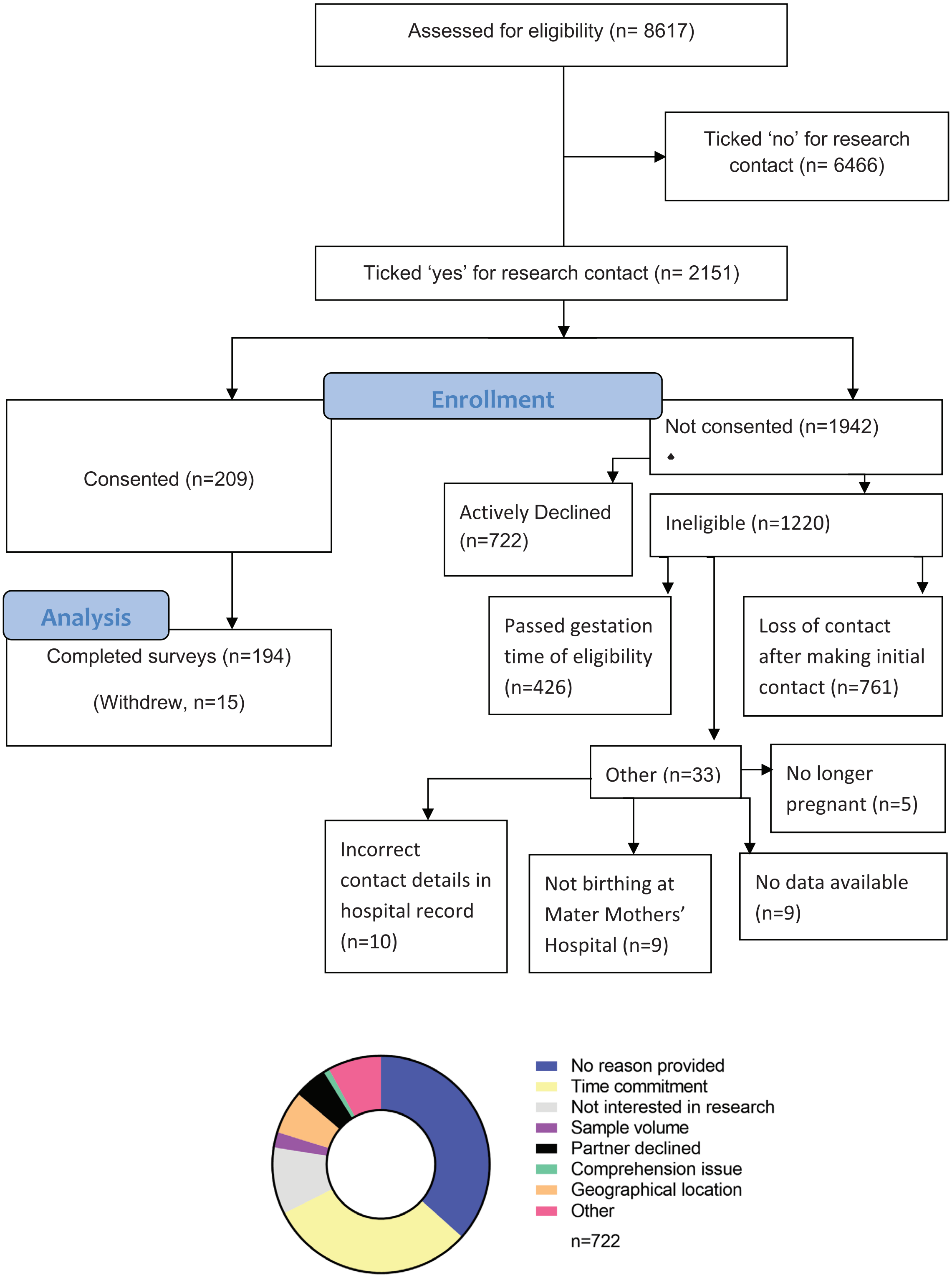

FIGURE 1 STROBE flowchart for participant inclusion in the Queensland Family Cohort study

both women and their partners (31.7% and 35.4%, respectively). Overall mean diet quality as indicated by the ARFS was 30.6 (*SD* 11.3) for women and 29.2 (*SD* 10.9) for their partners, out of a maximum of 73.

Mean total gestational weight gain was 13.0 kg (*SD* 5.5). Table 3 reports cumulative gestational weight gain across pregnancy according to pre-pregnancy BMI. Gestational weight gain from pre-pregnancy to 24, 28, and

TABLE 2 Nutrient and five core food group intake and adherence to guidelines at 24 weeks' gestation among pregnant women and their partners

	Requirements pregnancy; partners	Pregnant women *n* = 136 Daily intake mean (*SD*)	Pregnant women Guideline alignment %	Partners *n* = 129 Daily intake mean (*SD*)	Partners Guideline alignment %
Energy (kJ)		7551 (2814)		9992 (4175)	
Macronutrients					
Carbohydrates (g)		203.3 (85.5)		266.3 (118.5)	
Carbohydrates (% energy)	45–65%[a];45–65%[a]	45.7 (6.4)	59.7	45.3 (6.7)	53.1
Protein (g)	≥49[b]; 52	76.2 (29.2)	86.0	100.6 (41.7)	93.8
Protein (% energy)	15–25%[a];15–25%[a]	17.4 (2.7)	87.6	17.4 (2.8)	87.5
Total fat (g)		70.6 (26.7)		91.0 (42.2)	
Total fat (% energy)	20–35%[a];20–35%[a]	36.5 (4.5)	35.7	35.3 (5.2)	53.1
Saturated fat (g)		26.7 (11.1)		33.8 (16.5)	
Saturated fat (% energy)		13.7 (2.4)		13.1 (2.6)	
Polyunsaturated fat (g)		9.4 (3.8)		37.0 (17.6)	
Polyunsaturated fat (% energy)		4.9 (0.9)		4.8 (0.9)	
Monounsaturated fat (g)		28.4 (10.9)		12.5 (6.2)	
Monounsaturated fat (% energy)		14.8 (2.4)		14.4 (2.6)	
n-6 (linoleic) (g)	≥10[c]; ≥13[c]	7.9 (3.2)	25.7	10.6 (5.4)	24.8
n-3 (alpha-linolenic) (g)	≥1.0[c]; ≥1.3[c]	1.0 (0.4)	50.7	1.2 (0.6)	36.4
LC n-3 (DHA + EPA) (mg)	≥115[c]; ≥160[c]	136.8 (124.4)	63.6	209.1 (212.2)	44.2
Dietary fibre (g)	≥28; >30	24.8 (10.9)	38.2	28.9 (13.4)	39.5
Micronutrients, from diet					
Calcium (mg)	≥840; ≥840	708.9 (364.3)	28.7	828.7 (426.0)	39.5
Folate (μg)	≥520; ≥320	303.3 (126.5)	4.4	343.5 (153.9)	52.7
Iodine (μg)	≥160; ≥100	116.3 (56.7)	15.4	141.4 (67.5)	74.4
Iron (mg)	≥22; ≥6	9.3 (4.3)	0.7	11.9 (5.2)	92.3
Sodium (mg)	460–920; 460–920	1577.5 (677.2)	7.4	2077.8 (1062.2)	5.4
Zinc (mg)	≥9; >6.5	9.7 (3.9)	60.3	12.3 (4.9)	92.3
Foods[d]					
Grain (cereal) foods (servings)	≥8.5; ≥6	3.1 (1.5)	0.8	4.2 (2.1)	20.5
Fruit (servings)	≥2; ≥2	1.9 (1.2)	41.4	1.5 (1.1)	31.5
Vegetables and legumes/beans (servings)	≥5; ≥6	3.8 (1.9)	28.4	3.9 (2.1)	15.0
Milk, yoghurt, cheese, and/or alternatives (servings)	≥2.5; ≥2.5	1.3 (1.0)	10.9	1.4 (1.1)	13.3
Lean meat and poultry, fish, eggs, tofu, nuts and seeds, legumes, and beans (servings)	≥3.5; ≥3	2.4 (1.1)	25.4	2.8 (1.2)	38.1
Core foods (kJ)		5416 (1748)		6389 (2223)	
Core foods (% energy)		68.3 (11.5)		64.6 (10.3)	
Non-core foods (kJ)		2545 (1284)		3682 (2455)	
Non-core foods (% energy)		31.7 (11.5)		35.4 (10.3)	

TABLE 2 (Continued)

	Requirements pregnancy; partners	Pregnant women $n = 136$		Partners $n = 129$	
		Daily intake mean (*SD*)	Guideline alignment %	Daily intake mean (*SD*)	Guideline alignment %
Overall diet quality					
ARFS		30.6 (11.3)		29.2 (10.9)	

Abbreviation: ARFS, Australian Recommended Food Score.
[a]Acceptable macronutrient distribution range, AMDR.
[b]2nd and 3rd trimesters only.
[c]AI (adequate intake) not EAR.
[d]Serving size: (a) Breads and cereals: bread 40 g, cereal 30 g, cooked porridge 120 g, muesli 30 g, cooked rice/pasta/noodles/barley/quinoa 70–120 g, dry biscuits 40 g; (b) Fruit: whole fruit (including canned) 150 g, fruit juice 125 ml, dried fruit 30 g; (c) Vegetables: cooked or fresh vegetables 75 g; (d) Dairy and alternatives: milk 250 ml, hard cheese 40 g, soft cheese (ricotta) 120 g, yoghurt 200 g; (e) Meat and alternatives: lean (cooked) beef/ veal/lamb/pork/65 g, poultry (cooked) 80 g, fish (cooked)100 g, eggs 120 g, nuts/seeds/nut butters 30 g, tofu 170 g, cooked or canned legumes 150 g; (f) Extras: sweet biscuit 35 g, sweet pastries/cakes/pies 40 g, savoury pies/pastries 60 g, pizza 60 g, hamburger 60 g, chocolate 35 g, processed meats 110 g, sausage 50–60 g, potato crisps/ corn chips 30 g, jam/honey 45 g, ice-cream 75 g, fat spread 20 g, sugar 40 g, light beer 600 ml, full strength beer 400 ml, wine (including sparkling) 200 ml, spirits/liqueurs 60 ml, fortified wine 60 ml.

TABLE 3 Cumulative gestational weight gain according to pre-pregnancy BMI category, $n = 174$

	24 Weeks' gestation (kg) mean (*SD*)	28 Weeks' gestation (kg) mean (*SD*)	36 Weeks' gestation (kg) mean (*SD*)
Overall	7.3 (4.2)	9.5 (4.5)	13.0 (5.5)
Underweight	7.7 (2.4)	9.4 (2.4)	12.9 (3.5)
Normal weight	7.5 (3.5)	9.7 (3.8)	13.5 (4.8)
Overweight	8.0 (4.0)	10.3 (4.5)	13.6 (4.9)
Obesity	5.2 (7.0)	6.9 (7.6)	9.4 (9.2)
p value	0.06	0.04	0.02

Note: *p* values from analysis of variance comparing gestational weight gain between all pre-pregnancy BMI categories at each time point.

36 week's gestation differed by pre-pregnancy BMI ($p = 0.06$, 0.04 and 0.02, respectively) and was lower among women with obesity (pre-pregnancy BMI >29.9 kg/m^2). Women retained weight at 6-week postpartum, with an average weight of 69.7 kg (*SD* 14.9) compared with a pre-pregnancy weight of 65.4 kg (*SD* 13.9). Average weight retained at 6 weeks postpartum was 4.3 kg (*SD* 7.1).

A significant relationship exists between pre-pregnancy BMI and women's attainment of gestational weight gain guidelines, with a greater proportion of women gaining above their recommended gestational weight gain range among higher ppBMIs (data not shown). There was no significant difference between women with gestational weight gain within range, above Institute of Medicine guidelines or with inadequate gestational weight gain and their consumption of energy-dense, nutrient-poor foods (32%, 33%, and 29%, respectively, $p = 0.17$).

Tables 4 and 5 present associations between participant characteristics and attainment of dietary guidelines. Older women and partners diets were more likely to align with meat/alternatives recommendations ($p = 0.06$), and older partners compared to younger partners were also more likely to meet dairy food group recommendations ($p = 0.07$). Women with a higher level of education and a lower pre-pregnancy BMI were more likely to meet daily vegetable intake recommendations compared with those with lower levels of education ($p = 0.06$) and higher pre-pregnancy BMI ($p = 0.006$). Significant associations were observed between attainment of food group recommendations between women and partners. Women were more likely to meet daily dietary intake recommendations for the following food groups when partners also met these recommendations: fruit ($p = 0.008$); vegetable ($p < 0.0001$), dairy ($p = 0.04$), bread, cereal, and grain ($p < 0.0001$), meat and alternatives group requirements ($p < 0.0001$).

4 | DISCUSSION

This analysis of contemporary Australian pregnant women and partners' dietary intake patterns shows that a

TABLE 4 Associations of maternal characteristics with adherence to food-based dietary guidelines, $n = 136$[a,b]

	Fruit servings/day n (%)			Vegetables servings/day n (%)			Dairy servings/day n (%)			Meat and alternatives servings/day n (%)		
	<2 80 (58.6)	≥2 56 (41.4)	p value*	<5 98 (71.7)	≥5 39 (28.4)	p value*	<2.5121 (89.2)	≥2.5 15 (10.9)	p value*	<3.5101 (74.6)	≥3.5 35 (25.4)	p value*
Age (years), mean (*SD*)	33.1 (5.2)	34.0 (5.1)	0.32	33.6 (5.8)	33.6 (5.1)	0.97	33.6 (5.1)	33.5 (6.3)	0.94	33.1 (5.1)	35.3 (6.7)	0.06
Gestational age at study entry (weeks), mean (*SD*)	21.9 (2.4)	22.0 (1.9)	0.84	21.8 (2.3)	22.5 (1.4)	0.12	22.0 (2.2)	21.7 (1.5)	0.70	21.9 (2.2)	22.2 (1.9)	0.53
Born in Australia or New Zealand, *n* (%)	51 (68.0)	36 (67.9)	0.99	59 (67.1)	22 (62.9)	0.66	77 (67.0)	11 (78.6)	0.38	61 (67.0)	19 (61.3)	0.56
Education level, *n* (%)			0.23			0.06			0.21			0.47
Up to year 12	2 (2.7)	1 (1.9)		3 (3.5)	1 (2.9)		1 (0.9)	1 (7.1)		2 (2.3)	1 (3.2)	
Certificate/diploma	58 (78.4)	36 (70.1)		69 (80.2)	22 (62.9)		86 (76.1)	10 (71.4)		70 (78.7)	21 (67.7)	
Postgraduate degree	14 (18.9)	15 (28.0)		14 (16.3)	12 (34.3)		26 (23.0)	3 (21.4)		17 (19.1)	9 (29.0)	
Total weekly household income after tax, *n* (%)			0.28			0.16			0.60			0.51
AUD ≤ $1000	9 (15.0)	3 (7.7)		10 (14.5)	1 (4.0)		10 (11.4)	2 (16.7)		7 (10.5)	4 (15.4)	
AUD > $1000	51 (85.0)	36 (92.3)		59 (85.5)	24 (96.0)		78 (88.6)	10 (83.3)		60 (89.6)	22 (84.6)	
Nulliparous, *n* (%)	5 (10.6)	3 (10.3)	0.97	4 (7.8)	4 (16.7)	0.25	6 (9.0)	2 (20.0)	0.29	4 (7.4)	4 (20.0)	0.12
Pre-pregnancy BMI (kg/m^2), mean (*SD*)	24.7 (5.1)	24.1 (4.4)	0.45	24.8 (5.6)	22.0 (3.4)	0.006	24.4 (4.8)	25.2 (4.9)	0.59	24.0 (5.0)	24.0 (5.9)	0.97
Pre-pregnancy BMI category, *n* (%)			0.87			0.14			0.85			0.79
Underweight	4 (5.3)	2 (3.8)		7 (8.0)	2 (5.7)		6 (5.2)	1 (7.1)		6 (6.6)	3 (9.7)	
Normal weight	48 (64.0)	33 (62.3)		53 (60.2)	28 (80.0)		72 (62.6)	9 (64.3)		59 (64.8)	21 (67.7)	
Overweight	13 (17.3)	12 (22.6)		14 (15.9)	4 (11.4)		22 (19.1)	3 (21.4)		15 (16.5)	3 (9.7)	
Obesity	10 (13.3)	6 (11.3)		14 (15.9)	1 (2.9)		15 (13.0)	1 (7.1)		11 (12.1)	4 (12.9)	
Pre-exsting chronic condition, *n* (%)	15 (20.3)	7 (13.5)	0.32	14 (16.1)	9 (26.5)	0.19	19 (16.8)	3 (21.4)	0.67	17 (18.9)	6 (20.0)	0.89
Partner adhering to guideline for grains, *n* (%)	6 (10.9)	11 (24.4)	0.07	10 (11.0)	16 (44.4)	<0.0001	15 (16.7)	2 (18.2)	0.90	17 (18.1)	9 (28.1)	0.23
Partner adhering to guideline for fruit, *n* (%)	10 (18.2)	19 (42.2)	0.008	18 (19.8)	22 (61.1)	<0.0001	27 (30.0)	2 (18.2)	0.41	30 (31.9)	9 (28.1)	0.69
Partner adhering to guideline for vegetables, *n* (%)	4 (7.3)	8 (17.8)	0.11	1 (1.1)	19 (52.8)	<0.0001	12 (13.3)	1 (9.1)	0.20	14 (14.9)	4 (12.5)	0.74

TABLE 4 (Continued)

	Fruit servings/day n (%)			Vegetables servings/day n (%)			Dairy servings/day n (%)			Meat and alternatives servings/day n (%)		
	<2 80 (58.6)	**≥2 56 (41.4)**	***p* value***	**<5 98 (71.7)**	**≥5 39 (28.4)**	***p* value***	**<2.5121 (89.2)**	**≥2.5 15 (10.9)**	***p* value***	**<3.5101 (74.6)**	**≥3.5 35 (25.4)**	***p* value***
Partner adhering to guideline for dairy, *n* (%)	8 (14.6)	5 (11.1)	0.61	8 (8.8)	8 (22.2)	0.04	12 (13.3)	1 (9.1)	0.69	12 (12.8)	4 (12.5)	0.97
Partner adhering to guideline for meat and alternatives, *n* (%)	21 (38.2)	13 (28.9)	0.33	36 (39.6)	12 (34.3)	0.59	31 (34.4)	4 (36.4)	0.90	16 (17.0)	32 (100.0)	<0.0001

Note: **p* values from χ^2 tests or *t* tests.
[a]Number of participants varies due to missing data.
[b]Adherence to the guideline for bread and cereals was not included as only 0.8% of women adhered to the guideline.

large proportion of dietary intakes are not aligned with recommendations during pregnancy, with a high proportion also experiencing excessive gestational weight gain. Our findings suggest dietary intake of pregnant women is influenced by age, education levels, and pre-pregnancy BMI. An association exists between womens' and partners' dietary intake and their likelihood of alignment with national food and nutrient recommendations. This was particularly so in regard to fruit, vegetables, and meat and alternatives food groups.

Compared with the broader Australian population over the age of 18, pregnant women in our cohort were less likely to have overweight or obesity (Australian population: 29.6% and 30.1% versus Queensland Family Cohort 17.8% and 13.0%, respectively).[32] The pre-pregnancy BMI of the cohort is also lower than that documented for Queensland women; over 50% of women start pregnancy with a BMI above the healthy weight range.[33] A similar proportion of partners in the cohort had overweight, compared with the wider Australian population, however only a 17.6% had obesity compared with 32.5% of the population.[32]

The proportion of both women and their partners' intakes aligning with recommendations in the AGHE five core food groups for fruit intake per day were lower than the general Australian population's alignment.[34] The inverse was true for proportion meeting daily vegetable recommendations, with about three times as many women and eight times as many partners (males) meeting recommendations compared with the wider Australian population.[34] This pattern of (women's) fruit and vegetable intake is very similar to that recently reported in a study of 534 women surveyed using the same AES FFQ in their third trimester attending the John Hunter Hospital antenatal service (Newcastle, NSW, Australia).[10] The findings from our study are consistent with several other Australian and international studies that demonstrate poor alignment with vegetable, and cereal/grains recommendations.[35] Interestingly, apart from a slightly higher proportion of women meeting meat/alternatives guidelines in the John Hunter Hospital study compared with the Queensland Family Cohort (25.4% vs. 18.9%, respectively), the remainder of the women whose intake aligned with five core food group recommendations were extremely similar, including just ~1% aligning with the guideline for cereals grains) intake and approximately one-third of energy intake contributed by non-core (junk) foods.[10] This is also reflected in the Queensland Family Cohort's partners' intake and the wider Australian population.[36]

This pattern of food group (core and energy-dense, nutrient-poor) is mirrored in the proportion of Queensland Family Cohort women and partners' alignment with

TABLE 5 Associations of partner characteristics with adherence to food-based dietary guidelines, $n = 129$[a]

	Bread and cereals servings/day *n* (%)			Fruit servings/day *n* (%)			Vegetables servings/day *n* (%)			Dairy servings/day *n* (%)			Meat and alternatives servings/day *n* (%)		
	<6102 (79.5)	**≥6 27 (20.5)**	***p* value***	**<2 88 (68.5)**	**≥2 41 (31.5)**	***p* value***	**<6109 (85.0)**	**≥6 20 (15.0)**	***p* value***	**<2.5112 (86.7)**	**≥2.5 17 (13.3)**	***p* value***	**<3 80 (61.9)**	**≥3 49 (38.1)**	***p* value***
Age (years), mean (*SD*)	33.8 (6.8)	35.1 (4.1)	0.38	33.7 (6.9)	35.0 (4.7)	0.32	34.1 (6.6)	33.9 (4.8)	0.88	33.7 (6.1)	36.6 (7.0)	0.07	33.3 (6.5)	35.5 (5.9)	0.06
Born in Australia or New Zealand, *n* (%)	72 (71.3)	17 (65.4)	0.56	62 (71.3)	27 (67.5)	0.67	73 (67.6)	16 (84.2)	0.15	74 (66.7)	15 (88.2)	0.07	57 (73.1)	31 (64.6)	0.31
Education level, *n* (%)			0.40			0.86			0.09			0.10			0.72
Up to year 12	11 (11.1)	4 (15.4)		11 (12.6)	4 (10.5)		12 (11.3)	3 (15.8)		15 (14.2)	1 (5.9)		8 (10.5)	7 (14.6)	
Certificate/diploma	74 (74.6)	16 (61.5)		63 (72.4)	27 (71.1)		80 (75.5)	10 (52.6)		79 (74.5)	11 (64.7)		57 (75.0)	33 (68.8)	
Postgraduate degree	14 (14.1)	6 (23.1)		13 (14.9)	7 (18.4)		14 (13.2)	6 (31.6)		15 (11.3)	5 (29.4)		11 (14.5)	8 (16.7)	
BMI (kg/m^2), mean (*SD*)	26.4 (3.9)	25.5 (3.4)	0.28	26.7 (4.2)	25.3 (2.8)	0.05	26.6 (3.9)	23.9 (2.5)	0.005	26.4 (3.7)	25.7 (4.4)	0.51	26.2 (3.6)	26.4 (4.2)	0.80
BMI category, *n* (%)			0.69			0.13			0.07			0.74			0.79
Underweight	2 (2.0)	1 (4.4)		3 (3.5)	1 (2.6)		2 (1.9)	1 (5.9)		2 (1.8)	1 (6.3)		2 (2.6)	1 (2.2)	
Normal weight	40 (39.6)	11 (47.8)		32 (37.2)	18 (47.4)		40 (37.4)	10 (58.8)		45 (41.3)	6 (37.5)		30 (39.0)	20 (43.5)	
Overweight	43 (42.6)	9 (39.1)		35 (40.7)	17 (44.7)		47 (43.9)	5 (29.4)		46 (42.2)	7 (43.8)		35 (45.5)	17 (37.0)	
Obesity	16 (15.8)	2 (8.7)		16 (18.6)	2 (5.3)		18 (16.8)	1 (5.9)		16 (14.7)	2 (12.5)		10 (13.0)	8 (17.4)	
Pre-exsting chronic condition, *n* (%)	7 (9.0)	2 (10.0)	0.89	4 (5.7)	5 (17.9)	0.06	7 (8.6)	2 (11.8)	0.69	8 (9.3)	1 (7.7)	0.85	5 (8.5)	3 (7.9)	0.92
Women adhering to guideline for fruit, *n* (%)	34 (41.0)	11 (64.7)	0.07	26 (36.6)	19 (65.5)	0.008	37 (42.1)	8 (66.7)	0.11	40 (46.0)	5 (38.5)	0.61	32 (48.5)	13 (38.2)	0.33
Women adhering to guideline for vegetables, *n* (%)	20 (19.8)	16 (61.5)	<0.0001	14 (16.1)	22 (55.0)	<0.0001	17 (15.7)	19 (100.0)	<0.0001	28 (25.2)	8 (50.0)	0.04	23 (29.5)	12 (25.0)	0.59
Women adhering to guideline for dairy, *n* (%)	9 (10.7)	2 (11.8)	0.90	9 (12.5)	2 (6.9)	0.41	11 (12.4)	1 (8.3)	0.20	10 (11.4)	1 (7.7)	0.69	7 (10.6)	4 (11.4)	0.90
Women adhering to guideline for meat and alternatives, *n* (%)	23 (23.0)	9 (34.6)	0.23	23 (26.4)	9 (23.1)	0.69	28 (25.9)	4 (22.2)	0.74	28 (25.5)	4 (25.0)	0.97	1 (1.3)	32 (66.7)	<0.0001

Note: *p values from χ^2 tests or t tests.
[a]Number of participants varies due to missing data.

acceptable micronutrient distribution range for macronutrients which is at the very lower end of the range for carbohydrates (45%–65%) and at or above the high end of the range for total fat (20%–35%).[30] Very similar macronutrients distributions were reported in the John Hunter Hospital cohort.[10] These intakes are slightly higher than those of the general Australian population for carbohydrate (∼43%) and substantially lower for fat (∼39%).[37] Fibre intakes of women and their partners were lower than recommendations (24.8 g/d and 28.8 g/d compared with recommendations of 28 g/d and 30 g/d, respectively),[30] with women's intake similar to the John Hunter Hospital cohort.[10] Further, the sub-optimal intake of foods aligned with the ADG is reflected in the low proportion of women meeting estimated average requirements, particularly for calcium, iodine, folic acid, and iron. The John Hunter Hospital cohort reported similar proportions for calcium and iron, but higher for folic acid (53.7%) and iodine (23.7%) and other Australian and international studies have reported similar patterns of insufficient intake.[10,35] Comparing partners' intakes with the broader population, proportions of calcium were similar; however, lower (but still high) intakes of iron, zinc, and folic acid intake were documented.[38]

Reinforcing the pattern of inadequate intake, the ARFS scores around 30 for women and their partners were lower than those recently documented in a from a survey of 93 252 Australians (76% female) which reported a mean ARFS score of 34.1 ± 9.7 (females 34.5 ± 9.3; males 33.1 ± 10.6)[39] and substantially lower than the maximum score of 73.[40]

Relationships between intake, BMI, and education in this cohort are expected, with higher vegetable intakes regularly documented to be associated with lower pre-pregnancy BMI and higher education levels.[35,41–43] While it has been documented that demographic characteristics of education, income, and BMI influences an individual's intake, less has been recorded regarding influences within a relationship, particularly during pregnancy.[41–43] However, it is known that spousal support influences other health behaviours, for example the initiation and maintenance of regular exercise.[44] Furthermore, the influences on family, particularly of children's eating patterns is also well known.[45] Understanding the mediators and moderators of dietary intake relationships observed in the current study, particularly the direction of influence within the dyad could be a powerful health promotion strategy. This is particularly salient due to the pregnancy public health strategy of folic acid and iodine supplementation in bread since 2009[46] and the contribution of these food groups to sufficient fibre intake.

Consistent with previous research, this study has again highlighted the high prevalence of gestational weight gain above recommendations across all pre-pregnancy BMI categories in Australian women.[47] This is concerning given this study cohort appears to have a lower representation of women with a pre-pregnancy BMI above the healthy range than the broader Queensland pregnant population[33] and therefore is likely an underestimate of the extent of excess gestational weight gain. These findings reinforce the need to ensure multi-level strategies are implemented to support healthy gestational weight gain with mechanisms to identify deviations from a healthy trajectory and provide early intervention.

This study has a number of strengths. Recruitment of pregnant woman-partner dyads provides a unique opportunity enabling investigation of associations between dietary behaviours, gestational weight gain, and participant characteristics. Further work is required to examine mediators and moderators of relationships observed in this study.

A limitation of this study included the dietary assessment as part of a larger cohort study utilising a battery of questionnaires and assessments,[24] hence contributing to a lower completion of the FFQ from within the wider cohort. Further, the FFQ was not repeated across pregnancy to reduce participant burden so changes to macro and micronutrient intake was not captured. Despite some studies suggesting stability of dietary intake across pregnancy,[48] lack of multiple data collection points across pregnancy and the postnatal period precludes potential analyses regarding associations between dietary patterns, biological measures, and outcomes within and beyond pregnancy as is the goal of the wider cohort study.[24] Repeated dietary intake assessment, at a minimum, at the end of each trimester and within the postnatal period would be recommended to account for impact of morning sickness (early), satiety (late), development of conditions that change dietary intake (gestational diabetes mellitus), and/or educational interventions. An additional study limitation is the use of the AES FFQ and ARFS tool. Despite being previously used in pregnant women in Australia,[10,48–50] it has not been validated in these populations. Furthermore, the dietary analysis only considered intakes of foods and not supplements which may result in under-reporting of various nutrients, particularly folic acid, iodine, and iron. It is suggested that dietary intake assessment in the larger study is achieved through administration of the AES online (∼15 min) and/or a blended assessment with a smart-phone-image-based dietary assessment method (validated for use with pregnant women).[51,52] Self-reported pre-pregnancy weight was used to calculate pre-pregnancy BMI. While this method is common in studies examining relationships with pre-pregnancy weight and BMI,[16,53] with a high correlation with measured weight prior to pregnancy,[54] under and overreporting that results in misclassification cannot be eliminated.

Despite recruitment being designed to ensure the cohort was representative of the Queensland population, with efforts made to invite all eligible individuals, including those from non-English speaking backgrounds, <18 years of age, with special needs and First Nation community members, and participants with underlying serious or chronic health conditions, the sample had a lower BMI, was older and more educated than the wider pregnant and non-pregnant Australian population. A further limitation of this study is the small sample size and lack of power, particularly to examine subgroup analysis such as gestational weight gain adherence. However, it should be recognised this was a pilot study with the aim to inform the methodologies for a larger study.

In addition to the potential adaptations to the larger cohort study methodology, the findings of this study suggest the translation of antenatal-nutrition science evidence into clinical and public health policy and practice remains inadequate. Strong calls have been made for Australian nutrition practice guidelines for maternal health.[55,56]

In the current cohort of pregnant women and their partners, we have documented sub-optimal intakes of all foods and nutrients, reflecting the wider Australian population and comparable pregnant populations. A relationship exists between pre-pregnancy BMI and women's attainment of gestational weight gain guidelines. Future research should investigate mediators and moderators of dietary intake between women and their partners. There is an urgent need for evidence-informed public health policy and programs to improve diet quality during pregnancy due to its intergenerational effects.

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CONFLICTS OF INTEREST

Shelley Wilkinson and Helen Truby are Associate Editors of Nutrition & Dietetics. They were excluded from the peer review process and all decision-making regarding this article. This manuscript has been managed throughout the review process by the Journal's Editor-in-Chief. The Journal operates a blinded peer review process and the peer reviewers for this manuscript were unaware of the authors of the manuscript. This process prevents authors who also hold an editorial role to influence the editorial decisions made. The other authors declare no other conflicts of interest. No funding was received for undertaking the preparation, analysis, or writing of this study; funders did not influence the plan, analysis, or content of this paper. The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.

AUTHOR CONTRIBUTIONS

All authors are members of the QFC research collaborative and contributed to study variables that were collected and discussions regarding study design. All authors contributed to planning of the paper, data interpretation, critical manuscript review, and writing. SAW led the writing of the paper, with significant inputs from DAJMS, SdJ, and CEC. DAJMS undertook data analysis.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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