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Nutrition from conception to adulthood

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Address for Editorial Correspondence:
Editor, *Nutrition & Dietetics*
1/8 Phipps Close
Deakin ACT 2600
Australia
Email: ndi.eo@wiley.com

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INVITED EDITORIAL

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The first 1000 days: A critical period of nutritional opportunity and vulnerability

The period of life between conception and a child's second birthday, referred to popularly as the first 1000 days, is key to lifelong health and wellbeing.[1] It is a period of rapid growth and neurodevelopment, high nutritional requirements and high sensitivity to programming effects and, as a consequence, is a time of great vulnerability.[2] Failure to provide sufficient kilojoules and key nutrients during this critical period may result in stunting and lifelong deficits in brain function. In addition, child and adult health risks, including obesity, cardiovascular, metabolic and endocrine disease, may be programmed as a result of exposure to an adverse nutritional environment during this period.[3]

Although the most active period of neurological development occurs in the first 1000 days, parenting and early education in the preschool years also have an impact on long-term developmental and health outcomes.[4] From a dietary perspective, early childhood is a period of life when food preferences and eating behaviours, which are influenced by parental feeding practices and role modelling, are firmly established. Food preferences and eating behaviours have been shown to track into later life[5] and provide the foundation for either good or poor health in later childhood and adulthood.[6]

This issue of *Nutrition & Dietetics* includes a collection of original nutrition research that spans these critical first 1000 days of life and beyond. In addition to papers related to pregnancy,[7-10] infancy[11-13] and the preschool years,[14] there are papers related to schoolchildren,[15] adolescents[16] and young adults.[17,18]

Folate and iodine both play crucial roles in foetal neurodevelopment[7] but are often lacking in the diets of pregnant women. Consequently, routine supplementation in pregnancy of both of these nutrients is recommended.[19] However, adherence to these supplementation recommendations by pregnant women in Australia is far from universal,[20] and therefore, many pregnant women rely, at least in part, on dietary intake to meet their increased needs for these nutrients. In Australia, mandatory fortification of breads with iodine and folate was introduced in 2009 in an effort to increase population dietary intake of these nutrients.[21] Sherriff et al investigated the dietary iodine intake of pregnant women attending antenatal classes in Perth and found that only three of five women consumed bread daily.[8] Similarly, James-McAlpine et al assessed the diets of a cohort of pregnant South East Queensland women and found that the daily serves of grain-based food were less than half the recommended intake.[22] The implication of both these studies is that the dietary intake of both folate and iodine by pregnant Australian women is likely to be insufficient.

As well as being an important period for foetal development, pregnancy is considered an opportune time for promoting healthy nutrition practices to women when they are purportedly more motivated to care for their own health and that of their offspring. The internet has become the most popular source of nutrition information used by Australian adults in general.[23] While, traditionally, health professionals have been, and remain, the primary source of nutrition information for Australian pregnant women, in this issue, Lobo et al report that Australian pregnant women are increasingly searching the internet for information on a variety of nutrition topics relevant to pregnancy.[9] It is critical, therefore, that pregnant women have access to relevant and factual information from credible online sources. Lobo et al rated the accuracy of 136 websites and found that government and business/company websites had an encouragingly high degree of accuracy, whereas the websites of community groups had a lower degree of accuracy, and personal blogs were a source of largely inaccurate information.[9] Given the importance of iodine in pregnancy, surprisingly few women (11.8%) searched the internet for information on this nutrient. Of greater concern is the finding that just under half of the women surveyed in 2018 were unsure if they had received information on iodine, suggesting that iodine supplementation recommendations are not being effectively communicated to this target audience, let alone adhered to.

Not only does breastfeeding provide optimal nutrition to infants, it is also beneficially associated with a range of short- and long-term health outcomes.[24] Parizkova et al investigated the association between breastfeeding duration and infant disease in a cross-sectional study of 2304 Czech mothers.[11] Their findings are generally consistent with the current literature,[24] including that children fully

breastfed to 6 months of age had a significantly lower risk of having been prescribed antibiotics for an upper respiratory tract infection than infants who were partially breastfed or formula fed at 6 months. This is consistent with the evidence that breastfeeding reduces the severity of respiratory illnesses in infants.[25] This finding is also of importance given the disruptive effect that antibiotics have on the developing infant's gut microbiota, which may have long-term metabolic consequences.[26]

The consequences of poor nutrition in the first 1000 days are felt particularly in vulnerable populations. Leonard et al have previously highlighted an alarming rate of anaemia amongst pregnant Aboriginal and Torres Strait Islander women in Far North Queensland.[27] Iron deficiency anaemia in early childhood is common worldwide and can have a detrimental effect on growth and neurodevelopment. Young children are particularly vulnerable because of their rapidly developing brain, and iron deficiency in early childhood can have lifelong consequences.[28] In this issue, Leonard et al[14] report on the association of early childhood anaemia and developmental outcomes at school age among Aboriginal and Torres Strait Islander children of remote Far North Queensland. They show, in this study, that children who experienced anaemia between 6 and 24 months of age had double the risk of adverse developmental outcomes at school age.

Several papers in this issue provide further evidence of the importance of adequate and timely nutrition in the first 1000 days and the need for this to be communicated effectively to new mothers and mothers to be. While pregnancy is seen as a critical window of opportunity for promoting healthy eating to women, food choices of pregnant women appear to be driven primarily by sensory and not health motives,[22] as is the case in the general population. In particular, the iodine intake of pregnant women continues to be of concern, with dietary intakes likely to be insufficient, and the importance of iodine in pregnancy is seemingly ineffectively communicated to this target group. There is a need for nutritionists and dietitians, along with other health professionals, to continually advocate for public policies and deliver programs that ensure the provision of optimal nutrition and promotion of healthy eating during this critical period.

CONFLICT OF INTEREST

The author has no conflict of interest to declare.

Jane A. Scott PhD FDAA

Professor of Public Health Nutrition, Associate Editor, Nutrition and Dietetics, School of Public Health, Curtin University, Perth, Western Australia, Australia
Email: jane.scott@curtin.edu.au

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ORIGINAL RESEARCH

Dietary intake, food addiction and nutrition knowledge in young people with mental illness

Scott B. TEASDALE,[1,2] Tracy L. BURROWS,[3] Tegan HAYES,[4] Cin Y. HSIA,[4] Andrew WATKINS,[1,5] Jackie CURTIS[1,2] and Philip B. WARD[2,6]

[1]Keeping the Body in Mind Program, South Eastern Sydney Local Health District, [2]School of Psychiatry, University of New South Wales, [4]Department of Nutrition and Dietetics, University of Sydney, [5]Faculty of Health, University of Technology Sydney and [6]Schizophrenia Research Unit, South Western Sydney Local Health District, Ingham Institute of Applied Medical Research, Liverpool Hospital, Sydney and [3]School of Health Sciences and Priority Research Centre for Physical Activity and Nutrition, University of Newcastle, Newcastle, New South Wales, Australia

Abstract

Aim: The aim of this study was to comprehensively assess dietary intake, nutrition knowledge and food addiction in young people with mental illness.

Methods: This was a three-arm cross-sectional study of 16–25-year-olds attending community mental health services who met criteria for: (i) first-episode psychosis (FEP), (ii) ultra-high risk for psychosis (UHR) or (iii) depression/anxiety. Participants self-completed three validated questionnaires: (i) Australian Eating Survey, (ii) General Nutrition Knowledge Questionnaire—Revised and (iii) Yale Food Addiction Score Questionnaire.

Results: Thirty participants (mean age 19.7 ± 2.5 years) completed the study (10 per study arm); 43% of the energy intake was obtained from energy-dense, non-nutritious foods, higher than the recommended upper limit (<15%) and the levels reported in the general population (35%). Mean diet quality score was 33.5 ± 11.8 of 73. Mean food addiction symptom score was 3.3 ± 3.7. Prevalence of food addiction was 37%. Nutrition knowledge was lower in the FEP and UHR participants than the depression/anxiety group (48.2 ± 13.8 and 49.5 ± 8.2 of 88 respectively); however, this difference was not statistically significant.

Conclusions: Unhealthy dietary intake was observed in the early stages of mental illness, likely seeding future poor physical health. Further research is needed on the role of food addiction in this population, including effective intervention techniques.

Key words: depression, diet, food addiction, mental illness, nutrition, psychosis.

Introduction

People experiencing mental illness such as schizophrenia, bipolar affective disorder and major depressive disorder experience obesity and poor cardiometabolic health disproportionately than those without a mental illness,[1] and these are major contributing factors for the 15-year life-expectancy gap compared to the general population.[2]

Excessive and unhealthy dietary intakes in people with mental illness, when compared to national recommendations, as well as the general population, appear to be key diet-related factors driving high rates of obesity and poor cardiometabolic health.[3] With 75% of lifetime psychiatric disorders emerging during adolescence and early adulthood,[4] and rapid weight gain and metabolic abnormalities being most notable early in the course of mental illness treatment,[5] there are international calls for early physical health intervention for people with mental illness.[6] A recent systematic review found a large number of studies exploring dietary intake in adults with enduring severe mental illness;[3] however, there was a lack of high-quality studies, using validated tools, to assess dietary intake. The review also presented a clear gap in studies assessing dietary intake in people with first-episode psychosis (FEP), people at ultra-high risk of developing psychosis (UHR) and young people with high-prevalence mental illness (depression or anxiety).

Potential drivers of unhealthy dietary intake, such as food addiction (a measure of addictive-like eating behaviour based on the diagnostic criteria for substance dependence) and nutrition knowledge, remain unexplored in young

S.B. Teasdale, BNutrDiet, APD, Senior Mental Health Dietitian
T.L. Burrows, PhD, Associate Professor
T. Hayes, MNutrDiet, APD
C.Y. Hsia, MNutrDiet, APD
A. Watkins, MN, Clinical Nurse Consultant
J. Curtis, MBBS, Director of Youth Mental Health
P.B. Ward, PhD, Professor
Correspondence: S.B. Teasdale, Keeping the Body in Mind Program, 26 Llandaff Street, Bondi Junction, Sydney, NSW 2022, Australia.
Email: scottbteasdale@gmail.com

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people with mental illness. One study in people with mental illness found lower levels of nutrition knowledge coinciding with poor dietary intake;[7] and food addiction is thought to be highly prevalent in severe mental illness.[8] In addition, a recent meta-analysis found a positive correlation between depression, anxiety and food addiction.[9] However, to the authors' knowledge, neither has been examined in the populations targeted in this study.

This study aimed to describe the dietary intake, prevalence of food addiction and level of nutrition knowledge in young people with mental illness and test for between-group differences in those experiencing: (i) FEP, (ii) UHR and (iii) depression and/or anxiety.

Methods

This was a three-arm cross-sectional study completed at two sites: Bondi Junction Community Health Centre and Headspace Bondi Junction, within the South Eastern Sydney Local Health District mental health service, NSW Australia. A mental health dietitian or student dietitian completed assessments at each site. Written informed consent was obtained from each participant prior to conducting the assessment. Participants were reimbursed with a $20 gift voucher on completion of the assessment. This study received ethical approval from the South Eastern Sydney Local Health District Human Research Ethics Committee (17/213). This study was reported using the Strengthening the Reporting of Observational Studies in Epidemiology—Nutritional Epidemiology guidelines.[10]

Eligible participants were recruited from the youth mental health services within the South Eastern Sydney Local Health District. Inclusion criteria were as follows: aged between 16 and 25 years, with a clinician-confirmed diagnosis of either FEP (study arm 1), UHR (study arm 2) or depression/anxiety (study arm 3). Exclusion criteria were: (i) history of an eating disorder and (ii) previous exposure to the nutritional services of the physical health program (Keeping the Body in Mind) that is available to service users.

Participant's self-reported demographic details including gender, highest education level achieved and previous nutrition education. The mental health dietitian or student dietitian collected anthropometric data, including height, weight, body mass index (BMI), blood pressure and waist circumference, using standardised procedures. Participants were weighed without shoes and wearing light clothing on the OMRON HN-283 digital scale to the nearest 0.1 kg. Height was measured with shoes off, using a wall-mounted stadiometer to the nearest 0.1 cm. BMI was calculated as weight/height^2, with participants characterised according to the World Health Organization cut-off values.[11] Blood pressure was measured on the left arm in a seated position using an OMRON automatic sphygmomanometer. Waist circumference was measured horizontally at the navel at the end of expiration to the nearest 0.1 cm. Waist circumference was categorised as 'at-risk' according to International Diabetes Federation criteria for Europids.[12]

During the onsite consultation using a health service computer, participants self-completed the Australian Eating Survey (AES), a 120-item, semi-quantitative, online food frequency questionnaire that has been validated against objective biomarkers,[13,14] for use in the Australian population. Participants were able to ask the dietitian or student dietitian for assistance when completing the AES.

The AES assesses usual dietary intake over the past 6 months, with responses ranging from 'never' to 'four or more per day', and a response is required for each question to progress through and complete the AES. Foods were based on those most commonly consumed by Australians and are grouped into two broad categories: core foods and discretionary foods, as per the Australian Guide to Healthy Eating.[15] Portion sizes were based on adults for all participants in this study.

The AES provides mean daily intakes for total energy (kJ), core foods (%) and discretionary foods (%), including subcategories, macronutrients (g, %) including subcategories and a range of micronutrients, calculated using the Australian Food, Supplement and Nutrient Database 1999 database. The Goldberg equation[16] was used to determine implausible intakes, with participants considered underreporting if Estimated Energy Intake to Basal Metabolic Rate ratio was <0.9.

Diet quality was assessed using the Australian Recommended Food Score (ARFS), a validated measure of diet quality in the Australian population,[17] generated from responses to the AES, which has a maximum score of 73. Higher ARFS scores are representative of a diet more aligned to the Australian Dietary Guidelines.[15] Scoring categories for the ARFS are as follows: needs work (<33), getting there (33–38), excellent (39–46) and outstanding (47+).

Food addiction was assessed using the Yale Food Addiction Scale 2.0.[18] The Yale Food Addiction Scale 2.0 is a 35-item tool, which assesses the presence of 11 symptoms in addition to clinical distress and categorises participants based on severity into 'mild' (≥3 symptoms plus clinical distress), 'moderate' (4–5 symptoms plus clinical distress) and 'severe' (6+ symptoms plus clinical distress) food addiction. Those with <2 symptoms and/or do not have clinical distress are considered to not have food addiction. Symptoms include tolerance, withdrawal and loss of control with respect to eating behaviour. Food addiction questions were asked prior to food-based questions so they were not prompted to think about any foods in particular.

A modified General Nutrition Knowledge Questionnaire-Revised (GNKQ-R) was utilised to assess nutrition knowledge. The GNKQ-R was assessed for reliability and construct validity in the UK population.[19] The original GNKQ also underwent validation in the UK population;[20] however, a modified version, which altered question terminology, has been validated in the Australian population.[21] A modified GNKQ-R was utilised in this study, with altered terminology in line with the changes incorporated in the GNKQ validation study in the Australian population. In total, seven alterations were made to the GNKQ-R to reflect

current dietary guidelines for Australians and current public health nutrition recommendations. Alterations included: five substitutions of common UK food names or items with items more familiar to the Australian community, one change in a multiple-choice option to reflect Australian dietary guidelines and one modification in the correct answer to the main type of fat found in one food item.

The modified GNKQ-R consisted of 88 items in four sections: current dietary recommendations (18 items), food sources of nutrients (36 items), food choices (13 items) and diet–disease relationships (21 items). Each correct answer receives one point, which results in a total possible score of 88. A higher score reflects a higher knowledge level. The questionnaire was self-completed, and participants had the option to select 'not sure' for each question.

Descriptive statistics were calculated as mean and standard deviation for all continuous anthropometric (height, weight, BMI, waist circumference, blood pressure) and demographic variables; nutrient intakes; and scores for nutrition knowledge, food addiction and diet quality. A Shapiro–Wilk analysis was run as a test of normality. One-way analysis of variance with least significant difference was run on normally distributed data, and Kruskal-Wallis tests with pairwise comparisons were run to assess between-group differences for non-normally distributed data. An independent samples t-test was run to compare reported energy intake for all people prescribed a therapeutic dose of antipsychotic medication (APM) compared to those who were not, irrespective of diagnostic group.

Proportions of categorical variables (gender, BMI category, waist circumference category, education, nutrition education, medication use, nutrition recommendations met) were calculated via cross-tabulation. Chi-square tests were not calculated as cell counts were less than five. Statistical significance was set at $P < 0.05$. For multiple dietary intake analyses, a Bonferroni correction was utilised, and statistical significance was adjusted to $P < 0.001$. All statistical analyses were calculated using SPSS v24 (Chicago, IL, USA).

Results

Thirty participants consented to participate in the study and were included in the analysis: FEP (n = 10), UHR (n = 10) and depression/anxiety (n = 10). Two additional participants consented to participate but did not complete all questionnaires and were excluded. Of the 30 included participants, 22 (73%) were males, and the mean age of the total sample was 19.3 ± 4.3 years (Table 1). All participants within the FEP study arm were prescribed therapeutic doses of APMs, whereas two participants in the UHR study arm and none in the depression/anxiety arm were prescribed therapeutic doses of APMs. One participant in the depression/anxiety arm was prescribed a non-therapeutic dose of quetiapine (50 mg per day) to aid sleep. A range of mood stabiliser and antidepressant medications was also prescribed. Socio-demographic, diagnostic and treatment details are presented in Table 1.

Mean BMI was 25.3 ± 5.3 kg/m^2, with 20 participants (67%) having a healthy BMI, 5 participants (16.5%) in the overweight range and 5 participants (16.5%) in the obese range. The mean waist circumference for males was 85.8 ± 9.0 cm and for females was 95.1 ± 17.6 cm. There was a statistically significant between-group difference for mean waist circumference scores ($F(2) = 5.8$, $P < 0.01$), with participants with FEP being significantly higher than those with depression/anxiety (mean difference = 16.2 ± 4.8, $P = 0.002$). Eleven participants (37%) were within the at metabolic risk waist circumference range. Mean blood pressure was 124 ± 15 mmHg (systolic) and 77 ± 9 mmHg (diastolic). There were no statistically significant between-group differences for either systolic ($F(2) = 0.84$, $P = 0.45$) or diastolic blood pressure ($F(2) = 0.1$, $P = 0.9$).

Five participants reported implausible intakes and were excluded from the dietary analysis (FEP n = 2, UHR n = 2, depression/anxiety n = 1), leaving 25 participants included for analysis. Two participants requested assistance from the outset; however, the majority asked the assessor questions during the completion of the survey because of the complex nature of comprehensive dietary assessment methodology. The results of the dietary analysis are presented in Table 2. Mean energy intake was numerically higher in people with FEP compared to people at UHR and those with depression/anxiety—2378 ± 2377 kJ/day and 2556 ± 2446 kJ/day, respectively. These differences are clinically important although not statistically significant in this sample. People prescribed therapeutic doses of APMs reported significantly higher energy intakes compared to those who were not (mean difference = 3926 kJ/day, 95% CI −7732 to −120; $t(23) = -2.1$, $P = 0.04$). The proportion of energy from discretionary foods was above national recommendations across all three study arms, FEP = 47%, UHR = 43% and depression/anxiety = 38%. These numerical differences were not statistically significant. Mean diet quality score was 33.5 ± 11.8 of 73 (46%), with the lowest mean score found in the UHR group. Numerical differences in macro- and micronutrients between study arms were not statistically significant; however, numerical differences largely reflected the overall increased food intake observed in people with FEP.

Results of the food addiction and nutrition knowledge questionnaires are presented in Table 3. The prevalence of food addiction in the total sample was 37%, and mean food addiction symptoms were 3.3 ± 3.7. Five people in each of the FEP and UHR study groups met the criteria for food addiction, compared to one in the depression/anxiety group. Mean food addiction symptom scores were significantly higher in the FEP and UHR study arms compared to the depression/anxiety study arm ($F(2) = 3.6$, $P = 0.04$; FEP and depression/anxiety mean difference = 3.3 ± 1.5, $P = 0.04$; UHR and depression/anxiety mean difference = 3.7 ± 1.5, $P = 0.02$). The mean nutrition knowledge score was 50.5 ± 11.0 of 88 possible points (57%), and between-group differences were not statistically significant.

Table 1 Demographic details of participants

	Total (n = 30)	*FEP (n = 10)*	*UHR (n = 10)*	*Depression/ anxiety (n = 10)*	*Statistical test*	P *value*
Male (n)	22 (73%)	6	8	8		
Female (n)	8 (27%)	4	2	2		
Age (mean, SD)	19.7 ± 2.5	21.0 ± 2.6	19.8 ± 2.2	18.4 ± 2.3	*F* = 3.05	0.06
Education level (n)						
Year 9	1 (3%)	1	0	0		
Year 10	9 (30%)	2	2	5		
Year 12	13 (43%)	4	5	4		
Certificate 1–4	5 (17%)	2	2	1		
Bachelor degree	2 (7%)	1	1	0		
Previous nutrition education (n)						
None	17 (56%)	5	4	8		
Cooking classes	2 (7%)	1	1	0		
Consultation	6 (20%)	2	4	0		
Online course	5 (17%)	2	1	2		
Weight (mean kg, SD)	76.6 ± 16.3	86.5 ± 19.0	74.7 ± 15.5	68.5 ± 8.2	*F* = 3.77	**0.04**
BMI (mean kg/m^2, SD)	25.3 ± 5.8	29.5 ± 7.6	24.7 ± 3.9	21.8 ± 1.1	*F* = 6.31	**<0.01**
BMI classification (n)						
Normal	20 (67%)	4	6	10		
Overweight	5 (16.5%)	2	3	0		
Obese	5 (16.5%)	4	1	0		
Waist circumference (mean cm, SD)						
Male	85.8 ± 9.0	92.2 ± 10.8	85.1 ± 9.4	81.6 ± 3.5	*F* = 5.76	**<0.01**
Female	95.1 ± 17.6	102.9 ± 16.1	99.3 ± 18.1	75.3 ± 0.4		
Waist circumference classification (n)						
Not at increased risk	19 (63%)	3	6	10		
At increased metabolic risk	11 (37%)	7	4	0		
Blood pressure (mean mmHg, SD)						
Systolic	124 ± 15	127 ± 9	127 ± 23	120 ± 7	*F* = 0.84	0.45
Diastolic	77 ± 9	76 ± 8	78 ± 12	77 ± 8	*F* = 0.10	0.90
Psychotropic medications (n)						
Antipsychotic (second-generation)						
Therapeutic dose	12 (40%)	10	2	0		
Non-therapeutic dose	1 (3%)	0	0	1		
Mood stabiliser	4 (13%)	1	2	1		
Antidepressant	13 (43%)	2	4	7		
Benzodiazapine	1 (3%)	1	0	0		

Statistically significant between group differences are highlighted in boldface.
BMI, body mass index; FEP, first-episode psychosis; UHR, ultra-high risk for psychosis.

Discussion

This is the first study to comprehensively describe the dietary intake, prevalence of food addiction and nutrition knowledge in young people with mental illness. Given the growing focus on providing lifestyle interventions for people with mental illness, particularly in the early stages of illness, these findings will help shape the components of dietary intervention. The most relevant findings from this study were: (i) mean diet quality scores for the total sample was 33.5 ± 11.8 of 73; (ii) 43% of the energy consumed was from discretionary choices; and (iii) the prevalence of food addiction was 37%, more than twice that found in a meta-analysis of studies exploring food addiction across a range of cohorts.[9] Furthermore, 50% of each of the FEP and UHR studies met the criteria for food addiction.

The higher energy intakes in the FEP study arm, compared to UHR and depression/anxiety study arms, and higher energy intakes in those prescribed therapeutic dose APM reflect the wider literature.[3] Although the difference in intake between those with FEP and the UHR and depression/anxiety groups was not statistically significant, this was likely driven by the small sample size in each study arm. The higher energy intake in FEP group is similar to a cross-over randomised controlled trial (RCT) for the initiation of an APM, which found a mean increase in energy intake of 2286 kJ/day when receiving APM[22] and is reflective of the rapid weight gain that occurs in the early stages of

Table 2 Dietary intake of young people with mental illness after adjusting for underreporting

	Total (n = 25)	*FEP (n = 8)*	*UHR (n = 9)*	*Depression/ anxiety (n = 8)*	*Statistical test*	P *value*
Energy intake (kJ/d, SD)	12 153 ± 4829	13 826 ± 4355	11 449 ± 5463	11 270 ± 4706	*F* = 0.7	0.51
Diet quality						
Core foods (% of energy intake)	57 ± 16	53 ± 14	57 ± 19	62 ± 16	*F* = 0.9	0.62
Discretionary foods (% of energy intake)	43 ± 16	47 ± 14	43 ± 19	38 ± 16	*F* = 0.9	0.62
ARFS[17] (maximum score); (mean, SD)	33.5 ± 11.8	34.1 ± 15.5	30.3 ± 9.7	36.5 ± 10.5	*F* = 2.0	0.39
Vegetable (21 points)	11.1 ± 5.1	9.8 ± 4.2	11.2 ± 5.4	12.3 ± 5.8	*F* = 1.1	0.57
Fruit (12 points)	4.7 ± 3.1	4.8 ± 4.6	3.4 ± 2.4	6.0 ± 1.3	*F* = 3.6	0.21
Meat, chicken, fish (7 points)	3.3 ± 1.5	3.8 ± 1.3	3.3 ± 1.6	2.8 ± 1.8	*F* = 1.4	0.48
Vegetarian choices[(a)] (6 or 12 points)	2.4 ± 1.6	2.6 ± 1.8	2.1 ± 1.8	2.6 ± 1.2	*F* = 0.7	0.67
Grains (13 points)	5.9 ± 2.1	6.4 ± 2.7	5.0 ± 1.5	6.4 ± 2.1	*F* = 2.7	0.30
Dairy (11 points)	4.2 ± 2.3	4.6 ± 3.1	3.7 ± 2.1	4.3 ± 1.6	*F* = 0.4	0.81
Condiments (2 points)	1.3 ± 0.7	1.6 ± 0.5	0.8 ± 0.7	1.5 ± 0.8	*F* = 6.7	0.04
Water (1 point)	0.7 ± 0.5	0.5 ± 0.5	0.8 ± 0.4	0.8 ± 0.5	*F* = 1.7	0.42
Macro- and micronutrients						
Protein (g)	135 ± 70	160 ± 65	129 ± 87	117 ± 55	*F* = 3.1	0.20
Fat (g)	108 ± 51	124 ± 44	99 ± 60	100 ± 49	*F* = 2.1	0.33
Saturated (g)	46 ± 23	52 ± 20	42 ± 25	44 ± 25	*F* = 2.0	0.37
Polyunsaturated (g)	14 ± 6	16 ± 6	12 ± 7	12 ± 5	*F* = 3.5	0.16
Monounsaturated (g)	39 ± 19	46 ± 16	36 ± 23	36 ± 17	*F* = 2.5	0.28
Cholesterol (mg)	447 ± 263	506 ± 213	441 ± 312	394 ± 271	*F* = 2.4	0.31
Carbohydrate (g)	317 ± 122	362 ± 111	284 ± 113	310 ± 142	*F* = 2.9	0.20
Sugar (g)	153 ± 64	174 ± 69	137 ± 52	150 ± 73	*F* = 1.7	0.42
Fibre (g)	31 ± 11	33 ± 12	27 ± 11	33 ± 10	*F* = 2.3	0.31
Alcohol (g)	12 ± 25	7.5 ± 11.9	23 ± 39	5 ± 7	*F* = 0.5	0.80
Water (ml)	3311 ± 1033	3562 ± 840	3300 ± 1386	3072 ± 787	*F* = 1.0	0.58
Thiamine (mg)	2.1 ± 1.0	2.4 ± 1.0	2.0 ± 1.2	2.0 ± 1.0	*F* = 3.0	0.24
Riboflavin (mg)	2.9 ± 1.4	3.2 ± 1.1	3.0 ± 1.9	2.7 ± 1.1	*F* = 1.0	0.60
Niacin equiv. (mg)	30.9 ± 14.6	68.2 ± 25.4	56 ± 36	50 ± 23	*F* = 3.1	0.19
Folate (μg)	367 ± 141	370 ± 116	393 ± 190	334 ± 106	*F* = 0.3	0.83
Vitamin C (mg)	150 ± 60	150 ± 68	155 ± 60	145 ± 60	*F* = 0.3	0.88
Vitamin A (μg)	1375 ± 709	1165 ± 568	1683 ± 912	1237 ± 506	*F* = 2.2	0.29
Sodium (mg)	3064 ± 1499	3591 ± 1275	2978 ± 1903	2634 ± 1184	*F* = 2.7	0.32
Potassium (mg)	4177 ± 1639	4708 ± 1585	3918 ± 2079	3938 ± 1136	*F* = 3.3	0.18
Magnesium (mg)	474 ± 159	517 ± 156	457 ± 202	449 ± 114	*F* = 1.9	0.41
Calcium (mg)	1351 ± 598	1366 ± 505	1360 ± 803	1324 ± 483	*F* = 0.2	0.90
Phosphorus (mg)	2154 ± 1026	2453 ± 901	2089 ± 1308	1927 ± 821	*F* = 1.8	0.44
Iron (mg)	17.3 ± 7.0	19.0 ± 7.1	17.2 ± 8.9	15.7 ± 4.6	*F* = 1.3	0.54
Zinc (mg)	17.2 ± 8.7	20.0 ± 9.0	16.3 ± 10.3	15.3 ± 6.8	*F* = 2.5	0.31

Note: Statistical significance for differences in dietary intake was set at $P < 0.001$ after applying the Bonferroni correction.
[(a)] For vegetarians, the points in the 'vegetarian choices' category are doubled.
ARFS, Australian Recommended Food Score; FEP, first-episode psychosis; UHR, ultra-high risk for psychosis.

treatment for psychotic illness.[5] The energy intake difference in the FEP group was considerably higher than the energy intake in the general population aged 19–30 years, with a mean intake of 11 004 kJ/day for males and 7863 kJ/day for females.[23]

Discretionary food intake was substantially above the 15% of energy intake upper limit for all three study arms. The proportion of energy from discretionary foods was notably higher in the FEP (47%) and UHR (43%) cohorts compared to the general population (35%)[23] and should be examined further in larger studies as a potential independent risk factor for diabetes, cardiovascular disease and other non-communicable diseases. This high intake may be attributed to a number of reasons, including both the impact of the illness itself (executive performance and negative symptoms)[24] and side effects of psychotropic

Table 3 Food addiction and nutrition knowledge scores across study participants

	Total (n = 30)	*FEP (n = 10)*	*UHR (n = 10)*	*Depression/ Anxiety (n = 10)*	*Statistical test*	P *value*
Food addiction						
Symptom 1: Substance taken in larger amount and for longer period than intended	13 (43%)	5	8	0		
Symptom 2: Persistent desire or repeated unsuccessful attempts to quit	9 (30%)	4	4	1		
Symptom 3: Much time/activity to obtain, use, recover	11 (37%)	5	6	0		
Symptom 4: Important social, occupational, or recreational activities given up or reduced	9 (30%)	3	4	2		
Symptom 5: Use continues despite knowledge of adverse consequences	9 (30%)	3	5	1		
Symptom 6: Tolerance (marked increase in amount; maked decrease in effect)	7 (23%)	3	3	1		
Symptom 7: Characteristics withdrawal symptoms; substance taken to relieve withdrawal	13 (43%)	6	3	4		
Symptom 8: Continued use despite social or interpersonal problems	9 (30%)	5	4	0		
Symptom 9: Failure to fulfil major role obligation (e.g. work, school, home)	6 (20%)	3	3	0		
Symptom 10: Use in physically hazardous situations	7 (23%)	4	2	1		
Symptom 11: Craving, or a strong desire or urge to use	7 (23%)	2	5	0		
Symptom 12: Use causes clinically significant impairment or distress	11 (37%)	5	5	1		
Mean total symptom score	3.3 ± 3.7	4.3 ± 3.7	4.7 ± 4.2	1.0 ± 1.6	$F = 3.6$	**0.04**
Meets food addiction criteria	11 (33%)	5	5	1		
Food addiction category						
Severe	8 (27%)	3	5	0		
Moderate	2 (7%)	1	0	1		
Mild	1 (3%)	1	0	0		
None	19 (63%)	5	5	9		
Nutrition knowledge						
GNKQ section 1: Dietary recommendations	10.5 ± 2.5	10.7 ± 2.9	9.8 ± 2.1	11.0 ± 2.5		
GNKQ section 2: Food groups	20.5 ± 4.6	20.0 ± 5.9	20.4 ± 3.0	21.2 ± 4.9		
GNKQ section 3: Healthy food choices	7.8 ± 2.9	7.2 ± 3.5	7.9 ± 2.6	8.4 ± 2.8		
GNKQ section 4: Link between diet and ill health	11.6 ± 3.3	10.3 ± 3.3	11.4 ± 2.8	13.1 ± 3.4		
Total GNKQ score	50.5 ± 11.0	48.2 ± 13.8	49.5 ± 8.2	53.7 ± 10.7	$F = 0.66$	0.52

Note: Statistically significant between group differences are highlighted in boldface.
FEP, first-episode psychosis; GNKQ, General Nutrition Knowledge Questionnaire; UHR, ultra-high risk for psychosis.

medications,[22] as well as less well-documented factors, such as financial constraints and food insecurity.[25]

Food addiction is an evolving field. Although it is not a Diagnostical and Statistical Manual of Mental Disorders diagnosis,[26] there is a higher prevalence in those with mental illness, which may be attributed to psychiatric symptoms, such as low mood, or exacerbated by psychotropic medications. Although this is unclear given that food is consumed for a variety of reasons including social and emotional reasons, interventions should consider behaviour change and more specific interventions, such as combined psychological and dietetic approaches, around addictive overeating.

Nutrition knowledge scores were broadly similar to scores found in other cohorts,[20,27] suggesting that nutrition knowledge may not be the primary driving factor leading to unhealthy dietary intakes found in this study. However, this study provided some preliminary evidence that nutrition knowledge scores are lower in people with more severe mental illness (FEP compared to depression/anxiety). These between-group differences may have been statistically significant in a larger sample size.

Limitations of this study are acknowledged. First, the small sample size limited the ability to demonstrate statistically significant between-group differences. For example, the numerical dietary energy differences are clinically

relevant and are in line with the wider literature, with APM increasing dietary energy intake, and could contribute to the BMI and waist circumference differences observed in those with FEP compared to high-prevalence mental illnesses. In addition, the sample size limits the ability to generalise these findings for all young people living with these disorders.

Second, as is the case for the majority of methods to assess dietary intake, food addiction and nutrition knowledge, the assessment tools used in this study were subjective, which may have reduced accuracy. It is, however, reassuring to note that the findings for dietary energy (highest in FEP), food addiction (high rates in FEP and UHR) and nutrition knowledge (lowest in FEP) suggest the greatest cardiometabolic risk in psychotic illness, which is in line with the wider literature (higher intakes of energy and higher rates of obesity). In addition, measures were taken to improve the accuracy of reporting and account for implausible intakes.

Third, factors such as social environment, psychotropic medications assessed on an individual level and medications other than psychotropic medications were not explored in this study and should be considered in larger studies.

The Healthy Active Lives (HeAL) international consensus statement (www.iphys.org.au) lists dietary intervention as a core component of care for young people with psychosis.[6] Dietary intervention has been found to be more effective in the early stages of FEP as a preventative measure compared to intervention delivered to those with established and enduring severe mental illness.[28] Furthermore, as all study arms had a relatively poor diet quality and unhealthy dietary patterns, dietary intervention should be considered for people at UHR or with high-prevalence mental illness, with dietitians best placed to deliver these interventions.[29] Recent RCTs have demonstrated that improving diet quality improved symptoms of depression.[30]

Future studies with larger sample sizes are needed to explore food addiction, nutrition knowledge and dietary intake. Specific dietary and psychological methods may be required to increase the effectiveness of lifestyle interventions in people with serious mental illness.

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Conflict of interest

The authors have no conflicts of interest to declare.

Authorship

ST, PW, JC, AW and TB conceived and designed the study and obtained ethical approval. ST, TH and CH collected and analysed data with assistance from PW, JC, AW and TB. ST led the initial and subsequent draft manuscripts. All authors reviewed the manuscript content and approved the final version. The authors thank colleagues from the Bondi Junction Community Health Centre and headspace Bondi Junction for their assistance with this project and Dr Fiona O'Leary for providing academic supervision to student dietitians. Tracy Burrows is supported by University of Newcastle Brawn Research Fellowship.

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ORIGINAL RESEARCH

Associations between breastfeeding rates and infant disease: A survey of 2338 Czech children

Petra PARIZKOVA,[1] Nika DANKOVA,[1,2] Pavel FRÜHAUF,[3] Jitka JIRECKOVA,[3] Jiri ZEMAN[3] and Martin MAGNER[3]

[1]Czech Society of Midwives and Departments of [2]Obstetrics and Gynaecology and [3]Paediatrics and Adolescent Medicine, First Faculty of Medicine, Charles University and General University Hospital in Prague, Czech Republic

Abstract

Aim: Evidence has demonstrated that breastfeeding is the optimal nutrition for infants. The present study aims to report possible associations of the duration of full or partial breastfeeding with selected health outcomes during infancy.

Methods: Data from 2304 mothers were obtained by online mother-reported questionnaires at the age of 1 year of the child, providing information on full and partial breastfeeding durations, the frequency of infant upper respiratory tract infections and possible antibiotics use, and the occurrence of allergic diseases.

Results: Overall breastfeeding initiation rates (i.e. including both partial and full breastfeeding rates counted together) were 97.8%, declined to 95.1% at the age of 3 months, and remained as high as 90.0% at 6 months. At 1 year, 74.7% of children were still partially breastfed. There was no significant benefit of either full or partial breastfeeding over formula feeding for upper respiratory tract infection rates. Fully breastfed children had a significantly lower risk of early exposure to antibiotics when compared with either partially breastfed (odds ratio, OR: 0.74; 95% CI: 0.56, 1.00, $P = 0.048$) or formula-fed (OR: 0.67; 95% CI: 0.46, 1.0, $P = 0.047$) children. We found a neutral effect of breastfeeding on the development of allergies.

Conclusions: Although no significant association between either full or partial breastfeeding versus formula feeding and the occurrence of respiratory infections during infancy was found, we demonstrated a significantly lower risk of early exposure to antibiotics in fully breastfed children when compared with those either partially breastfed or formula-fed.

Key words: allergic disease, antibiotic use, full and partial breastfeeding rates, upper respiratory tract infection.

Introduction

The presence of mammary glands is a characteristic feature of all mammals, including humans, and breastfeeding is a natural part of the human reproductive cycle. The current World Health Organisation recommendations are for full breastfeeding for 6 months and continued partial breastfeeding to 2 years.[1,2] Recent global analyses have shown that breastfeeding initiation exceeds 90% in nearly all countries, but that the rates of full breastfeeding decline below 50% by the age of 6 months.[1] The overall prevalence of children still breastfed at 1 year is lower than 20%; however, the numbers broadly vary. According to data of the Institute of Health Information and Statistics of the Czech Republic (IHISCR) collected from reports of general paediatric physicians, there was an increase of breastfeeding rates from 2007 to 2015 from 16.3% to 50.7% at 6 months of life, 15% of Czech children were still breastfed at the age of 1 year in 2015 and only 4.9% were not breastfed at all.[3] For comparison, in the UK, the prevalence of breastfeeding at 1 year is below <1%, but is higher, for example, in Norway (35%) and Sweden (16%).[4]

It is widely accepted that human breast milk is a perfectly adapted nutritional supply for the infant. The nutritional advantages of breastfeeding and its protection against infection have been thoroughly investigated.[1,2,5–7] Breast milk contains a wealth of immunologic factors with a strong impact on the nasopharyngeal microbial community composition,[7] and there is support in the literature for a protective effect of breastfeeding against respiratory illness and infections.[2,8,9] However, other studies have found limited or the very limited evidence of a protective effect of

P. Parizkova, Nurse
N. Dankova, Nurse
P. Frühauf, PhD, MD, Paediatrician
J. Jireckova, MD, Paediatrician
J. Zeman, PhD, MD, Paediatrician
M. Magner, PhD, MD, Paediatrician
Correspondence: M. Magner, Department of Paediatrics and Adolescent Medicine, First Faculty of Medicine, Charles University and General University Hospital in Prague, Ke Karlovu 2, 120 00 Prague 2, Czech Republic. Tel.: +420-224967792; fax: +420-224911453.
Email: martin.magner@vfn.cz

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breastfeeding against all types of respiratory illnesses during the first 2 years of life, although the data suggest that extended breastfeeding (>6 months) might protect against bronchiolitis[10] or reduce the severity and duration of respiratory illnesses.[11] The few studies assessing the effect of full breastfeeding in terms of exposure to antibiotics during infancy have concluded that artificial formula use significantly increases the odds of early antibiotic use.[12,13]

Breastfeeding has also been suggested to prevent the development of allergic disease, but this relationship remains controversial.[2,14–17] The data regarding allergy prevention are conflicting, and recent publications on breastfeeding have provided mixed results on atopic disease and asthma.[15,18–20] There is no definitive evidence that breastfeeding prevents sensitisation to allergens in infants or the development of asthma; however, according to some studies exclusive breastfeeding for at least 4 months seems to protect against the development of atopic dermatitis and early childhood wheezing,[21] possibly by altering the child's gut microbiome and immune development.[15,19] According to other authors,[22–24] breastfeeding may induce the development of some allergies.

The purpose of the present study was to examine associations of partial and full breastfeeding at 0, 3 and 6 months with the occurrence of respiratory disease, allergic disease and the use of antibiotics in infancy.

Methods

A total of 2375 women from all regions of the Czech Republic who had a delivery date from January to December 2016 and provided the maternity ward with an email contact on a voluntary basis were sampled for this cross-sectional study. Data were gathered using maternal recall questionnaires sent by email at the age of 1 year of the child.

The questionnaire asked mothers the type of infant feeding used at birth, and then at 3, 6 and 12 months of the child's age, classifying the feeding as either full breastfeeding, partial breastfeeding (combined breastfeeding and formula feeding) or formula feeding only.[25] Thus, for instance, it was possible for an infant to be partially breastfed at birth, but then fully breastfed at later dates if formula was discontinued. The duration of breastfeeding was then categorised as initiated (started at birth), breastfed for 3, 6 or 12 months of the child's age, with data collected separately for full and partial breastfeeding.

The mothers were asked whether their child had suffered from an upper respiratory tract infection (URI) in the first year of their life and if antibiotics had been prescribed for this or any other reason. The frequency of allergies including to cow's milk, other food allergies and eczema, was also assessed at the age of 12 months of the child. The questionnaires further included the following covariates: maternal age, delivery mode, parity, the child's sex and maternal educational level (recorded as (i) primary, (ii) secondary and (iii) tertiary).

A descriptive analysis was performed for sample background characteristics. For categorical variables, a chi-squared test was performed. The Kruskal–Wallis H test was used to test for differences between the groups. An association with potential confounders was performed by the odds ratio (OR).[26] The results are reported as ORs and 95% CIs, and are based on two-sided tests. A P-value <0.05 was considered as statistically significant. Statistical analyses were carried out using SigmaStat 3.5 for Windows (SPSS Inc., Chicago, Illinois).

The study was approved by the ethical review board of the General University Hospital in Prague (1256/17). Mothers expressed their consent with participation by taking part in the study on the website, which had detailed information about the project.

Results

At the children's age of 1 year, we sent questionnaires to 2375 mothers, and received 2304 responses (97% of the initial cohort). This represents 2.045% of 112 663 children who were born in the Czech Republic in 2016.[26] Maternal and child characteristics and feeding patterns are presented in Table 1. The majority of children were born from mothers of the age groups 25–29 (39.7% of children) and 30–34 (37.8% of children) years. Children mostly came from a singleton pregnancy (98.5%) of primiparous women (68.8%), and were delivered at term (66.7%). Up to three quarters (70.2%) of children were vaginally delivered. Of the mothers who responded, about 6 in 10 (60.1%) had a tertiary education.

The data on feeding patterns revealed a high prevalence of fully breastfeeding mothers within the first 6 months after birth. 82.6% of mothers reported initiating full breastfeeding after birth. The percentage of fully breastfeeding mothers further increased at the age of 3 months (up to 87.3%), and then declined to 67.1% at the age of 6 months. At 1 year of age, about three quarters of children were still partially breastfed (74.7%).

Associations between maternal education and feeding patterns were also examined. At the time of initiating breastfeeding, there was no association between education level and likelihood to breastfeed. However, mothers with tertiary education were more likely to either partially or fully breastfeed their infants at the age of 3 months than those with secondary (OR: 1.69; 95% CI: 1.12, 2.56, P = 0.01) or primary education (OR: 3.23; 95% CI: 1.72, 5.88, P = 0.0002). Similarly, at the age of 6 months, mothers with tertiary education breastfed their children more often than those with secondary education (OR: 1.43; 95% CI: 1.04, 1.96, P = 0.03) or primary education (OR: 2.7; 95% CI: 1.63, 4.54, P = 0.0001). At the age of 12 months, mothers with tertiary education showed significantly lower odds of ceasing partial breastfeeding when compared to those with primary education (OR: 0.57; 95% CI: 0.38, 0.87, P = 0.008). However, we observed no significant differences in the odds of using no form of breastfeeding between mothers with tertiary and secondary

Table 1 Characteristics of the study population in this cross-sectional study of breastfeeding rates and infant disease in the Czech Republic

Maternal characteristics					
N	2304				
Maternal age, years (mean ± SD)	29.9 ± 4.4				
Maternal age groups, years	<24	25–29	30–34	35–39	>40
N	203	915	871	277	38
% of N	8.8	39.7	37.8	12.0	1.6
Maternal education	Primary	Secondary	Tertiary		
N	128	792	1384		
% of N	5.6	34.4	60.1		
Parity	1	2	3	4	
N	1585	563	128	28	
% of N	68.8	24.4	5.6	1.2	
Type of pregnancy	Singleton pregnancy	Twin pregnancy			
N	2269	35			P = <0.001
% of N	98.5	1.5			
Delivery mode (total 2304)	Vaginal	Caesarean section	Vacuum extraction	Forceps delivery	
N	1618	601	64	21	P = <0.001
% of N	70.2	26.1	2.8	0.9	
Child characteristics					
N	2338				
Child sex	Boys	Girls			
N	1200	1138			
% of N	51.3	48.7			
Gestational age at birth	<34	34–37		38–42	
N	36	218		2050	
% of N	1.5	9.5		89.0	

	Feeding patterns			
% of N	*Breastfeeding initiation*	*At 3 months*	*At 6 months*	*At 12 months*
Full breastfeeding	82.6	87.3	67.1	0.0
Partial breastfeeding	15.3	6.8	22.9	74.7
Formula feeding	2.1	5.9	10.0	25.3

education at the age of 12 months (OR: 0.83; 95% CI: 0.66, 1.03, P = 0.09).

Out of 2338 children, about half of them suffered from at least one episode of an URI in the first year of life. Comparing the odds of particular feeding patterns at the age of 6 months, we found no significant benefit of either full or partial breastfeeding over formula feeding during the first 6 months for URI rates.

Furthermore, the relationship between breastfeeding patterns and the use of antibiotics for URI treatment was assessed. At the age of 6 months, about 11% of babies who were fully breastfed had been prescribed at least one course of antibiotics, compared to 14.4% of partially breastfed and 15.7% of formula-fed children. The odds of antibiotic exposure were almost equal for partially breastfed and formula-fed infants at the age of 6 months (OR: 0.91; 95% CI: 0.59, 1.39, P = 0.65). However, for fully breastfed children, our findings indicate a significantly lower risk of early exposure to antibiotics when compared with either partially breastfed (OR: 0.74; 95% CI: 0.56, 1.00, P = 0.048) or formula-fed (OR: 0.67; 95% CI: 0.46, 1.0, P = 0.047) children. This borderline but significant difference in antibiotic exposure was more marked at 12 months of age, when 31.5% of formula-fed children but only 20.2% of the partially breastfed group had received antibiotics. This represents a significantly lower risk of needing antibiotics in partially breastfed children (OR: 0.55; 95% CI: 0.45, 0.69, P < 0.0001) at 12 months.

The incidences of allergies in infants who were fully breastfed, partially breastfed and formula-fed at 6 months were 5.4%, 5.7% and 3.9%, respectively. There was no significant difference between the incidence of allergies in fully breastfed (OR: 1.41; 95% CI: 0.70, 2.84, P = 0.34) or partially breastfed infants (OR: 1.48; 95% CI: 0.70, 3.17,

P = 0.31), and formula-fed infants. There was no benefit of partial breastfeeding over formula feeding in 12-month-old children (OR: 1.05; 95% CI: 0.71, 1.54, P = 0.82).

Discussion

In the present study, we assessed feeding patterns in a population of 2304 Czech mothers and possible associations with URIs, the usage of antibiotics and the development of allergies.

Rates of overall breastfeeding initiation in the present study sample were 97.8%, including 82.6% full breastfeeding and 15.2% partial breastfeeding, similar to the data collected by the IHISCR and comparable with rates in some other countries.[2,3,27] At the age of 3 months, full breastfeeding rates increased up to 87.3%, with an overall breastfeeding rate of 95.1%, and only dropped to 67% (with an overall breastfeeding rate of 90.0%) by 6 months. This relatively high number of full breastfeeding rates in the present study population is in contrast to known Czech data (50% full or partial breastfeeding at 6 months according to the IHISCR in 2015).[28] We ascribe this apparent discrepancy to the high rate of tertiary-educated mothers in our survey (60.1% *vs* 31.7% in the general population between 25–29 years of age in the Czech Republic in 2015 according to the Czech Statistical Office).[28] College-educated mothers have been shown to exhibit higher rates of breastfeeding in our own and other studies.[2,27,29–32] A second important factor augmenting breastfeeding rates among the present study population may be related to the longer maternity leave in our country (28 weeks, compared to the Organisation for Economic Co-operation and Development (OECD) average of 19.1 weeks) followed by parental leave for another 134 weeks (OECD average of 65.7 weeks).[33,34] In addition, the average maternity financial compensation benefit in the Czech Republic, up to 70% of previous earnings, may be also of importance.

Our results are in accordance with those showing a limited benefit of breastfeeding on URIs. We did not find any significant beneficial contribution of either full or partial breastfeeding over formula feeding for URI rates during the first 6 months. On the other hand, we found a significantly lower risk of early exposure to antibiotics for fully breastfed children compared with either partially breastfed or formula-fed children at 6 months. In addition, children who were still partially breastfed at 12 months had a significantly lower risk of needing antibiotics than bottle-fed children. This is in agreement with the findings of Cushing *et al*. who found a breastfeeding-related reduction in the severity and duration of all respiratory illnesses.[11] In addition, other authors have shown that artificially fed infants are at greater risk of needing antibiotics to treat infections than breastfed infants.[12,13] Although few studies so far have examined the effects of breastfeeding on the exposure of infants to antibiotics for URI treatment, our results are in good concord with those studies, and add substantial data on the beneficial impacts of breastfeeding to this body of evidence. It must be kept in mind, however, that our data do not discriminate between antibiotic use for URIs and for other infections.

In the present study, we found no significant difference in the frequency of allergies between full or partial breastfed and formula-fed infants. We also did not observe any benefit of partial breastfeeding over formula feeding in 12-month-old children. Our data thus indicate a neutral effect of breastfeeding with respect to the manifestation of allergies.

The results of the present study have to be interpreted with caution because of several limitations: (i) the questionnaire was not validated; (ii) the high proportion of tertiary-educated mothers in the study sample; (iii) possible confounding factors of the parameters studied and (iv) the lack of some related information (e.g. previous parental allergic history, discrimination of antibiotic use).

In conclusion, our data revealed very high full breastfeeding rates at the age of both 3 and 6 months. We found no associations of breastfeeding with the development of allergies or upper respiratory infections in infants; however, we did find a lower risk of needing antibiotics in breastfed compared to formula-fed children.

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Conflict of interest

The authors declare no competing interests.

Authorship

This study was designed by PP and MM. The data were collected by PP and ND. MM, PF, JJ and JZ analysed the data. MM drafted the manuscript. All authors read and approved the final version of the manuscript.

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ORIGINAL RESEARCH

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Influence of dietary intake and decision-making during pregnancy on birth outcomes

Janelle M. James-McAlpine PhD[1,2] | Lisa J. Vincze PhD[3] | Jessica J. Vanderlelie PhD[4] | Anthony V. Perkins PhD[2]

[1]School of Nursing and Midwifery, Griffith University Logan Campus, Meadowbrook, Queensland, Australia

[2]School of Medical Science, Menzies Health Institute Queensland, Griffith University Gold Coast Campus, Southport, Queensland, Australia

[3]School of Allied Health Sciences, Menzies Health Institute Queensland, Griffith University Gold Coast Campus, Southport, Queensland, Australia

[4]The Judith Lumley Centre, La Trobe University, Bundoora, Victoria, Australia

Correspondence
Janelle M. James-McAlpine, School of Nursing and Midwifery, Griffith University Logan Campus, University Drive, Meadowbrook, QLD, Australia.
Email: j.james-mcalpine@griffith.edu.au

Abstract

Aim: This study aimed to examine dietary intake and decision-making in a cohort of pregnant South-East Queensland women to determine compliance with dietary guidelines and the relationships between dietary intake, decision-making and birth outcomes.

Methods: Pregnant women attending maternity services at participating hospitals reported food frequency and motivations using the Maternal Outcomes and Nutrition Tool, a novel digital instrument. Birth outcomes were sourced from hospital records. A cross-sectional cohort design was used to examine the data.

Results: Analysis demonstrated suboptimal intake of core food groups; meat and alternatives (median [IQR]) (2.6 [2.0-3.4] serves/day) and grains (3.1 [2.1-4.1]) fell below recommendations; fruit (3.8 [2.5-5.3]) and discretionary foods (3.1 [2.1-4.4]) exceeded them. Hypertensive disorders demonstrated a negative linear relationship with vegetable intake ($P = .017$). Cultural diversity was significantly associated with decreased birthweight ($P = .022$) but increased intake of meat and alternatives (3.1 vs 2.6, $P < .001$) compared to Caucasian women; median intake of meat and alternatives was lower in women who reported smoking in the examined time frame. Smokers were less likely to declare health motives for food selection than non-smokers; smoking and health were inversely associated with increasing maternal age. Food choice was primarily sensory-driven.

Conclusions: This cohort demonstrated poor adherence to dietary guidelines. Culturally and linguistically diverse women and smokers exhibit dietary behaviours which may contribute to suboptimal birth outcomes; targeted nutrition counselling may improve outcomes in these women. These findings highlight the need for transdisciplinary maternity care and provide a foundation for further research aimed at optimising nutrition-related birth outcomes in at-risk groups.

KEYWORDS

birth outcomes, cultural diversity, decision-making, diet, nutritional status, pregnancy

1 | INTRODUCTION

Suboptimal maternal diet is associated with poor perinatal outcomes,[1] outcomes common to populations from low-and middle-income countries.[2] However, a growing body of evidence highlights the associations between poor diet and suboptimal birth outcomes in high-income countries, including increased rates of caesarean section and macrosomia.[3] In Australia, states of over and undernutrition can influence perinatal outcomes, particularly in groups identified as exhibiting nutritional risk factors, including women who smoke,[4] are from cultural and linguistically diverse (CALD)[5] or low socio-economic backgrounds (SES). [6]

The Australian Dietary Guidelines for pregnant women indicate optimal dietary intake across five core food groups (meat and alternatives, vegetables and legumes, fruit, dairy and alternatives and grains) and discretionary foods (including those high in fat and sugar-energy-dense, nutrient-poor [EDNP] foods).[7] Compliance with these guidelines during pregnancy is traditionally poor,[8] with a maternal knowledge gap regarding dietary recommendations highlighted as a significant contributing factor.[8]

Several factors influence awareness of nutrition requirements during pregnancy. A variety of health disciplines contribute to primary maternity care, including general practitioners, midwives and obstetricians, each of which has limited access to specialised nutrition education.[9] Additionally, dietetic referrals during pregnancy are currently restricted to women with modifiable risk factors identified in Australia's clinical practice guidelines for pregnancy care,[10] such as gestational diabetes and obesity. These factors have resulted in inconsistent nutritional advice[11] in the context of uncomplicated pregnancy.[3]

Adding to these challenges is a paucity of knowledge surrounding maternal food selection motivations. These dietary behaviours are currently under-studied, yet their understanding is vital for the development of public health strategies targeting improved perinatal outcomes.[12] Therefore, addressing this research deficit is an essential step toward understanding how dietary motivations may influence the health of an infant at birth.[13]

This research aimed to collect and examine self-reported dietary intake and decision-making information from a cohort of pregnant South-East Queensland (SEQ) women in order to determine their adherence to dietary intake recommendations and the factors driving their dietary decision-making. Further, the study explored interactions between dietary intake, motivations, socio-cultural determinants of health and birth outcomes in this cohort.

2 | METHODS

This cross-sectional cohort study was approved by the Gold Coast Hospital and Health Service Human Ethics (HREC 16/QGC/70) and Griffith University Human Ethics Committees (HREC 2016/423). Pregnant women aged 16-44 years residing in South East Queensland attending antenatal clinics at the Logan, Beaudesert, Redlands, GCUH and Royal Brisbane and Women's Hospitals (RBWH) between 23 May 2016 and 30 September 2018 were the target population for this research. Women were provided with study information at routine visits by way of promotional material distributed and displayed by the clinics. All women attending hospital pathology centres at GCUH and RBWH for the Oral Glucose Tolerance Test at 26-28 weeks gestation on recruiting days were offered participation by the researcher. Women were not provided any dietary education prior to participation; information regarding daily intake was afforded after completion of data collection. Digital or written consent was required from all participants prior to participation.

Data were self-reported using the Maternal Outcomes and Nutrition Tool (MONT), a novel digital instrument whose design has previously been described elsewhere.[14] Adapted from the Norwegian Mother and Child (MoBa) Study,[15] Harvard,[16] the Block [17] and diet history questionnaires,[18] the MONT Food Frequency Questionnaires (FFQ) facilitate collection of data regarding 259 individual foods; additionally, demographic, health and birth outcome information is collected by the full survey set.

Food frequency for each of the food groups (vegetables and legumes, fruit, grain, meat and alternatives, dairy and alternatives and discretionary) were recorded for the month prior to participation. Each FFQ response was allocated a numerical value (Data S1), facilitating calculation of the average equivalent serves consumed by the respondent per day. Calculated totals were compared to the Australian Dietary Guidelines for pregnant women.[7] Respondents also declared the motives driving their food selection using the MONT food choice questionnaire, adapted for research in pregnancy from Steptoe, Pollard and Wardle's FCQ.[19] The food choice survey proposed the statement "I choose the foods I eat based on..." with participants able to select multiple responses from 21 available options (Data S2). Responses were classified into eight motives (health, mood, convenience, sensory appeal, natural content, price, weight control and familiarity) according to the original FCQ.[19] Birth outcomes were derived from each hospitals mandatory perinatal data reporting system.

Descriptive statistics were used to detail the cohort; maternal age (≤24, 25-29, 30-34, ≥35 years), parity

(nulliparous/multiparous), ethnicity (defined as identifying with an ethnicity other than Caucasian and/or birth in a traditionally non-English speaking country, including Indigenous Australian—dichotomous), education (did not attend/finish high school, finished high school, TAFE trade or apprenticeship, university degree), annual family income (<$50 k, $50-70 k, $70-120 k, >$120 k), currently smoking (dichotomous) and pre-pregnancy BMI (lean, ≤24.99 kg/m^2/overweight or obese, ≥25.00 kg/m^2). Calculated food group frequencies and declared food choice factors were analysed in relation to individual demographic groups and the cohort as a whole. Demographic variables were reported with mean (±SD); intake variables with median [25th-75th percentile]. Frequency of each health motive was also reported (n, % responses). Hypertensive disorders of pregnancy (HDP), gestational diabetes mellitus (GDM), preterm birth and birthweight constituted the examined outcomes. All variables were assessed for correlation with Pearson correlation analysis (r, *P* value); significant associations were examined with chi-square analysis (χ^2, df, *P* value). Significant relationships were subject to linear regression analysis (β, 95% CI, *P* value). Data were analysed using IBM SPSS version 25; significance was accepted at $P \leq .05$.

3 | RESULTS

Four hundred and thirty one women (28 ± 2 weeks gestation) participated in this research; 259 completed the full survey set (60%); descriptive groups have been detailed in Table 1. The calculated median energy intake of the cohort was 12 743 kJ/day (5925-33 970 kJ/day), a figure within the calculated requirements of pregnant women (7200-14 600 kJ/day).[20]

Suboptimal consumption of three of the five core food groups for pregnant women (19-50 years) was demonstrated; intake of meat and alternatives (2.6 [2.0-3.4] of 3.5 serves/day) and grains (3.1 [2.1-4.1] of 8.5 serves/day) were below recommendations; median fruit consumption was 90% above requirements (3.8 [2.5-5.3] vs 2 serves/day). Intake of vegetables and legumes (4.6 [3.6-5.9] of 5 serves/day) and dairy and alternatives (2.3 [1.5-3.0] of 2.5 serves/day) were the closest to meeting recommendations. Discretionary food intake (3.1 [2.1-4.4] serves/day) exceeded the limitations recommended by the Australian Dietary Guidelines (0-2.5 serves/day)[7] (Table 2).

Significant relationships were found between food groups and selection motives (Table 2); further correlations were found with dietary behaviours, demographic characteristics and birth outcomes. Women identifying as culturally and linguistically diverse reported a higher daily intake of meat and alternatives (3.1 vs 2.6 median serves/day; β = 0.488, 95%CI 0.232, 0.745, $P < .001$) and placed a lower emphasis on convenience (β = −0.339,

TABLE 1 Demographic characteristics of participants (n = 431)

Variable	n (%)
Mean gestation at recruitment (weeks, ± SD)	28 (± 2 weeks)
Mean age (years, ± SD)	29.9 (± 5.87)
Mean pre-pregnancy BMI (± SD)	25.15 (± 5.67)
Maternal age (years)	
< 24	47 (10.9)
25-29	69 (16.0)
30-34	71 (16.5)
≥ 35	50 (11.6)
Not declared	194 (45.0)
Annual household income (Australian dollars) (thousands)	
<50	115 (26.7)
50-70	75 (17.4)
70-120	124 (28.8)
>120	95 (22.0)
Not declared	22 (5.1)
Education	
< High school	54 (12.5)
Finished high school	94 (21.8)
TAFE trade or apprenticeship	96 (22.3)
University degree	165 (38.3)
Not declared	22 (5.1)
Ethnicity	
Caucasian	291 (67.5)
Cultural or linguistic diversity (ex ATSI)	101 (23.4)
Indigenous Australian	18 (4.1)
Not declared	21 (4.9)
Parity	
Nulliparous	171 (39.7)
Multiparous	241 (55.9)
Not declared	19 (4.4)
Smoker	
Yes	21 (4.9)
No	293 (68.0)
Not declared	117 (27.1)
Pre-pregnancy BMI (kg/ m^2)	
Lean (<25)	193 (44.8)
Overweight/obese (≥25)	130 (30.2)
Not declared	108 (25.1)

TABLE 2 Dietary recommendations during pregnancy (19-50 years); decision-making factors, median daily intake and chi-square analysis (n = 431)

		Meat and Alternatives	Grains	Fruit	Vegetables/ legumes	Dairy and alternatives	Discretionary
Decision-making factors	Recommended	3.5 serves/day	8.5 serves/day	2 serves/day	5 serves/day	2.5 serves/day	0-2.5 serves per day
	Median cohort intake (25th-75th centile)	2.6 (2.0-3.4)	3.1 (2.1-4.1)	3.8 (2.5-5.3)	4.6 (3.6-5.9)	2.3 (1.5-3.0)	3.1 (2.1-4.4)
Factor 1— Health	(χ^2, df, *P*)	157.845, 164, 0.621	217.336, 220, 0.538	313.808, 288, 0.142	286.326, 280, 0.385	160.518, 180, 0.849	286.674, 260, 0.123
	Median (25th-75th centile)	2.8 (2.1-3.4)	3.1 (2.3-4.0)	4.1 (3.0-5.6)	4.9 (3.8-5.9)	2.3 (1.6-3.0)	3.1 (2.0-4.3)
Factor 2—Mood	(χ^2, df, *P*)	29.433, 41, 0.911	60.913, 55, 0.272	79.597, 72, 0.248	54.013, 70, 0.921	47.177, 45, 0.384	75.050, 65, 0.185
	Median (25th-75th centile)	2.6 (2.0-3.3)	3.3 (2.4-4.3)	3.9 (2.5-5.3)	4.5 (3.4-5.6)	2.5 (1.6-3.2)	3.6 (2.6-5.0)
Factor 3— Convenience	(χ^2, df, *P*)	76.577, 82, 0.648	113.886, 110, 0.381	167.597, 144, 0.087	147.353, 140, 0.319	99.257, 90, 0.237	124.897, 130, 0.610
	Median (25th-75th centile)	2.6 (2.0-3.4)	3.1 (2.1-4.1)	3.6 (2.4-4.8)	4.5 (3.5-5.8)	2.4 (1.6-3.0)	3.3 (2.3-4.6)
Factor 4— Sensory appeal	(χ^2, df, *P*)	142.499, 164, 0.886	238.010, 220, 0.193	**332.604, 288, 0.036**[a]	279.779, 280, 0.492	200.518, 180, 0.141	250.130, 260, 0.659
	Median (25th-75th centile)	2.6 (2.0-3.3)	3.0 (2.1-4.0)	3.8 (2.5-5.0)	4.6 (3.5-5.8)	2.3 (1.5-3.0)	3.3 (2.1-4.6)
Factor 5— Natural content	(χ^2, df, *P*)	**60.704, 41, 0.024**[a]	55.338, 55, 0.482	**96.890, 72, 0.027**[a]	61.574, 70, 0.754	41.480, 45, 0.622	60.972, 65, 0.619
	Median (25th-75th centile)	2.9 (2.4-3.9)	3.3 (2.3-4.2)	4.5 (3.2-6.1)	5.3 (3.7-6.1)	2.5 (2.0-3.4)	2.4 (1.7-4.0)
Factor 6—Price	(χ^2, df, *P*)	88.854, 82, 0.283	123.496, 110, 0.179	155.339, 144, 0.245	135.824, 140, 0.584	88.840, 90, 0.515	137.050, 130, 0.319
	Median (25th-75th centile)	2.7 (1.9-3.3)	3.0 (2.1-4.0)	3.6 (2.4-4.8)	4.4 (3.4-5.6)	2.3 (1.5-3.0)	3.3 (2.4-4.6)
Factor 7—Weight control	(χ^2, df, *P*)	**106.733, 82, 0.035**[a]	108.897, 110, 0.512	164.810, 144, 0.113	131.295, 140, 0.688	**115.689, 90, 0.035**[a]	82.140, 130, 1.000
	Median (25th-75th centile)	3.1 (2.4-3.9)	3.1 (2.1-4.0)	4.3 (3.3-5.9)	5.4 (4.4-6.7)	2.6 (2.1-3.6)	3.0 (1.8-4.0)
Factor 8— Familiarity	(χ^2, df, *P*)	178.757, 205, 0.907	239.773, 275, 0.939	**450.969, 360, 0.001**[a]	337.450, 350, 0.675	231.159, 225, 0.375	**368.395, 325, 0.049**[a]
	Median (25th-75th centile)	2.6 (2.0-3.3)	2.9 (2.1-4.0)	3.8 (2.5-5.0)	4.5 (3.4-5.6)	2.3 (1.5-2.9)	3.3 (2.3-4.6)

[a]Statistically significant ($P \leq .05$).

95% CI −0.558, −0.120, $P = .003$) than those identifying as Caucasian. Current smokers consumed a lower median number of serves of meat (and alternatives) per day than their non-smoking counterparts (2.3 vs 2.8 serves; β = −0.501, 95% CI −0.968, −0.034, $P = .036$), however declared a higher median number of serves of discretionary foods per day (4.6 vs 3.4 serves; β = 1.174, 95% CI 0.255, 2.093, $P = .012$); these women were also less likely to declare health as a motivation for food selection (β = −0.993, 95% CI −1.625, −0.361, $P = .002$). "Health" motive scores increased with age (β = 0.317, 95% CI 0.139, 0.495, $P = .001$) and education (β = 0.250, 95% CI 0.106, 0.395, $P = 0.001$). The consumption of the core food group grains also increased concurrently with age (β = 0.068, 95% CI 0.026, 0.111, $P = .002$).

Birth outcomes were available for 186 women (39%). Hypertensive disorders (n = 14, 7.5%), preterm birth (n = 18, 9.7%) and gestational diabetes (n = 21, 11.3%) were not associated with any descriptive group or food selection motive ($P > .05$), however the incidence of HDP increased with decreasing vegetable intake (β = 1.514, 95%CI 0.270, 2.757, $P = .017$). Low birthweight in the absence of multiple pregnancy or medical complexity was recorded for 29 infants (15.6%). Birthweight was significantly associated with cultural and linguistic diversity in this cohort ($P = .022$); mean birthweight for CALD women was 8% lower than their non-diverse peers (3025 g vs 3290 g).

4 | DISCUSSION

This research aimed to collect and examine self-reported dietary intake and decision-making data from a cohort of pregnant South-East Queensland women, exploring the overall interactions between diet, food selection motives, health determinants and birth outcomes. This cohort demonstrated poor adherence to dietary recommendations during pregnancy, a finding supported by similar Australian studies.[21-23] Fruit and discretionary food intake exceeded recommendations in this cohort; however, the daily serves of grain-based foods were less than half the recommended intake. While this deficit suggests a dietary guideline knowledge gap, it may also be indicative of a poor understanding of serving sizes for complex carbohydrates. The halving of the cereal serving size and concurrent increase of daily grain serves for pregnant women in the 2013 Australian Dietary Guidelines[7,8] may have contributed to these results. These findings are supported by two Australian cohorts,[21,22] suggesting that suboptimal dietary intake and nutrition literacy during pregnancy are nationwide rather than a regional public health issue.

The median daily serves of meat (and alternatives) was universally low, however CALD women exhibited a significantly higher intake of this food group than their non-diverse peers. Despite this, women of CALD backgrounds exhibited a lower mean birthweight than Caucasian women, a disparity that cannot be explained by the dietary intake of this group of women. However social influences—including the known socio-economic disadvantage and reluctance to engage with health services[24] demonstrated by CALD women in high-income countries—may have contributed to this finding. Additionally, these women declared a significantly lower emphasis on convenience in their dietary decision-making than non-CALD group, suggesting a trend toward home-cooked, traditional meals in the culturally diverse population. These behaviours may have cumulatively contributed to the lower mean birthweight demonstrated by this group.

Conversely, women who declared smoking in the previous month reported lower meat (and alternative) intake than their non-smoking counterparts. This is a novel finding in the context of pregnancy. Smokers also demonstrated excessive discretionary food intake and a negative association with "health" motivations. These findings support previous research linking tobacco smoking and unhealthy diet (defined as high in refined grain and low in fruit and vegetables), [25] and continued smoking despite knowledge of associated health risks.[26] Identification of continuing smokers during pregnancy may facilitate provision of dietary education and advice aimed at optimising outcomes though dietary management. These strategies may minimise the effects of continued smoking on the health of women and their infants improving both immediate and longitudinal health outcomes.[27]

Despite their association with unhealthy dietary practices, smokers did not demonstrate any significant association with the birth outcomes in question. This reflects findings reported in a similar study population, who reported no relationship between smoking and the incidence of pre-eclampsia.[28] However, a significant inverse linear relationship between maternal vegetable intake and the incidence of HDP has been reported in both local[28] and international research, [29] an association also demonstrated by the women of this cohort. This suggests that adequate vegetable intake acts as a protective factor in the aetiology of hypertensive disorders, potentially due to the high proportion of micronutrients with antioxidant effects found in this food group[30] and their effect on the oxidative stress associated with hypertensive disorders of pregnancy.[31] Therefore, nutrition counselling for women with identified risk for HDP may

reduce the incidence and severity of these pregnancy disorders.

Significant positive associations were evident between health factor scores, maternal age and education. Analysis suggests that women of the cohort were more motivated to make healthy dietary choices with advancing age and increasing education, conclusions supported by contemporary research in a comparative population.[32,33] As such this data may indicate the presence of a nutrition literacy deficit in young women of this cohort, particularly those who have not undertaken a tertiary education.[33] Appropriate dietetic interventions in these women have the potential to influence the development of lifelong dietary behaviours for both themselves and their children.[34]

This study has inherent strengths and limitations. Participants were recruited through public hospital antenatal clinics; busy, fragmented models with limited access to continuity of care. This recruitment environment resulted in an inability to compare the intake and outcomes of women engaging private maternity services. While women with high income and education levels are more likely to access private models of care,[35] potential inequities have been negated by the heterogeneity of income brackets and the high percentage of university-educated women in the cohort. Furthermore, data were collected from a representative cohort of the South-East Queensland region,[36,37] and included data declared by women of cultural, linguistic, literacy and socio-economic diversity.

Over and under-reporting of intake is common with self-reported dietary recall.[38] While reporting inconsistencies potentially exist within this research, outliers had no significant impact on the mean for any food group. As such, these effects have been considered minimal and all declarations retained in the analysis. Social desirability bias is also common in research of this nature[39]; the anonymisation of respondents and the unassisted and unsupervised survey completion has minimised this effect.

This study has highlighted the importance of considering individual risk factors, dietary intake and decision-making motivations when assessing the need for nutrition counselling and referral during pregnancy. Women with identified risk factors exhibit dietary behaviours which may benefit from individualised dietary assessment, planning and service provision. This novel examination of food-selection motives in relation to socio-cultural risk factors has determined that selected birth outcomes may be modifiable with behaviour-specific counselling in at-risk groups of this region. These findings form a foundation for further transdisciplinary research and service integration.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTIONS

This article is the original work of the Author(s). J.J. proposed, developed, collected data and authored the paper; L.V., J.V. and A.P. critically reviewed and approved the manuscript for final submission and publication. It is not under consideration elsewhere and has not been previously published.

ORCID

Janelle M. James-McAlpine https://orcid.org/0000-0002-1157-9527

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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ORIGINAL RESEARCH

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Determinants of eating behaviours in Australian university students: A cross-sectional analysis

Megan C. Whatnall BND (Hons), APD, PhD candidate[1] |
Amanda J. Patterson PhD, APD, Senior Lecturer[1] |
Simon Chiu GDip (AppStats), Statistician[2] |
Christopher Oldmeadow PhD, Associate Director[2] |
Melinda J. Hutchesson PhD, APD, Senior Lecturer[1]

[1]School of Health Sciences, Faculty of Health and Medicine, and Priority Research Centre for Physical Activity and Nutrition, University of Newcastle, Newcastle, New South Wales, Australia

[2]Clinical Research Design and Statistics Support Unit, Hunter Medical Research Institute, Newcastle, New South Wales, Australia

Correspondence
Melinda Hutchesson, School of Health Sciences, Faculty of Health and Medicine, and Priority Research Centre for Physical Activity and Nutrition, Hunter Building (HA12), University of Newcastle, Callaghan, 2308, NSW, Australia.
Email: melinda.hutchesson@newcastle.edu.au

Abstract

Aim: This study aimed to explore clustering among individual eating behaviours in a sample of Australian university students, and explore associations between clustered eating behaviours and demographic characteristics.

Methods: A cross-sectional analysis of data from the University of Newcastle (UON) Student Healthy Lifestyle Survey 2017 was conducted. Measures included eating behaviours (eg, vegetables, energy-dense nutrient poor [EDNP] food intakes) assessed using short diet questions, and demographic characteristics (eg, age, undergraduate/postgraduate student). Factor analysis was used to explore clustering of individual eating behaviours (ie, identify factors). Linear regression models were used to explore associations between eating behaviour factors identified and demographic characteristics.

Results: A total of 3062 students (70% female; 56% aged 17-24 years) were included in the analysis. The six eating behaviour factors identified (characterised by higher consumption of the named foods/drinks) were; EDNP snack foods, meat and takeaway foods, fruit and vegetables, sugary drinks, breakfast, and breads and cereals. A higher fruit and vegetable factor score was associated with being female ($P < .001$), and a higher meat and takeaway foods factor score was associated with being male ($P < .001$) and of younger age ($P < .001$).

Conclusions: Nutrient-rich foods clustered together and EDNP foods clustered together, that is, the identified factors represent either nutrient-rich or EDNP foods. Interventions in the university setting should target students with the poorest eating behaviours, including males and younger students.

KEYWORDS

college students, cross-sectional study, determinants, eating behaviours, university students

1 | INTRODUCTION

Internationally, approximately 83% of university students consume less than five fruit and vegetable serves per day.[1] Additionally, cross-sectional studies from the UK, the USA and Europe show 22% to 37% of students consume confectionary or fast foods between 4 days per week and several times per day.[2-4] Unhealthy eating behaviours in this group are associated with poorer mental health, including higher stress[5] and symptoms of depression,[6] lower academic achievement, including lower grades,[7] and an increased risk of chronic disease risk factors, predominantly obesity.[8] Therefore, university students' unhealthy eating behaviours are of interest as they are widespread and can have detrimental effects on health and academic achievement.

In order to develop effective interventions to improve university students' eating behaviours, an understanding of the determinants of eating behaviours are required. University students are a unique population group due to elements of their personal and social environment that are specifically relevant to the life-stage and the setting, and may influence eating behaviours.[9] For example, academic pressures and changing living arrangements and social relationships. Living situation has been identified as a determinant, with most studies showing that students living away from the parental home, including at college, have lower consumption of nutrient-rich foods such as fruits, vegetables and dairy,[1,2,10] and higher consumption of energy-dense, nutrient-poor (EDNP) foods, including confectionary and takeaway foods.[10,11] Additionally, limited budget is a common constraint among university students and lower socio-economic status is a known determinant of poorer eating behaviours and diet quality.[1,12]

Observational studies from the USA, the UK and Europe confer that unhealthy eating behaviours are common in university students.[2-6,10] However, most studies have included a narrow exploration of diet, with most exploring only a select few eating behaviours or food groups, rather than a broad range, and few studies have explored the associations among eating behaviours. There is also a need to further explore determinants of a broader range of eating behaviours. This is necessary to identify sub-groups of students who are most at risk of poor eating behaviours, and therefore who should be targeted in interventions, as well as to inform the content of such interventions.[13]

Furthermore, a limited body of evidence exists for prevalence of eating behaviours and their determinants in Australian university students, including only seven studies.[5,14-19] The scope of these is limited in terms of small samples, specific sub-groups of students (eg, nutrition students), narrow explorations of diet, and only three which explore determinants of behaviour. Due to socio-cultural differences between countries, some international findings may not be generalisable to the Australian setting.[9] For example, most students in the UK and the USA live in university accommodation and have food provided, whereas in Australia living situation and food acquisition are more varied.[20,21]

The present study aimed to explore clustering of individual eating behaviours in a sample of Australian university students, and explore associations between clustered eating behaviours and demographic characteristics.

2 | METHODS

This study was a secondary analysis of cross-sectional data from the University of Newcastle (UON) Student Healthy Lifestyle Survey (SHLS) 2017. Full study methods and results have been previously published.[22] The SHLS overall aim was to identify lifestyle-related health risk factors, mental health and wellbeing and overweight/obesity prevalence. The survey was conducted online using Survey Monkey and allowed access on one device to prevent multiple entries by the same individual. The survey was setup to require a response to each question before participants could progress to the next question, with the exception of sensitive questions (drug use, sexual health and mental health) which were optional to complete. The conduct and reporting of this work complies with STROBE-nut guidelines.[23]

Participants were students from the UON, a large urban university with the main campus in Newcastle, NSW, Australia, and additional campuses across NSW (N = 4) and Singapore (N = 1). All students enrolled as of September 4, 2017 were invited to participate (N = 33 783). Eligibility criteria included current enrolment as a student at the University of Newcastle. To determine eligibility, a screening question asked individuals if they were a current student. The survey was open from 4th September to 1st October 2017.

Students were recruited via email invitation from the administrators of their University email, including reminder emails 1 and 3 weeks later, via University social media, and posters and digital signage across campuses. The survey was also advertised via University teaching staff, who were emailed with the request to promote the recruitment materials in class or on the online learning management system. On completion, participants could enter a prize draw to win one of five $AU100 vouchers. All participants gave informed consent to participate. The study was approved by the UON Human Research Ethics Committee (H-2015-0459).

Eating behaviours were assessed using short diet questions from the NSW Adult Population Health Survey (Appendix).[24] These questions have good relative validity and consistency compared with other dietary assessment methods.[25,26] The questions assessed the consumption frequency of various nutrient-rich and EDNP foods, defined

according to the Australian Guide to Healthy Eating (AGHE).[27] This included: usual serves/day of fruit and vegetables ("Do not eat" to "≥6 serves"), with one serve defined as 150 g and 75 g, respectively, as per the AGHE[27]; consumption frequency of red meat (excluding pork and ham), bread, breakfast cereal, and pasta, rice, noodles or other cooked cereals (all types eg, white, wholemeal or wholegrain) ("Never/rarely" to "≥once/day"), water ("≤1 cup/week" to "≥2 cups/day"), and breakfast ("Never/rarely" to "Everyday"). EDNP foods assessed were processed meat products, hot chips, potato crisps/other salty snacks (eg, corn chips), snack foods (eg, sweet/savoury biscuits, cakes), confectionery (eg, sweets, chocolate), ice-cream/ice-lollies ("Never/rarely" to "≥once/day"), and takeaway meals/snacks ("Never/rarely" to "Everyday"). EDNP beverages assessed were soft drink/soda, cordials or sports drinks, and fruit juice ("≤1 cup/week" to "≥2 cups/day"), with one cup defined as 250 mL. Eating behaviours are reported as below recommendations for fruit (<2 serves/day) and vegetables (<5 or 5.5 serves/day based on age and gender). All other nutrient-rich foods are reported as lower intake (<once/day), with the exception of red meat (<3 times/week), as per the response options most in line with the AGHE.[27] EDNP items are reported as higher intake for foods (1-2 times/week or more) or beverages (2-6 cups/week or more), as per the AGHE lower end of the range for discretionary items.

Demographic data collected included age, gender, country of birth, Aboriginal or Torres Strait Islander (ATSI) background, marital status, living situation, sources of financial support and hours of paid work/week, and were based on questions from the national census. Student-specific data collected included type of degree (undergraduate/postgraduate), faculty of study, number of years studying and whether they were a domestic or international student.

Data were analysed using STATA statistical software version 14.1 (StataCorp LLC, Texas). In total, 3465 individuals consented and were eligible to participate, 3077 completed all compulsory questions, and 3062 were included in this analysis (Figure 1). Participants were excluded where gender was unspecified (n = 15). Eating behaviours and demographic characteristics are described as percentages for categorical variables and means and SDs for continuous variables. Eating behaviour variables were dichotomised for the reporting of descriptive statistics, however were analysed in their raw form for all further analyses. Principal component analysis (PCA) was used to explore clustering of individual eating behaviours (n = 18). PCA determines the minimum number of factors to explain the greatest amount of variance in the data. The number of components retained was based on eigenvalue >1.0 and visual interpretation of the scree-plot. Components were obliquely rotated to aid interpretability of the resulting components. Labels were assigned to factors (representing a collection of eating behaviours with rotated component loadings >0.3), a higher loading relates to a greater contribution of a given eating behaviour to the component. Factor scores were calculated as the unweighted sum of the rotated loadings of each eating behaviour contributing to the factor. Unadjusted linear regression models were used to explore associations between each of the factor scores and individual demographic characteristics. Each linear regression model was then repeated (adjusted model) to include the other demographic characteristics of significance in the unadjusted models as potential confounders. All adjusted linear regression models controlled for age and gender. Adjusted models were tested for multi-collinearity, with variance inflation factor for each model between 1.3 and 1.5 (ie, not showing

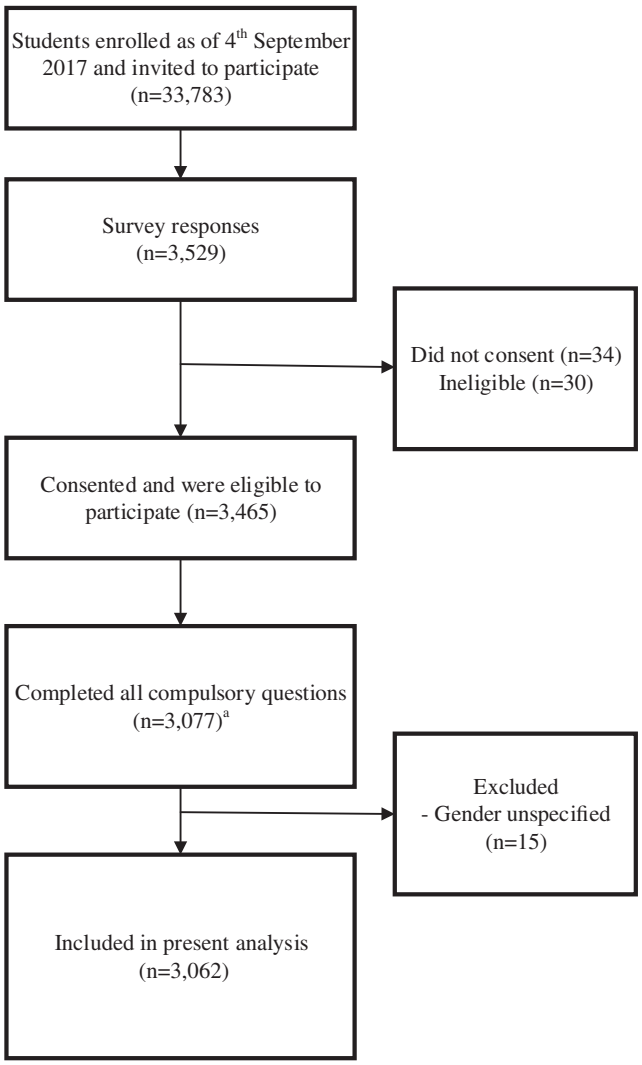

FIGURE 1 Flow diagram of individuals included in a subset analysis of the University of Newcastle Student Healthy Lifestyle Survey 2017. [a]Compulsory survey questions included demographics, eating behaviours, physical activity, sitting time, sleep and alcohol intake. Questions of a sensitive nature were optional to complete (drug use, sexual health and mental health)

TABLE 1 Demographic characteristics and eating behaviours of a sample of Australian university students (n = 3062)

Demographics **Variable**	**% (n) or mean ± SD**
Age (years) (mean ± SD)	27.1 ± 9.8
Age groups (years) % (n)	
17-20	25 (772)
21-24	31 (940)
25-29	17 (528)
30-39	15 (459)
≥40	12 (363)
Female % (n)	70 (2134)
Australian born % (n)[a]	81 (2475)
Aboriginal or Torres Strait Islander % (n)	3 (92)
Living situation % (n)	
Own home	15 (465)
Parents home	33 (1010)
On-campus	8 (247)
Renting	41 (1254)
Boarding/homestay	2 (59)
Irregular	1 (27)
Paid work (hours/week) (mean ± SD)	13.4 ± 13.2
Receiving financial support % (n)	63 (1914)
Student type % (n)	
Undergraduate	71 (2167)
Postgraduate	22 (668)
Other[b]	7 (227)
Domestic/International % (n)	
Domestic	89 (2710)
International	11 (352)
Number of years studying % (n)	
1st	39 (1189)
2nd	20 (616)
3rd	20 (608)
4th	11 (336)
5th year or later	10 (313)
Faculty of study % (n)	
Business and Law	14 (416)
Education and Arts	25 (759)
Engineering and Built Environment	12 (362)
Health and Medicine	31 (944)
Science	14 (417)
English Language and Foundation Studies	5 (164)

(Continues)

TABLE 1 (Continued)

Eating behaviours					
	% (n) 0-1 serves/day		**% (n) 2-4 serves/day**		**% (n) ≥5 serves/day**
Fruits	49 (1509)		48 (1477)		3 (76)
Vegetables	24 (748)		64 (1955)		12 (359)
		Never/rarely	**1-2 times/week**	**3-6 times/week**	**≥Once/day**
Processed meat products		40 (1226)	38 (1174)	19 (575)	3 (87)
Red meat		24 (735)	43 (1317)	30 (905)	3 (105)
Bread or similar products		11 (333)	21 (635)	39 (1184)	30 (910)
Breakfast cereal		45 (1381)	18 (544)	20 (608)	17 (529)
Pasta, rice, noodles or other cooked cereals		8 (252)	33 (1021)	46 (1416)	12 (373)
Hot chips, wedges or fried potatoes		45 (1391)	42 (1295)	11 (346)	1 (30)
Potato crisps or salty snacks		55 (1674)	34 (1040)	10 (320)	1 (28)
Snack foods for example, biscuits/cookies, cakes		27 (821)	38 (1150)	29 (891)	7 (200)
Confectionary		31 (940)	39 (1196)	24 (739)	6 (187)
Ice-cream/ice-lollies		60 (1828)	31 (941)	8 (251)	1 (42)
	≤Once/week	**1-2 times/week**	**3-4 times/week**	**5-6 times/week**	**Everyday**
Takeaway food	69 (2107)	25 (777)	5 (150)	1 (24)	<1 (4)
Breakfast	10 (319)	9 (271)	11 (341)	12 (365)	58 (1766)
		≤1 cup/week	**2–6 cups/week**	**1 cup/day**	**≥2 cups/day**
Soft drink/soda, cordial or sports drink		74 (2258)	19 (584)	4 (115)	3 (105)
Fruit juice		69 (2107)	25 (757)	5 (149)	2 (49)
Diet soft drink/ soda, cordial or sports drink		80 (2442)	14 (439)	3 (79)	3 (102)
Water		1 (19)	4 (133)	4 (116)	91 (2794)

[a]n = 3051 (n = 11 unspecified).
[b]Includes students enrolled in enabling (ie, transition to university) courses and English language courses for international students.

multi-collinearity). Statistical significance was considered $P < .05$.

3 | RESULTS

Participants were mostly aged 17 to 24 years (56%) (Table 1). Most participants were female (70%) and Australian born (81%). Many were Faculty of Health and Medicine (31%) or Education and Arts (25%) students and living in rented accommodation (41%). Sample characteristics are consistent with the average Australian university student in terms of age groups and proportion of undergraduate students, with slightly higher proportions of female students.[28] The representation of domestic, ATSI, and enabling course students was higher, however, proportional to UON numbers.

The majority of participants reported lower consumption of nutrient-rich foods, including 88% consuming pasta, rice, noodles or other cooked cereals less than once per day, 89% consuming below recommendations for vegetables (<5 or 5.5 serves/day), and 42% consuming breakfast less than daily (Table 1). Most participants reported higher consumption (1-2 times/week or more) of EDNP foods including 73% for snack foods and 69% for confectionery.

PCA identified six factors, explaining 77% of the variability in eating behaviours in the sample (Table 2). Factors were labelled as: 1) EDNP snack foods, 2) meat and takeaway foods, 3) fruit and vegetables, 4) sugary drinks, 5) breakfast, and 6) breads and cereals.

Results of the adjusted linear regression models are reported in Table 3 and Figure 2, and key findings described below. Higher factor scores relate to more frequent consumption of the included foods/drinks. Table SS1 contains all regression results.

Higher factor 1 score (ie, higher intakes of confectionary, snack foods, ice-cream/ice-lollies and diet soft drink/soda) was associated with younger age ($P < .001$), and living in their parent's home compared with their own home

TABLE 2 Rotated component (factor) loadings and explained variances for the eating behaviour factors (n = 6) identified in a sample of Australian university students (n = 3062)

Eating behaviour variables	Factor 1 (EDNP snack foods)	Factor 2 (Meat and takeaway foods)	Factor 3 (Fruit and veg)	Factor 4 (Sugary drinks)	Factor 5 (Breakfast)	Factor 6 (Breads & cereals)
Fruits			.79			
Vegetables			.77			
Processed meat products		.69				
Red meat		.93				
Breakfast					.65	
Bread or similar products					.34	.54
Breakfast cereal					.81	
Pasta, rice, noodles or other cooked cereals						.83
Hot chips, wedges or fried potatoes					−.31	
Potato crisps or salty snacks	.42					
Snack foods for example, biscuits/ cookies, cakes	.80					
Confectionery	.89					
Ice-cream/ice-lollies	.66					
Takeaway foods		.41				
Soft drink/soda, cordial or sports drink				.58		
Fruit juice				.87		
Diet soft drink/soda, cordial or sports drink	.36					−.38
Water			.63	−.39		
Proportion of variance explained (76.8%)	16.8%	13.9%	13.2%	12.4%	10.9%	9.7%

Notes: Loadings for all eating behaviour variables were used in calculating factor scores. Eating behaviours with loadings >0.3 are displayed and were used to interpret factors.

($P = .028$), on-campus ($P = .004$), rented accommodation ($P < .001$) or irregular accommodation ($P = .030$).

Higher factor 2 score (ie, higher intakes of red and processed meat, and takeaway foods) was associated with younger age ($P < .001$), being male ($P < .001$), ATSI ($P = .032$), an undergraduate student ($P = .002$), and with living in their parent's home compared with living in rented accommodation ($P < .001$). Higher factor 2 score was also associated with being from the Faculty of Business and Law ($P = .008$), Engineering/Built Environment ($P = .027$) or English Language/Foundation Studies ($P = .002$) compared with Health and Medicine.

Higher factor 3 score (ie, higher intakes of fruit and vegetables) was associated with being female ($P < .001$), a domestic student ($P = .005$), not receiving financial support ($P = .040$), and being from the Faculty of Health and Medicine compared with the Faculty of Education and Arts ($P = .001$), Engineering/Built Environment ($P = .024$) or English Language/Foundation Studies ($P = .009$).

Higher factor 4 score (ie, higher intakes of soft drink/soda and fruit juice, and lower water intake) was associated with younger age ($P = .034$), being male ($P < .001$), ATSI ($P = .016$), an undergraduate student ($P = .001$), and an international student ($P < .001$). Higher factor 4 score

TABLE 3 Adjusted linear regression results of eating behaviour factors with socio-demographic characteristics in a sample of Australian university students (n = 3062)

	β-coefficient[a]					
Variable	**Factor 1 (EDNP snack foods)**	**Factor 2 (Meat and takeaway foods)**	**Factor 3 (Fruit and veg)**	**Factor 4 (Sugary drinks)**	**Factor 5 (Breakfast)**	**Factor 6 (Breads and cereals)**
Age	−.009***	−.009***	−.003	−.005*	.011***	−.013***
Female	−.063	−.559***	.292***	−.415***	−.009	−.221***
Non-ATSI		−.217*		−.248*		
Living situation						
Reference category = Parent's home						
Own home	−.152*	−.073		−.091	−.022	−.156
On-campus	−.207**	−.089		−.132	.005	.050
Renting	−.187***	−.153***		−.158***	−.104	−.030
Boarding/homestay	.081	.055		−.146	−.119	−.008
Irregular	−.420*	−.357		−.100	−.119	−.358
Paid work (hours/week)			.002	−.0002		−.0003
Receive financial support			−.088*	−.061		.099*
Student type						
Reference category = Undergraduate						
Postgraduate	.030	−.145**	.106	−.177**	.121*	
Other[b]	−.120	−.058	−.004	−.063	−.300**	
International	−.106		−.177**	.231***		.381***
Number of years studying						
Reference category = 1st year						
2nd year			.035	−.006	.124	−.002
3rd year			.059	−.145**	.051	.018
4th year			.151	−.204**	.166**	.018
5th year/later			.079	−.053	.143*	−.174*
Faculty of study						
Reference category = Health and Medicine						
Business and Law	−.023	.151**	−.100	.141*	−.190**	−.081
Education and Arts	.085	.053	−.111**	.141**	−.149**	.028
Engineering and Built Environment	−.001	.139*	−.156*	.011	−.031	.048
Science	.024	−.057	−.147	.055	−.081	.058
English Language /Foundation Studies	.341	.405**	−.093**	.578***	−.120	.010

Abbreviation: ATSI, Aboriginal or Torres Strait Islander.

[a]β-Coefficient indicates the increase in factor score per unit increase in the independent variable.

[b]Includes students enrolled in enabling (ie, transition to university) courses and English language courses for international students.

*$P < .05$.; **$P < .01$.; ***$P < .001$.

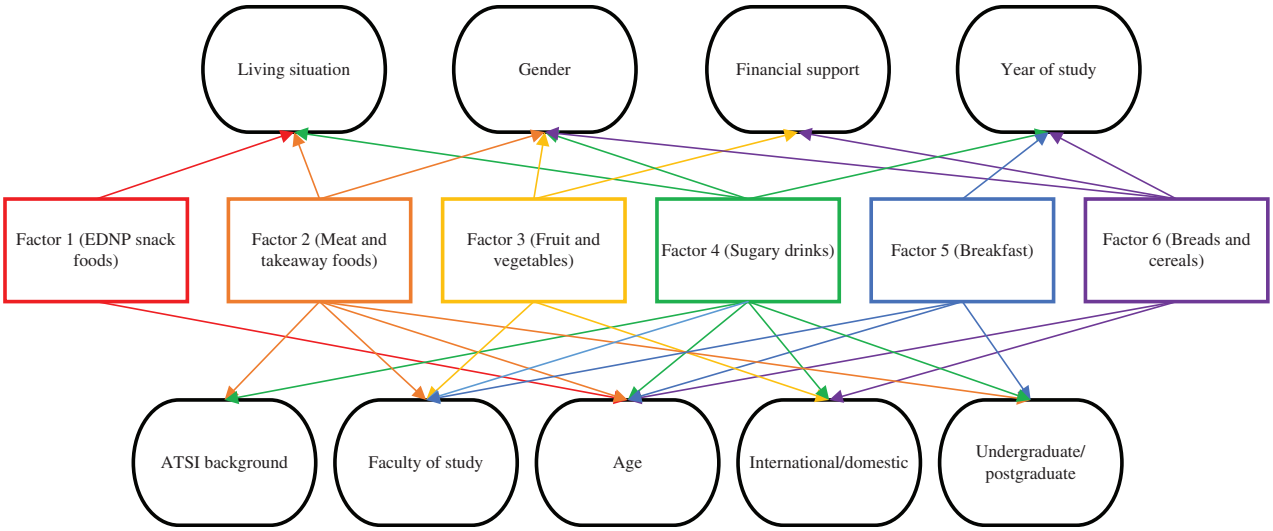

FIGURE 2 Diagram of associations between eating behaviour factors and demographic characteristics in a sample of Australian university students (n = 3062)

was also associated with living in their parent's home compared with rented accommodation ($P < .001$), and being from the Faculty of Business and Law ($P = .015$), Education and Arts ($P = .003$) or English Language/Foundation Studies ($P < .001$) compared with Health and Medicine.

Higher factor 5 score (ie, higher intakes of breakfast cereal, breakfast and bread) was associated with higher age ($P < .001$), and being a postgraduate student ($P = .015$). Higher factor 5 score was also associated with being from the Faculty of Health and Medicine compared with Business and Law ($P = .001$), or Education and Arts ($P = .002$).

Higher factor 6 score (ie, higher intakes of pasta, rice, noodles or other cooked cereals, and bread) was associated with being male ($P < .001$), younger age ($P < .001$), receiving financial support ($P = .019$), and being an international student ($P < .001$).

4 | DISCUSSION

This cross-sectional study explored clustering of eating behaviours in a sample of Australian university students and their associations with demographic characteristics. Nutrient-rich foods were found to cluster together, and EDNP foods clustered together. The associations between eating behaviour factors and demographic characteristics show consistent trends. Overall, females, older students, students living in rented accommodation and students enrolled in postgraduate or health and medicine degrees had higher nutrient-rich foods consumption and lower EDNP foods consumption. Males, younger students, students living in their parent's home and students enrolled in undergraduate degrees or from non-health faculties had lower nutrient-rich foods consumption and/or higher EDNP foods consumption.

The eating behaviour factors identified in the present study, in particular the EDNP snack food and fruit and vegetable factors, are consistent with similar analyses among UK university students.[10,13] For example, Sprake et al conducted a factor analysis among 1500 UK university students and identified a snacking dietary pattern characterised by high consumption of biscuits, cakes and confectionary.[13] These findings suggest that students consuming more of one nutrient-rich food also have higher consumption of other nutrient-rich foods, and vice versa for EDNP foods. Dietary intake is more complex than this, in that diets are typically a mixture of healthy and unhealthy eating behaviours, however, this provides some insight into overall diet among university students and highlights the importance of exploring a range of eating behaviours to contextualise individual behaviours. There are no similar studies among Australian university students for comparison, however, the findings demonstrate that Australian students are similar in their eating behaviours to students in other western countries.

Students' living situation was found to be a significant determinant of EDNP food intakes but not nutrient-rich foods. Specifically, students living in their parent's home more frequently consumed EDNP snack foods, meat and takeaway foods and sugary drinks than students living in rental accommodation, their own home and/or on-campus, while living situation was not significantly associated with nutrient-rich eating behaviour factors. Comparatively, a study among 309 Australian university students found no significant differences in students' diet quality score between those living with parents, flatmates, a partner or on their own.[17] These findings are interesting as they differ from previous studies in the USA, the UK and Europe, where students living with their parents were found to consume less EDNP foods and more healthy foods.[1,2,10,11] However, students in

the USA, the UK and Europe commonly move out of their parents' home and live in university accommodation,[29,30] whereas most Australian students enrol in local universities,[28] with greater variation in living situation. Students living with their parents in the Australian context possibly have more disposable income to spend on socialising outside of the home environment and therefore greater access to EDNP foods.

In this sample, older and female students less frequently consumed EDNP foods than younger and male students. While females and domestic students consumed fruit and vegetables more frequently than males, and international students consumed breads and cereals more frequently than domestic students. In terms of age, the poorer eating behaviours among younger students is supported by national and international study findings where 18 to 24 year olds have been found to consume lower fruit and vegetables and have worse dietary pattern scores compared with adults 25 years and above.[31,32] This demonstrates the importance of targeting eating behaviours in emerging adults.[32] The findings around gender are consistent with studies of university students from the UK and Australia where female students have also been found to consume more fruit and vegetables and less highly processed foods than males,[2,5] while studies from the USA reported no significant gender differences in fruit and vegetable intake.[8,33] It is widely recognised that gender differences exist in the perceived importance of, and motivation towards, healthy eating, with males generally found to place less importance on healthy eating.[9] This could provide some explanation for the gender differences in the present study. The differences between domestic and international students could reflect different cultural food preferences and dietary guidelines between countries.

In a university sample, students' field of study could also provide some explanation for their perceived importance of health and health awareness, and subsequently their eating behaviours, that is, students enrolled in health degrees may be more health conscious.[34] Consistent with this idea, Faculty of Health and Medicine students in the present study more frequently consumed fruit and vegetables and breakfast, and less frequently consume meat and takeaway foods and sugary drinks than students from non-health faculties. Although, even these students were performing poorly compared with dietary guidelines.[27] Interestingly, in a study comparing health science and non-health science university students across 17 low- and middle-income countries, health science students were found to have greater awareness of dietary risk behaviours, however, they also had poorer dietary behaviours than non-health science students.[34] Therefore, students' field of study may have some impact on eating behaviours, however, it may not necessarily be positive and other factors may have greater impact.

In the present study, the number of hours students worked and whether they received financial support, both indicators of financial status, had limited associations with eating behaviours. This differs from previous studies, for example, poorer family background and coming from a lower income country were significantly associated with lower fruit and vegetable intakes among a sample of 17, 789 university students from 26 countries.[1] Our lack of findings around financial status, and the finding of lower fruit and vegetable intake being associated with receiving financial support, could indicate that a more specific measure, such as income or money available to spend on food, is needed to better explore this association.

The main strengths of the present study include the broad range of eating behaviours and characteristics explored, and the large sample size. In terms of limitations, not all EDNP foods were considered, such as alcohol, energy drinks and some fried foods, intake of dairy foods was not assessed, and the diet questions do not consider non-Anglo-Saxon cultural eating patterns. Furthermore, the large sample size may have contributed to some statistically significant findings where effect sizes are small. However, definite trends can be identified and findings are largely supported by previous research. Other limitations include self-report data and the cross-sectional design. However, the use of tools/methods with good validity[25,26] reduces the potential bias from self-reporting. The study sample was a small proportion of the total student body (9.1%), however, this is similar to other online surveys in university students using convenience sampling.[35]

In terms of future observational research, more studies are needed which explore a broad range of eating behaviours and determinants to further understand eating behaviours in this group, and studies which track how these change over time, for example, cohort studies. Tracking eating behaviours over time could help to identify when and potentially why eating behaviours change, for example, in relation to moving away from parents, or in the transitions from first to final years of study. Such research would be useful to inform and enhance future interventions, in terms of both key time points for intervention, that is, before changes in eating behaviours may occur, and intervention content that is, how to manage healthy eating in circumstances associated with unhealthy eating behaviours. The study findings reinforce that targeted nutrition interventions for university students are needed, as these are lacking. Interventions should target all students, but in particular, students identified as higher-risk of unhealthy eating behaviours, including male, younger, and undergraduate students, and students living in their parent's home. Furthermore, healthy eating advice should consider the factors that have been shown to influence students eating behaviours, such as living situation and gender, so that it is relevant and may be more effective in

changing behaviour. For example, providing advice to students living in their parent's home for selecting healthier alternatives to EDNP foods when purchasing their own foods or eating out. There is a vital role for dietitians and other health professionals in designing these interventions.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR CONTRIBUTIONS

M.H., A.P. and M.W. conceptualized the study design, with assistance from S.C. and C.O. for the statistical approach. M.W. conducted the statistical analysis with the assistance of S.C. and C.O. All authors contributed to the interpretation of results. M.W. drafted the initial manuscript, with the assistance of M.H. and A.P. All authors critically reviewed the manuscript and approved the final version submitted for publication. The contents of the manuscript are the authors' original work, and the manuscript, including all parts of its content, have not been submitted to or published in another journal. All listed authors have made significant contribution to the work and give their permission for it to be submitted to Nutrition & Dietetics. The authors received no funding for this study. M. Hutchesson is supported by a University of Newcastle Gladys M Brawn Career Development Fellowship (Teaching Assistance). M. Whatnall is supported by an Australian Government Research Training Program (RTP) Scholarship.

ORCID

Megan C. Whatnall https://orcid.org/0000-0003-4798-4505
Amanda J. Patterson https://orcid.org/0000-0002-1868-7918
Melinda J. Hutchesson https://orcid.org/0000-0002-1851-0661

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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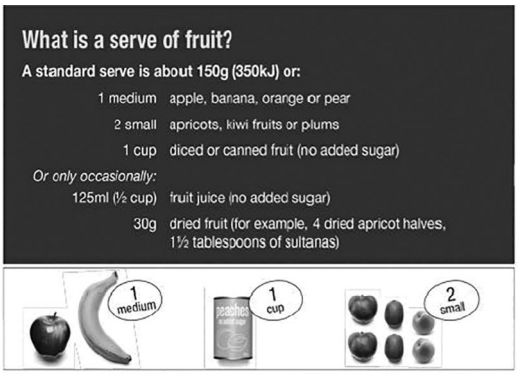
APPENDIX: SHORT DIET QUESTIONS INCLUDED IN THE UNIVERSITY OF NEWCASTLE (UON) STUDENT HEALTHY LIFESTYLE SURVEY 2017

*With canned varieties, choose those with no added salt



How many serves of vegetables do you normally eat each day?

- ◯ I don't eat vegetables
- ◯ Less than 1 serve
- ◯ 1 serve
- ◯ 2 serves
- ◯ 3 serves
- ◯ 4 serves
- ◯ 5 serves
- ◯ 6 or more serves

How many serves of fruit do you usually eat each day?

- ◯ I don't eat fruit
- ◯ Less than 1 serve
- ◯ 1 serve
- ◯ 2 serves
- ◯ 3 serves
- ◯ 4 serves
- ◯ 5 serves
- ◯ 6 or more serves

How often do you usually eat the following foods:

	Never or rarely	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 or more times per day
Processed meat products such as sausages, frankfurts, devon, salami, hamburgers, chicken nuggets, meat pies, bacon or ham	◯	◯	◯	◯	◯	◯
Red meat, such as beef, lamb, liver and kidney (but not pork or ham)	◯	◯	◯	◯	◯	◯
Bread, including bread rolls, flat breads, crumpets, bagels, English or bread type muffins.	◯	◯	◯	◯	◯	◯
Breakfast cereal	◯	◯	◯	◯	◯	◯
Pasta, rice, noodles, or other cooked cereals	◯	◯	◯	◯	◯	◯
Hot chips, French fries, wedges or fried potatoes	◯	◯	◯	◯	◯	◯
Potato crisps or other salty snacks such as Twisties or corn chips	◯	◯	◯	◯	◯	◯
Snack foods, such as sweet and savoury biscuits, cakes, donuts or muesli bars	◯	◯	◯	◯	◯	◯
Confectionary such as lollies and chocolate	◯	◯	◯	◯	◯	◯
Ice cream or ice-blocks	◯	◯	◯	◯	◯	◯

Please indicate how many cups of each of the drinks you usually drink

1 cup is equal to 250mL

	1 cup or less per week	2-4 cups per week	5-6 cups per week	1 cup per day	2-4 cups per day	5-6 cups per day	6 or more cups per day
Soft drink, cordials or sport drink, such as lemonade or Gatorade	◯	◯	◯	◯	◯	◯	◯
Fruit juice	◯	◯	◯	◯	◯	◯	◯
Diet soft drink, cordials or sport drink, such as Diet Coke or Sprite Zero	◯	◯	◯	◯	◯	◯	◯
Water	◯	◯	◯	◯	◯	◯	◯

How often do you have meals or snacks such as burgers, pizza, chicken or chips from places like McDonalds, Hungry Jacks, Pizza Hut, KFC, Red Rooster, or local take-away places?

- ◯ Never or rarely
- ◯ Less than once a week
- ◯ About 1 to 2 times a week
- ◯ About 3 to 4 times a week
- ◯ About 5 to 6 times a week
- ◯ Everyday

How often do you usually have something for breakfast?

- ◯ Never or rarely
- ◯ Less than once a week
- ◯ About 1 to 2 times a week
- ◯ About 3 to 4 times a week
- ◯ About 5 to 6 times a week
- ◯ Everyday

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ORIGINAL RESEARCH

Diet quality in adolescents with premenstrual syndrome: A cross-sectional study

Kubra ISGIN-ATICI,[1] Nuray KANBUR,[2] Sinem AKGÜL[2] and Zehra BUYUKTUNCER[1]

Faculty of [1]Health Sciences, Department of Nutrition and Dietetics and [2]Medicine, Department of Paediatrics, Division of Adolescent Medicine, Hacettepe University, Ankara, Turkey

Abstract

Aim: Premenstrual syndrome (PMS) is a complex of symptoms that can seriously affect the quality of life in women. It has been suggested that the nutritional status of adult women may influence the presence and/or severity of PMS symptoms. However, little is known about this association in adolescents. The present study aimed to examine the relationship between diet quality and the presence/severity of PMS symptoms in adolescents.

Methods: A case-control study of 272 female students, aged 13–18 years, was conducted in a high school. PMS was diagnosed and the symptoms were recorded using Premenstrual Syndrome Scale (PMSS)-2006 in 2 consecutive months. Dietary intake was assessed with 24-hour-dietary intake recall method and Healthy Eating Index-2010 (HEI-2010) score was calculated as an indicator of diet quality. Anthropometric measurements, including body weight, height, waist circumference and hip circumference were taken.

Results: PMS was diagnosed in 56.9% of the study sample. The mean HEI-2010 score was significantly lower in the PMS group (47.5 ± 23.95) when compared to the control group (53.5 ± 20.98), $P = 0.034$. The PMS symptoms, anxiety ($P = 0.009$), depressive feelings ($P = 0.016$) and changes in sleeping pattern ($P = 0.000$) were associated with lower diet quality scores in the PMS group. No significant difference in anthropometric measurements was observed between the groups.

Conclusions: The present study suggested that adolescents with a high-quality diet might experience depressive feelings, anxiety or changes in sleeping less when compared to those with a low quality diet. Therefore, the causal relationship between diet quality and presence/severity of PMS should be investigated in further studies.

Key words: adolescent, diet quality, premenstrual syndrome.

Introduction

Premenstrual syndrome (PMS) is characterised by the presence of physical, behavioural and emotional symptoms that occur repetitively in the luteal phase of the menstrual cycle and interfere with certain aspects of life.[1–3] Most common PMS symptoms are irritability, depressive mood, anxiety, changes in appetite and sleep quality, headache, muscle pain and arthralgia, enlargement and increase in the sensitivity of breasts, nausea, vomiting, weight gain, water retention, fatigue, acne and diarrhoea.[4,5] These symptoms are a frequent source of concern for women of reproductive age and can impair their work productivity, relationships, social activities and life quality.[3,6] The prevalence of PMS has been reported substantially high in many populations. Therefore, PMS can cause insufferable situations for many women of reproductive age.[7–9]

Although the aetiology of PMS has not been clearly defined, factors such as hormonal imbalance (serotonin deficiency and impaired levels of other neurotransmitters, abnormalities in renin-angiotensin-aldosterone axis and alterations in the gamma-amino butyric acid (GABA)), dietary intake (excessive energy intake, deficiency of calcium, magnesium or thiamine), genetic predisposition and psychological abnormalities play a major role in the occurrence of PMS. It seems that these factors frequently result in hypoglycaemia, insulin resistance, dysmenorrhea and symptoms of depression, anxiety or irritability in women with PMS.[10,11] In addition to the biological factors, sociodemographic characteristics, cultural behaviours and attitudes towards menstruation are reported as the trigger factors of PMS development.[12]

Different aspects of nutritional status have been associated with the presence and/or severity of PMS. First, obesity has been suggested as a risk factor for PMS according to the results of cross-sectional studies conducted on adult women

K. Isgin-Atici, MSc, Research Assistant, Dietitian
N. Kanbur, MD, PhD, Professor
S. Akgül, PhD, Associate Professor
Z. Buyuktuncer, PhD, Associate Professor
Correspondence: Z. Buyuktuncer, Faculty of Health Sciences, Department of Nutrition and Dietetics, Hacettepe University, 06100 Sihhiye, Ankara, Turkey. Tel: +90 312 3051096; Fax: + 90 312 3091310.
Email: zbtuncer@hacettepe.edu.tr; zbuyuktuncer@gmail.com

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aged 25–52 years.[13–15] Because obesity is diagnosed using anthropometrics, one of the four components of nutritional assessment, and is generally an inevitable outcome of overnutrition, it is considered as a factor that linked to nutritional status. Second, cross-sectional studies showed that consumption of certain specific food and beverages such as tea, coffee, soft drinks, alcohol and chocolate was associated with the presence of PMS symptoms in adult women.[16,17] Finally, excessive or deficient intake of certain specific macronutrients (e.g. total carbohydrates, total fat, saturated and polyunsaturated fatty acids) and micronutrients (e.g. thiamine, riboflavin, vitamin B6, vitamin D, calcium, magnesium, sodium, potassium and zinc) were associated with the presence or severity of PMS symptoms in adult women.[13,17,18] For instance, high intake of fat, in particular saturated fatty acids, was associated with the presence of symptoms like breast swelling, tenderness and nodularity and water retention due to the increased levels of oestrogen.[17,18] A Western diet rich in fast foods, fried foods, meats, sugars, snacks, refined grains, soft drinks, high-fat dairy products was also associated with a higher PMS morbidity in a case-control study on adult women.[19] Moreover, an intervention study on adult women showed that the Western diet with a high fat (40% of energy) and low fibre (12 g/day) content increased the severity of premenstrual symptoms compared to a vegetarian diet containing a moderate-fat (30% of energy) and high fibre (28 g/day), explained by the increased level of oestrogen in the Western diet group.[20] Similarly, a low-fat vegetarian diet was associated with increased serum sex-hormone binding globulin concentration and premenstrual syndrome duration in a cross-over study conducted on adult women.[21] Although the effects of different dietary components on PMS have been separately examined, the role of diet quality of different dietary components as a whole in PMS has not been examined. Moreover, the relation between nutritional status and presence and/or severity of PMS symptoms is not known well in adolescents. Therefore, the present study aimed to examine the relationship between diet quality and the presence/severity of PMS symptoms in adolescents aged 13–18 years.

Methods

The data used in the present study were obtained from a broad case-control study in which the relationship between nutritional status, eating attitudes, and the presence/severity of PMS in adolescents were surveyed.[22] Data were collected from female students aged 13–18 years at a high-school setting in Ankara, Turkey, between September 2013 and September 2014, and processed between September 2014 and April 2015. The school was selected randomly by the Ministry of Education and participants were randomly chosen by the administrative staff of high school. Participants were excluded if they presented with irregular menstruation, history of a psychiatric disorder or a serious childhood trauma, a chronic disease or if they used hormone therapy, antidepressant drugs or were on a special diet in the past 3 months. The present study was approved by Hacettepe University Non-Interventional Clinical Research Ethics Board (GO 13/482—15). In addition, an informed consent was obtained from each participant and their parents.

PMS was diagnosed by administrating the premenstrual syndrome scale (PMSS) twice in consecutive 2 months to the same participants prospectively, and assessing the symptoms during the 1 week prior to the menstruation. PMSS was adapted from DSM-III (Diagnostic and Statistical Manual of Mental Disorders-Third Edition) and DSM-IV-R (DSM-IV Revised) by Gençdoğan.[23] PMSS has nine subscales: depressive feelings, anxiety, fatigue, irritability, depressive thoughts, pain, changes in appetite, changes in sleeping and swelling. The score of PMSS is ranged between 44 and 220 points and the cut off for the diagnosis of PMS is 110 points. Therefore, adolescents with a score of 110 or more were included in the PMS group whereas the others were included in the control group. The study sample consisted of 272 participants; 155 adolescents with PMS in PMS group and 117 adolescents without PMS in control group. The post hoc power of the study was between 65 and 82% according to HEI total and subscale scores, whereas it was 99% according to PMSS score. The alpha level, used to arrive at the power observed, was chosen at 5%.

A face-to-face interview method between participants and researchers in a meeting room at school setting was used to record the details of the participants. General characteristics (age, health status, educational background and occupation of mothers), the smoking habits and alcohol consumption, physical activity level and meal pattern (number of meals in a day) were recorded once, on the same day that the initial PMSS was administered. Physical activity level was assessed using a validated scale, Turkish version of the International Physical Activity Questionnaire (IPAQ) short form by confirming the replies of participants after they filled the questionnaire. The physical activity level was classified into three groups according to the total MET values: sedentary (<600 MET/min/w), moderate (600–3000 MET/min/w); and vigorous (>3000 MET/min/w).[24]

On the initial visit, dietary intake was assessed using 24-hour-dietary recall method and PMSS was administered. This method was chosen as it has relatively minimal burden imposed on participants. Portion sizes were confirmed using food portion size photographic atlas. Records were analysed by BEBIS dietary analysis program (Version 7.1) based on the national food composition database. Diet quality was assessed by The Healthy Eating Index—2010 (HEI-2010) due to its reliability and consistency. HEI-2010 is a tool including 12 components: 9 adequacy and 3 moderation components. Adequacy components are total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, fatty acids; while moderation components are refined grains, sodium, empty calories. The maximum score of this index is 100 points; and 0–50 points is categorised as 'poor', 51–80 points is 'needs improvement', and 81 points and above is 'good'.[25,26] The number of meals in a day was also investigated.

Body weight, height, along with waist and hip circumferences were measured once by the research dietitian when

the PMSS was administered for the first time. Body weight was measured in lightly dressed clothing without shoes using Inbody 720 (Biospace, Seoul, Korea). Height was measured using Seca Medical Scale (model 767; Hanover, Maryland, USA) in the position of Frankfort plane without shoes. Waist circumference was performed at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest (considered as normal: ≤80 cm); hip circumference was measured around the widest portion of the buttocks (waist/hip ratio considered as normal <0.85). Height and Body Mass Index (BMI) were assessed according to World Health Organization (WHO) 2007 z-score classification. Participants who had BMI lower than −1 SD were accepted as underweight, between −1 and +1 SD as normal, and over 1 SD as obese.[27]

Statistical package for social sciences (SPSS) program Version 22 was used to analyse the data. General characteristics were presented using frequency distributions. χ^2 Test was used to examine the statistical differences between the PMS and control groups. Kolmogorov–Smirnov test was used to confirm whether distribution was normal or abnormal for continuous variables. Independent Sample *t*-test was used to examine the difference between groups for parametric continuous data, while Mann Whitney *U* Test was used for nonparametric continuous data. PMSS subscales were compared using one-way analysis of variance (ANOVA), and Bonferroni correction was used for post hoc analysis. The odds ratio for presence of PMS according to the HEI category was estimated by adjusting for age, age of menarche, physical activity, energy intake and BMI using the high HEI as the reference category (OR = 1.0) with logistic regression. The value of error level α was chosen as 0.05.

Results

The prevalence of PMS was 56.9% in the study population. The mean PMSS score of all participants was 116.6 ± 37.11 points, while it was 143.3 ± 21.27 points in the PMS group and 82.4 ± 15.87 points in the control group ($P = 0.007$).

Mean age was 15.6 ± 1.04 and 15.5 ± 0.93 years in PMS and control groups, respectively ($P = 0.356$). Sociodemographic characteristics, maternal occupational status and educational background were similar in both groups ($P = 0.539$ and $P = 0.454$, respectively). Both smoking and alcohol consumption were reported 4.5% by the PMS group, while no one used tobacco or alcohol in the control group ($P = 0.021$, for each). The participants usually had a moderate physical activity level (PMS group, 58.8%; control group 47.1%; $P = 0.140$). No significant difference was found in anthropometric measurements between groups ($P > 0.05$, for each) (Table 1).

As seen in Table 2, diet quality was significantly better in the control group compared to the PMS group. HEI-2010 total score was 47.5 ± 23.95 points in the PMS group whereas it was 53.5 ± 20.98 points in the control group ($P = 0.034$). The difference between total HEI-2010 scores of groups can be explained by the different consumption patterns of total fruits, whole and refined grains, seafood and plant proteins. Among the HEI sub-scores, total fruit score was lower in the PMS group (2.0 ± 2.32 points) when compared to the control group (2.6 ± 2.40 points) ($P = 0.045$). Similarly, whole grain score (2.2 ± 2.37 points) was lower whereas refined grain score (7.8 ± 4.83 points) was higher in PMS group compared to control group (2.8 ± 2.32 points and 6.7 ± 4.17 points, respectively) ($P = 0.037$, for each). Moreover, the score of seafood and plant proteins was significantly lower in PMS group (3.4 ± 2.75 points) than in control group (4.1 ± 2.13 points) ($P = 0.019$). Other sub-scores of HEI-2010, including whole fruit, total vegetables, greens and beans, dairy, total protein foods, fatty acids, sodium, empty calories were similar in both groups ($P > 0.05$ for each).

PMSS subscale scores, except swelling, were higher in participants with poor diet quality compared to participants with better diet quality. However, only the scores of depressive feeling, anxiety and changes in sleeping were significantly different between HEI-2010 groups. Participants with good diet quality had significantly lower scores of depressive feeling ($P = 0.016$), anxiety ($P = 0.009$) and changes in sleeping ($P = 0.000$) compared to the other HEI-2010 groups (Table 3). Furthermore, in the total study sample those with a decreased in HEI scores had a significant increase in the likelihood of having PMS. The trend for increasing presence of PMS was statistically significant among HEI groups. When poor diet quality was compared with good diet quality, PMS risk was 3.33 times higher in the participants with poor diet quality (OR: 3.3, 95% CI: 0.87–12.77; $P = 0.07$); however, this finding was not statistically significant because CI was wide and also included 1.

Discussion

Although for some women the occurrence and recurrence of mood and physical symptoms during the luteal phase of the menstrual cycle causes a minor disturbance, for others these disturbances can be severe enough to disrupt their lives. Therefore, it is of extreme importance to establish the factors both contributing to and increasing premenstrual symptoms. In the present study, the relationship between nutritional status including diet quality and anthropometric measurements, and the presence/severity of PMS symptoms was examined in adolescents, and it was suggested that a diet with low quality could be a trigger factor in the presence and/or severity of PMS.

Previous studies showed that individuals with PMS consume fast foods rich in total fat and sugar, snacks, red and fatty meats, and caffeinated beverages more frequently and in higher amounts whereas they rarely consume dairy products.[17,19,28] A Western dietary pattern has been associated with PMS morbidity.[19] A study showed the prevalence of PMS to be 2.96 times higher in women consuming fast food when compared with those consuming vegetables and fruits.[29] Moreover, excessive intake of total carbohydrate, total fat, sodium, and deficient intake of calcium,

Table 1 Demographic characteristics

		PMS group (n = 155)		*Control group (n = 117)*		P
Age (X ± SD)		15.6 ± 1.04		15.5 ± 0.93		0.356[(a)]
Mother education		n	%	n	%	
Illiterate		8	5.2	3	2.6	0.454[(c)]
Literate/Primary school		89	57.4	71	60.7	
Secondary school		35	22.6	21	17.9	
High school and higher degree		23	14.8	22	18.8	
Mother occupational status						
Stay at home mother		132	85.2	103	88.0	0.539[(c)]
Self-employment		8	5.2	3	2.6	
Civil servant/ worker/ retired		15	9.6	11	9.4	
Smoking	Yes	7	4.5	0	0.0	0.021[d*]
	No	148	95.5	117	100.0	
Alcohol consumption	Yes	7	4.5	0	0.0	0.021[d*]
	No	148	95.5	117	100.0	
Physical activity level	Sedentary	40	35.1	35	40.2	
	Moderately active	67	58.8	41	47.1	0.140[(c)]
	Vigorously active	7	6.1	11	12.6	
Body mass index	Lean	19	12.2	19	16.4	
	Normal	107	69.1	77	65.6	0.888[(e)]
	Overweight-obese	29	18.7	21	18.0	
Waist circumference (cm)		76.2 ± 2.18		75.9 ± 9.17		0.477[(a)]
Hip circumference (cm)		93 (66–121)		93.5 (81–126)		0.948[(b)]
Meal pattern	Number of main meals in a day	2.2 ± 040		2.3 ± 0.49		0.300[(a)]
(Mean ± SD)	Number of total meals in a day	3.9 ± 1.20		3.9 ± 1.13		0.696[(a)]

[(a)] Independent sample *t*-test.
[(b)] Mann Whitney *U* test.
[(c)] Likelihood test.
[(d)] Fischer exact test.
[(e)] Pearson χ^2 test.
*$P < 0.05$; PMS, premenstrual syndrome.

Table 2 Total and sub-group HEI-2010 scores of high-school students according to the presence of PMS

	The presence of PMS				
	PMS (n = 155)		*Control (n = 117)*		
Scores of HEI	*Mean ± SD*	*Median (Min-Max)*	*Mean ± SD*	*Median (Min-Max)*	P
Total fruit	2.0 ± 2.32	0 (0–5)	2.6 ± 2.4	3.9 (0–5)	0.045[(a)*]
Whole fruit	2.1 ± 2.43	0 (0–5)	2.7 ± 2.46	5 (0–5)	0.072[(b)]
Total vegetables	2.3 ± 2.46	0 (0–5)	2.8 ± 2.46	5(0–5)	0.078[(b)]
Greens and beans	0.1 ± 0.79	0 (0–5)	0.1 ± 0.8	0 (0–5)	0.954[(a)]
Whole grains	2.2 ± 2.37	0.6 (0–5)	2.8 ± 2.32	4.3 (0–5)	0.037[(b)*]
Dairy	3.0 ± 3.41	1.2 (0–10)	3.4 ± 2.99	5 (0–10)	0.355[(b)]
Total protein foods	3.1 ± 2.85	5 (0–5)	3.7 ± 2.61	5(0–5)	0.070[(b)]
Sea food and plant proteins	3.4 ± 2.75	4 (0–5)	4.1 ± 2.13	4 (0–5)	0.019[(a)*]
Fatty acids	5.9 ± 3.25	6.4 (0–10)	5.7 ± 3.57	6 (0–10)	0.552[(a)]
Sodium	4.7 ± 4.4	5.9 (0–10)	5.1 ± 4.29	5.6 (0–10)	0.503[(b)]
Empty calories	12.1 ± 9.5	19 (0–20)	12.7 ± 9.05	10 (0–20)	0.596[(b)]
Refined grains	7.8 ± 4.83	10 (0–10)	6.7 ± 4.17	9 (0–10)	0.037[(b)*]
Total healthy eating index score	47.5 ± 23.95	53.7 (0–86)	53.5 ± 20.98	57.4 (0–94.8)	0.034[(a)*]

[(a)] Independent sample *t*-test.
[(b)] Mann Whitney *U* test
*$P < 0.05$; HEI, healthy eating index; PMS, premenstrual syndrome.

Table 3 PMSS subscale scores according to HEI score classification

	HEI scores						
	0–50 Points (poor, n = 110)		*51–80 Points (needs improvement, n = 149)*		*81–100 Points (good, n = 13)*		
PMSS subscales	*Mean ± SD*	*Median (Min-Max)*	*Mean ± SD*	*Median (Min-Max)*	*Mean ± SD*	*Median (Min-Max)*	P[(a)]
Depressive feeling	23.5 ± 7.87	25 (9–35)	19.8 ± 6.67	20 (7–35)	17.7 ± 7.18	18 (7–35)	0.016*
Anxiety	19.6 ± 8.67	16 (9–33)	15.4 ± 6.23	14 (7–32)	13.5 ± 6.34	12 (7–33)	0.009*
Fatigue	21.5 ± 5.68	21 (12–30)	18.9 ± 6.13	19 (6–30)	18.1 ± 6.57	17 (7–30)	0.151
Irritability	16.3 ± 6.05	16 (6–25)	15.3 ± 6.06	16 (6–25)	14.2 ± 6.22	14 (5–25)	0.240
Depressive thoughts	20.1 ± 7.3	19 (10–35)	17.3 ± 7.24	16 (7–34)	16.3 ± 7.3	16.5 (7–35)	0.172
Pain	9.8 ± 2.48	9 (6–15)	8.1 ± 3.15	8 (3–15)	8.1 ± 3.25	7 (0–15)	0.158
Changes in appetite	10.2 ± 3.18	10 (5–15)	9.1 ± 3.69	9 (3–15)	8.8 ± 3.67	9 (0–15)	0.419
Changes in sleeping	11.5 ± 2.6	12 (7–15)	8 ± 3.18	8 (3–15)	7.2 ± 3.26	7 (0–15)	0.000*
Swelling	7.2 ± 3.63	8 (3–14)	6.6 ± 3.35	6 (3–15)	7.1 ± 3.74	6 (0–15)	0.508

[(a)] *P* one-way analysis of variance test (ANOVA).
*$P < 0.05$; HEI, healthy eating index; PMSS, premenstrual syndrome scale.

magnesium, zinc, thiamine, riboflavin, vitamin B6, vitamin D and vitamin E are linked to presence and/or severity of PMS.[17,30–32] It seems that high fat, in particular saturated fat, and high-sodium content of Western diet plays a critical role in this association. Because high-fat intake has a potential to increase the level of oestrogen in the circulation,[17] it may cause hormonal fluctuations during the premenstrual period.[18] Furthermore, it was suggested that dietary sodium intake may lead to increase in fluid retention as oestrogen induces angiotensinogen synthesis from the liver and increases aldosterone release, and thus resulting in bloating and breast tenderness related to PMS.[33] Although the current study suggests that diet is a contributing factor to the presence of PMS in adult women, this is the first study examining the relationship between diet quality and PMS and its subscales in adolescents.

Because different aspects of diet have been linked to PMS symptoms, it can be expected that PMSS subscales scores could vary depending on the diet quality. The present study showed that almost all PMSS subscale scores were decreased by increased HEI scores. Of all subscales, depressive feeling, anxiety and changes in sleeping subscale scores were significantly lower with a high-quality diet. Depressive feeling and anxiety have been linked to some dietary components such as omega-3 fatty acids and phytochemicals. It is known that dietary intake of omega-3 fatty acids has a positive effect on depressive mood.[34] As expected, a higher consumption of sea foods and plant proteins, rich in omega-3 fatty acids and phytochemicals was obtained in the high HEI group. Menstrual-related hormonal fluctuations may be responsible for sleeping changes especially in women with PMS.[35] Changes in sleeping also have been linked to diet previously. For instance, Peuhkuri *et al.*[36] reviewed the literature, and reported that the increased consumption of refined grains and decreased consumption of fruits and vegetables were associated with decreased sleeping duration, that is also parallel with the results of the current study. Due to the fish, whole grain, fruit and vegetable content, Mediterranean diet might be a promising dietary pattern in the prevention of PMS. Further research is required to confirm this.

The present study showed that the quality of diet of the adolescents with PMS was lower than those without PMS because consumption of seafood and plant proteins, total fruits and whole grains were lower, whereas that of refined grains were higher. The consumption of seafood included fish, and plant protein sources included nuts, seeds, soy provides dietary omega 3 fatty acids, vitamin E, B vitamins, magnesium, calcium, zinc and isoflavones. Previous studies showed that deficient intake of calcium, magnesium, zinc, thiamine, riboflavin, vitamin B6, and vitamin E may play role in the presence and/or severity of PMS.[17,30–32,37] The present study is consistent with the literature in terms of less consumption of these foods containing the relevant nutrients in the PMS group. The intake of n-3/n-6 fatty acids in adequate amounts is especially important for a normal GABA level and management of PMS symptoms.[38] A study conducted in Japanese athletes with PMS/Premenstrual Dysphoric Disorder (PMDD), suggested that fish consumption may be positively associated with alleviating of PMS/PMDD-induced athletic problems.[39] Additionally, n-3 fatty acids have been shown to be effective on the relief of depression and menstrual pain related to PMS.[40]

Studies showed that total fruit consumption was significantly lower in people with PMS.[19,28] Consumption of fruit and vegetable also has been shown to have a positive effect on menstrual pain.[41] Fruit and vegetable consumption significantly contributes to the dietary intake of fibre, B

vitamins, potassium, calcium and magnesium that has been associated with the occurrence of PMS. The present study emphasised the importance of adequate fruit consumption in terms of prevention of PMS symptoms via the significantly low level of consumption of fruits in PMS group. In the present study, it was also shown that adolescents with PMS had a low consumption of whole grains and a high consumption of refined grains which could also be a contributing factor triggering the symptoms of PMS. Whole grains are important components of a healthy diet as they are packed with protein, fibre, B vitamins, iron, zinc, copper, magnesium and antioxidants including vitamin E and phytochemicals.[42,43] The content of B vitamins, fibre and minerals of whole grains might be especially linked to PMS symptoms. B group vitamins are associated with GABA, serotonin and dopamine neurotransmitter synthesis, and the deficiency of each neurotransmitter is associated with some psychological symptoms such as depression in PMS.[44,45] For instance, in a previous study, dietary thiamine intake decreased the PMS risk up to 25% in participants who took 1.9 mg/day thiamine compared to the participants whose thiamine intake was lower.[32] Vitamin E is known to play role in the regulation of both prostaglandin and neurotransmitters synthesis. It was shown that vitamin E supplementation blocks arachidonic acid causing a decrease in GABA levels.[46] In addition to vitamins, low levels of magnesium cause a decrease in brain dopamine concentration, which causes adrenal cortex hyperplasia, aldosterone elevation and fluid retention. Magnesium can also regulate possible hypoglycaemic conditions that can be seen in PMS, also by reducing glycaemic-dependent insulin secretion.[47,48] Dietary zinc intake also might be related to PMS symptoms due to its progesterone binding effect on human endometrium.[49] Therefore, sufficient dietary intakes of these vitamin and minerals through dietary sources seems to be critical to prevent or manage with the PMS symptoms. However, further research is required to understand fully their potential role in the physiological mechanisms.

Prevalence of PMS changes in a wide range depending on the characteristics of study sample and the used diagnostic tool.[7–9,49,50] The prevalence of PMS (56.9%) in the present study was found similar to the prevalence reported in the previous studies which the same scale was used.[8,51]

Lifestyle behaviours such as smoking, alcohol consumption and physical activity levels have been associated with the presence of PMS.[17] It was suggested that cigarette smoking exacerbated the severity of PMS symptoms;[52] and studies showed that smoking was more common in women with PMS.[14,52,53] Similarly, alcohol use was also suggested as a trigger for some PMS symptoms such as depressive mood, anxiety and headache.[14] Furthermore, this supports the role of these factors in PMS because smoking and alcohol consumption were only reported in the PMS group. However, the present study failed to show different physical activity levels in PMS and control groups. This can be explained by the sedentary behaviour in almost all of the study population that prevented us from examining the effect of different physical activity levels on the presence of PMS. Because mothers' education and employment were suggested as the sociodemographic factors that might affect the presence and/or severity of PMS in previous studies,[7,54] mothers' education and occupational status were also recorded in the present study. Similar to the results of current study, a study showed no association between mother educational or occupational status and the presence of PMS.[54] The majority of mothers had similarly low education level in both groups, thereby any significant difference that impact PMS symptoms was observed. It is recommended that future studies incorporate a large percentage of mothers with higher levels of education to identify any difference in diet quality, anthropometric measurements and PMS.

The presence of obesity or being overweight has been commonly studied in regards of PMS.[27,55–57] A study showed that the risk of PMS in the participants with high BMI was 2.43 times more than those with normal BMI.[37] Another study has determined a strong relationship between risk of PMS and higher BMI.[15] However, comparable to the results of the present study, there are also conflicting results that showed no relationship between anthropometric measurement and PMS.[27,56] Further research incorporating larger study population over a longer time period is needed to address the conflicting relationship between anthropometric measurements and PMS.

Some limitations of the study should be addressed. First, it is important to note that small sample size and single-centre study setting limited the generalisation of the results. The homogeny structure of study sample might be caused to observe similar results in both groups. For instance, the majority of the study sample had a poor diet quality independent of the PMS presence. Therefore, further studies with heterogeneous study samples, in terms of sociodemographic characteristics, are required. Second, 24-hour dietary recall method had some limitations even if it is accepted as adequate for surveying intake in a large group and estimating group mean intakes of diet. This method may not represent the long-term dietary habits due to the variations in the dietary intake day-to-day, in particular depending on the day of week or the season. Furthermore, all information recorded using 24-hour dietary recall depends on the participants' memory and the skills of a trained researcher to minimise recall bias. Also, misreporting is an important issue for 24-hour dietary recall as in other dietary assessment methods. A previous study showed that the misreporting was associated with age, gender, education level, income level, household status, self-rated health, physical activity and obesity.[58] Because the general characteristics of participants in both groups were similar in the present study, it might be considered that misreporting did not lead to confound the findings. In spite of the limitations, the present study provided a significant contribution because it is one of the first studies that report the relationship between overall diet quality and PMS in adolescents. Future studies are needed to understand the causal relationship between diet quality and presence/severity of PMS.

In conclusion, dietary intake may be a trigger factor for PMS morbidity in adolescents. While focusing on specific food and beverages or certain nutrients as a risk factor for PMS, the quality of the diet as a whole should also be considered. Encouraging the adolescents to improve the quality of their diet may not only alleviate the severity of the PMS symptoms but may also reduce the risk of its development.

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Conflict of interest

The authors declare no potential conflicts of interests.

Authorship

KI contributed to the collection, analysis and interpretation of data; NK and SK revising the manuscript critically for important intellectual content and the final approval of the version; ZB was supervisor in the present study, and participated to the design of the study, drafting, revision of the manuscript and approval of the final version. All authors are in agreement with the manuscript and declare that the content has not been published elsewhere. The authors wish to thank the school students and teachers for their contribution to the study.

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ORIGINAL RESEARCH

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Mothers' experiences with complementary feeding: Conventional and baby-led approaches

Libby Swanepoel PhD, Lecturer | **Justine Henderson BND (Hons), APD, Student** | **Judith Maher PhD, Lecturer**

School of Health and Sport Sciences, University of the Sunshine Coast, Sunshine Coast Region, Queensland, Australia

Correspondence
Libby Swanepoel, School of Health and Sport Sciences, University of the Sunshine Coast, Locked Bag 4, Maroochydore DC, QLD 4558, Australia.
Email: lswanepo@usc.edu.au

Funding information
School of Health and Sport Sciences, University of the Sunshine Coast

Abstract

Aim: Lifelong eating behaviours are shaped in infancy with the introduction of solid foods (complementary feeding). A conventional approach to complementary feeding, encompassing spoon feeding of pureed foods, has long been the standard. Baby-led weaning is a contemporary approach whereby the infant is encouraged to choose what and how much they eat. Mothers navigate decisions about what and how to introduce foods to their infant in diverse ways. This study set out to explore the complementary feeding approaches of women.

Methods: A qualitative study utilising photovoice and focus groups generated data that provided insight into women's lived experiences of complementary feeding. Thirteen women were purposively sampled and data were analysed in line with descriptive phenomenology.

Results: Three recurrent themes emerged from the data. Women's approaches to complementary feeding were mediated by "trust," "convenience" and making decisions that were "value based versus practical based." Trust manifested in various forms including trusting the infant, trusting women's own instincts and the tension between social pressures and trust of self.

Conclusions: Differences between women following a conventional vs baby-led approach were also seen in perceptions of convenience, and the decision-making process. This study provides insight into how and why women choose certain feeding practices and can be used to better equip health professionals to work with new mothers in providing realistic and nuanced feeding support.

KEYWORDS

baby-led weaning, complementary feeding, infant feeding decisions, qualitative methods

1 | INTRODUCTION

Infancy, the period from birth to 12 months of age, is a crucial time of developing healthy eating behaviours.[1] During infancy the process of introducing solid food to an infant (complementary feeding) begins.[2] In most families, mothers play a primary role in feeding children.[3] Conventional infant feeding recommendations advise the use of a spoon to introduce pureed foods, followed by progression to mashed, lumpy and regular family foods between 6 and 12 months of age, depending on infant rate of development, which can vary from quickly to more gradual.[1,4] Baby-led weaning is an alternative approach that has grown in popularity in the past 10 to 15 years.[5] The emphasis of the baby-led approach

is on allowing the infant to choose what and how much they eat based on food that is offered, as well as inclusion of the infant in family meals.[5]

Benefits of the baby-led approach include the development of healthier eating patterns in childhood,[6] higher macronutrient intake associated with foods that require chewing,[7,8] possible association between chewing ability and speech development,[5] better appetite control in some cases[9] and convenience.[6] At about 6 months of age, most infants are considered capable of eating soft finger foods which aligns with the baby-led approach.[5,6,8] Despite this, some health professionals have raised concern regarding the potential for energy and iron deficiencies and choking hazards.[6,10] Consequently, some have suggested that a combination of pureed and finger foods may be the best way of increasing nutrient intake during the early complementary feeding phase.[8,11]

Transition from milk feeds to solid food is one of the critical timepoints where feeding preferences are established.[12] Feeding preferences, in turn, effect dietary patterns as the infant moves through childhood and can influence the development of chronic diseases later in life.[13] Mothers report the process of complementary feeding as being an essential part of their lives, requiring time, consideration and commitment.[14] Understanding what underpins mothers' decisions about complementary feeding at this initial stage can help practitioners to appropriately support women during this crucial time of infant development, and promote optimal lifelong healthy eating behaviours. Available studies suggest that all mothers find complementary feeding both a challenging and a positive experience.[15-17] However, qualitative research exploring mothers' experiences of complementary feeding has largely focussed on women following a conventional approach or a baby-led approach, and rarely the two together. This study explores the lived experience of women following each of these approaches. As such, the aim of this study is to explore the complementary feeding approaches and experiences of a sample of Australian mothers.

2 | METHODS

Descriptive phenomenology underpins, this qualitative study given the exploratory nature of the study in aiming to understand the complementary feeding experiences of mothers.[18] Descriptive phenomenology is congruent with the aim of this study as it examines everyday conscious experiences derived from the participants' natural viewpoint while preconceived opinions are set aside (bracketed).[19] Qualitative methods, including photo-voice and focus groups, were used to generate data that enabled us to gain insight into women's lived experiences. Photo-voice is a process whereby participants use cameras to document the reality of their lives[20] and has previously been used successfully to explore experiences and attitudes.[21] Focus groups were used for their ability to display diversity of experiences, as well to generate discussion and prompt recall of experiences not possible through other data collection methods.[18] Ethical approval was obtained from the University of the Sunshine Coast Human Research Ethics Committee (approval number S13543).

Participants were sampled purposively based on the following inclusion criteria: (a) women about to introduce solid foods to their infants, (b) 18 years of age or over, (c) infants without any health or medical conditions, (d) access to a camera or camera phone, (e) access to email and (f) live in South-East Queensland, Australia. Several modes of advertising were used to recruit women over a 3-month period, these included posters displayed at child care centres, parents' rooms in shopping centres and pharmacies; advertisements posted online through social media. Snowball sampling was additionally used whereby existing participants recruited others from within their own social circles, a common technique used in qualitative research to recruit information-rich participants.[22] Consent was assumed on receipt of photographs and written consent was obtained prior to the focus group.

Women were asked to view a training video developed by the research team, which reiterated the aim of the research and instructed them on the steps to taking an appropriate photograph. Participants were instructed to take photographs of objects personally meaningful to their complementary feeding experience and all new foods offered to their infant, being anything other than breast milk, infant formula or water. Participants submitted their photographs once a week for the month when they first introduced complementary foods to their infant. Photographs were coded and sorted into categories. Participant recruitment ceased when no new categories emerged from the photos. Photographs were de-identified by removing people's faces and printed for use in the focus group. Selecting and contextualising participants photos during the focus group was used to promote reflection and develop an understanding of the meaning attributable to their experience.[23]

Focus group questions were developed to guide discussion enabling exploration of women's experiences and to reduce researcher influence on the topics covered in the focus group (see Table 1). Demographic information was collected via a short self-administered questionnaire. Focus group questions and the demographic questionnaire were piloted with a group of mothers resulting in minor alterations to wording. Focus groups were held at local community centres and lasted between 60 and 90 minutes. No incentives were offered; however, participants were provided with morning tea and petrol/travel costs were reimbursed. A

TABLE 1 Guiding questions for focus group discussions

(1) How did you come to introduce solid foods to your infant?
(2) Thinking back to when you first introduced solid foods, what were some of your more memorable experiences?
(3) Looking at your photographs could you please select one or two photographs that are most meaningful to your experience of introducing solids that you would like to share?

single experienced female facilitator (L.S.) conducted all focus groups to increase project rigour, while a second moderator (J.H. or J.M.) was present to take field notes and prompt further discussion if considered necessary.

Focus groups were audio taped, transcribed and de-identified. Field notes were taken regarding the content of the focus group to assist data immersion and reflection.[18] In line with descriptive phenomenology, analysis of transcripts focused on identifying common patterns of meaning for participants.[24] Initial analysis was conducted in context of the broader research questions and initial codes developed from an inductive process to which the data was central.[25] As with descriptive phenomenological analysis, coding centred around the experiences and perceptions of women to gain insight and understanding.[26] Photos provided insight into women's lives allowing for greater contextualisation of the focus group data. From this, codes were examined for repetition resulting in the merging of multiple codes. These codes were then sorted under potential themes.[25] Following this, secondary analysis of themes identified from women following a baby-led approach or a conventional approach to complementary feeding was conducted. Transcripts were analysed by two authors (J.M. and J.H.). The other author (L.S.) subsequently analysed a subset of focus group transcripts. Consensus on major themes was reached through discussion.[27] Bracketing was employed, whereby the researchers attempted to remove themselves from their own personal experiences throughout the analysis process in order to improve the trustworthiness of the data.[28] The software QSR NVivo10 was utilised to assist in data management and demographic data was analysed descriptively. The authors followed qualitative research reporting guidelines set out in the consolidated criteria for reporting qualitative research (COREQ).

3 | RESULTS

Twenty-nine eligible women expressed initial interest in the study, of which 16 submitted photographs and 13 attended one of four focus groups. Only the photographs of women attending each of the focus groups were included, the remainder were removed and deemed lost to follow-up. Six women were classified as following a baby-led approach and seven women followed a conventional approach to complementary feeding. Classifications were made based on the type and texture of foods first offered to infants according to photographs submitted. Definitions of conventional vs baby-led approaches were discussed, and although women self-identified as following a baby-led approach it appeared that in practice some were more relaxed around the definition and followed a combination of the two approaches.

The demographic characteristics of the participants are summarised in Table 2. On average, women identifying as adopting a baby-led approach were younger (29 years old [±1.8]) than those identifying as following a conventional approach (35 years old [±3.2]). Most women who identified utilising a baby-led approach (n = 5) introduced solids at 6 months, while those using a conventional approach largely (n = 6) commenced complementary feeding between 4.5 and 5.5 months.

Participants described in detail their approaches to complementary feeding. Instead of a completely distinctive approach of introducing purees or solid finger food we

TABLE 2 Demographic characteristics

Characteristics of sample (n = 13)	Conventional (n)	Baby-led (n)
Number of children		
Primiparous	1	3
Multiparous	6	3
Marital status		
Married	6	3
De facto relationship	1	2
Unknown	0	1
Highest education		
Bachelor degree or higher	7	3
Without a bachelor degree	0	3
Current employment		
Not in the labour force	2	1
Employed on paid leave	1	1
Employed on unpaid leave	2	0
Employed part time	2	1
Employed full time	0	2
Unknown	0	1
Time of decision regarding how to introduce solids		
Before I became pregnant	0	2
Early in my pregnancy	0	1
After my baby was born	5	3
Other: using perceived readiness cues	2	0

found some variability. Those who self-identified as following a baby-led approach described key concepts including the use of family foods (of any texture), and an emphasis on infant exploration of finger foods rather than feeding from a spoon. The following quotes highlight some of this diversity from those identifying as following a baby-led approach:

> "…he just got what we ate, but blended." (Participant 7, baby-led)

> "At six months I decided just to start playing around with different foods, we did baby-led weaning. Well kind of – my take on it, and yeah, he just played with food." (Participant 5, baby-led)

Three recurrent themes emerged from the data. Women's approaches to complementary feeding were mediated by (a) trust, (b) convenience and (c) making decisions that were value based vs practical based.

The first theme that emerged was labelled "trust." The three areas where participants demonstrated trust in their infant related to (a) determining when to commence complementary feeding, (b) selection of appropriate foods and textures and (c) being able to eat or handle foods safely. Determining when to commence complementary feeding was predominantly informed by women's perception of readiness cues. Regardless of the feeding approach, common cues women used included the infant displaying a chewing action or waking more frequently at night. Women reported using these cues more often than a prescriptive age. The actual type and texture of foods introduced differed by approach. Women who identified using a baby-led approach avoided purees as a starting food, trusting their infant to choose foods they could manage. One woman describes her infant's quick transition to finger foods as:

> "She hates pureed food, anything that's mushy, so yeah, she's always been a soft solids finger food person, so we sort of ended up following a baby-led weaning type strategy, accidentally, just because that's what she really wanted to do… I just went with her." (Participant 8, baby-led)

Trusting the infant to choose when to eat was important to a few women who self-identified as adopting a conventional approach. These women trusted that their infant would self-regulate food intake based on need and as such they felt confident offering foods at times when they as mothers did not feel feeding was necessary. Although women adopting both approaches discussed trusting the infant's food preferences, the foods offered to the infant were ultimately selected by the mother.

All women discussed concerns related to choking. Despite underlying concerns, those identifying as using a baby-led approach appeared to trust their infant's ability to eat or handle non-pureed foods safely. As women observed their infant over time, their trust in their abilities increased. Some women felt that when the father had less contact with the infant at meal times, he worried more about choking because he had not developed trust in the infant over time. This was seen more often in those who identified with baby-led approach due to the solid nature of the foods offered.

> "…it was a struggle with my husband who didn't feel comfortable with it [infant's ability]. Every time I'd turn my back he'd have his fingers in her mouth prying food out and he's like, 'No that amount was too big'… and I'm saying, 'She's fine. Let her work it out'. Because I'm doing it all through the day and watching her and then he just come home for the dinner feed… So it's definitely a hard thing to grasp the concept that they can actually work it out." (Participant 5, baby-led)

All women spoke about trusting their own instincts. This self-trust was often associated with responding to and understanding their infant and was used before taking advice from friends, family and health professionals. Much of this trust stemmed from the participant's prior feeding experiences with the infant's siblings, with nine participants being multiparous. A few women following a conventional approach also trusted their own mothers' input, often using her experience as a benchmark for their own child's development and readiness for certain foods. Some women expressed guilt that they associated with not trusting their own instincts, as illustrated in the following quote:

> "My GP had given me some samples of rice porridge… I went home and thought, oh well, I'll try that. But within ten minutes it was all over me and her and the kitchen… And it was bad, because it went against my gut feeling too. I wasn't happy doing it. I didn't want to do it, because I really liked the theory behind baby-led weaning." (Participant 6, baby-led)

Women using both approaches spoke of the perceived pressures from society, media and family members regarding timing of introduction and the type of food offered. Contrary to those identifying as following a conventional approach, some women who self-associated with a baby-led approach

felt strongly about limiting external influences, such as peer groups and family members who were perceived as exposing infants to less "healthy" foods. These women also emphasised difficulties with family members directly offering their child food without understanding the philosophy behind their approach as illustrated in the following quote:

> "The minute she started eating, everyone felt like they could just give her food and they offered her food all the time, especially because she was having chunks of food… Just because it was in the same shape as her pumpkin piece she was eating they just offer it." (Participant 8, baby-led)

They also felt their approach was "alternate," as the following quote explains:

> "… you often hear people say 'Oh, you're giving your baby that?', you know, I guess it's just that if you're doing baby-led weaning, you're doing something that's a little bit different still…" (Participant 6, baby-led)

Despite an intention to follow a baby-led approach, and their subsequent use of this approach, many of these women also felt compelled to use rice cereal as a first food, as illustrated in the quote below:

> "I just really struggled with what to start with, so I went with the social norm of giving rice cereal and she just looked like she was trying to hurl every time I put it near her mouth…" (Participant 8, baby-led)

Women identifying as utilising a baby-led approach appeared to use their own research to overcome their perceived challenges, such as infant choking. Whilst they noted advice from others, their knowledge and confidence seemed to stem from their own research in books, online videos and the internet, as illustrated below:

> "… the biggest fear was choking… So I Googled it and watched quite a few videos of how to tip them upside down and pat their back. So then I felt empowered. I felt like I could manage, that really made a difference, otherwise I would have done the puree, but instead I did the food thing." (Participant 5, baby-led)

In contrast, only one woman who identified as following a conventional approach spoke about using her own research, with many others trusting the advice of health professionals.

On the other hand, a few women did not have a good relationship with their health professional, highlighting the perceived pressure and disapproval felt by women from professionals regarding their complementary feeding practices.

> "I introduce him so early and got lots of those looks like 'What you started at four and a half months?'… From the doctor especially, it's a disapproving look." (Participant 4, conventional)

The second theme that emerged was labelled "convenience." The desire for ease and time efficiency appeared to underpin many feeding decisions for women following a conventional approach. The need for maternal ease influenced when feeding commenced. For example, women discussed introducing solid foods when they returned to work as an attempt to improve their child's overnight sleeping pattern. Conversely, some women who self-identified as conventional feeders delayed solids due to the perceived inconvenience of complementary feeding in their situation, as demonstrated in the following quote:

> "Probably my biggest reason for delaying, we didn't start solids until closer to seven months… I think the main reason is it's inconvenient…" (Participant 10, conventional)

Women identifying as following a conventional approach described using commercial baby foods when time was limited. Although women had intended to prepare food at home, the waste associated with the baby refusing to eat the home cooked food or time constraints led to using commercial baby food. The following quote highlights this transition for a time-poor participant:

> "…I think we're really lucky in this day and age that we've got access to such good premade baby food,… Because I don't have any other children, if I wasn't working I think I would've continued to do a lot of the fresh preparation but whether you've got another child in the mix or if you're working it just becomes a time factor." (Participant 2, conventional)

All women referred to equipment they used to make the feeding process easier or less messy. Using bibs or feeding the infant without clothes on allowed for easier clean up, as did the use of a plastic highchair or a portable infant seat, as illustrated in the following quote:

> "…we have the full hard plastic high chair… and we put it outside, so I can just hose it off and if stuff gets dropped on the ground the dog can eat it up." (Participant 6, baby-led)

Women felt that the feeding process was easier once their infant was able to independently feed him or herself. The use of a "fresh food feeder" in which solid foods are placed in an infant held mesh bag, was utilised by many women who identified as following a conventional approach, and one identifying with a baby-led approach. This was mainly used to increase infant feeding independence reducing the woman's time devoted to feeding the baby, as well as lessening fears of choking.

The third theme that emerged was labelled "value based versus practical based." Women's decision making was underpinned by either their core values or a desire to be practical. It appeared that utilising a baby-led approach allowed women to fulfil their ideals and uphold their feeding values. The following quote demonstrates this ideal:

> "I love food and I want her to grow up appreciating food." (Participant 6, baby-led)

Although to a lesser extent, some women who identified as adopting a conventional approach also shared ideals centred on infant inclusion in family meal times and exploration of foods. These women highlighted an increase in infant enjoyment and independence once complementary feeding progressed to finger foods, as shown in the following quote:

> "When first introducing solids it's the mundane cooking and pureeing. It's when they get to nine months where you're giving them solid foods… those ones are a bit more exciting. It's seeing them feed themselves and having an enjoyable experience with it, that's the more exciting part of the feeding." (Participant 1, conventional)

The original ideals held by women identifying as conventional feeders tended to focus of the use of organic, homemade, "real" food and maternal control of foods offered, with a few highlighting the importance of routine. The following quote illustrates the common ideal:

> "Real food as opposed to going to supermarkets and buying things that have already had the pureeing done for you… I guess trying to take as many unknowns out of it as possible, starting with organic and going through the processes of making all the foods, preparing all the foods yourself just so you're controlling what's going in…" (Participant 10, conventional)

These ideals seemed to change as time became limited and women needed to prioritise what could be realistically achieved. The desire for ease during complementary feeding appeared to lead to a change in values and ideals for most women following the conventional approach, especially related to homemade food preparation. Once feeding ideals were relaxed, it appeared that many women identifying as adopting a conventional feeding approach made practical decisions to facilitate ease and convenience, such as relying on commercial baby foods. These women referred to the availability of organic pre-prepared foods which made them feel okay about this transition:

> "When you can buy it and it's normally organic, hasn't got additives then I think it's just an obvious solution." (Participant 2, Conventional)

4 | DISCUSSION

This study explored the complementary feeding approaches of a sample of Australian women. Using a qualitative approach, we uncovered the similarities and differences in women's experiences. We uncovered three themes that were central to women's experiences with feeding; trust, convenience and a value-driven or pragmatic approach to decision making.

Women in this study were categorised into discrete focus groups based on their approach to complementary feeding; however, some women had a more liberal definition of baby-led weaning that was specific to their context and experience. The variances in how women defined baby-led weaning was underpinned by where (or whom) trust was placed, perceptions of convenience and the values that supported their decision-making process. Some women in this study who self-identified as following a baby-led approach were more flexible in the type and texture of foods offered to their infant; however, they derived value from other elements of the baby-led approach such as shared family food and mealtimes and infant self-regulation of feeding.[6] Practice efforts to support complementary feeding can benefit from understanding the value that women derive from the feeding process, even when approaches are adapted to fit the reality of everyday life.

Trust was central to the complementary feeding experience for all women in this study. Women emphasised the need to trust themselves and their "instincts." As the

primary carer for their child they felt in the best position to make judgements about and respond adequately to their child's needs yet felt challenged by others who were providing advice, whether family, friends or professionals. Murphy (2003) describes the tension between autonomy and privacy in decisions mothers make around infant feeding and the normalising judgements of medicalised discourses and health experts.[29] Women in this study were at times in disagreement with health professionals' guidance and felt guilt in the process of navigating this. While women in this study who identified as following a baby-led approach reported confidence to undertake their own research, those identifying as following a conventional approach were more likely to utilise and follow health professionals' advice. Interestingly, Brown (2015) reported that mothers adopting a baby-led approach in their study tended to be more confident in everyday life compared to more introverted mothers using the conventional approach.[9] Understanding how and why women choose certain feeding practices can better equip health professionals to work with new mothers in providing realistic and nuanced feeding support.

Trusting the infant and allowing them to drive the feeding process was common for women identifying as following the baby-led approach, which is consistent with previous research around baby-led weaning.[17] Emphasis on the infant was more pronounced among those following a baby-led approach in this study, whereby complementary feeding experiences were characterised by infant focused ideals and beliefs and trusting the infant. These women appeared to trust in their infant's innate ability to manage. This finding is supported by recent evidence indicating that a responsive maternal feeding style that is low in control allows the infant to self-regulate feeding naturally.[30] Women identifying as following a baby-led approach wanted their infant to build a healthy relationship with food in the future, another concept supported by findings in previous research.[17] Trust, in various forms, influenced decision making for women in this study. Understanding the role that trust plays in decision making is important for practitioners and researchers to be able to appropriately support women to enable healthy eating opportunities for their infant. This area warrants more research to better understand the needs and perspectives of all mothers.

Convenience was important to all women in this study, but their approach to making the feeding process more convenient differed. Despite all women beginning complementary feeding with the intention to use homemade foods, the ideals of those who aligned themselves with a conventional approach relaxed over time as other priorities became more important and the use of commercial baby puree was accepted as more convenient. Conversely, mothers identifying as following a baby-led approach perceived it to be more time efficient to integrate the use of family foods that were already being prepared as part of the family meal. This may extend a baby-led infant's exposure to a variety of fresh and homemade foods, which could potentially be linked to a higher acceptance of new foods into childhood.[31,32] Health professionals need to consider their advice to women given the importance of convenience for mothers who are time poor. Providing support that addresses both ease and good feeding practices may be better accepted by women.

We have limited understanding of the intake of commercially prepared infant foods in developed countries.[33] The focus of the most recent infant feeding survey in Australia was on breast and formula feeding, no data was collected on commercial infant food.[34] Future research could investigate the extent to which [ultra] processed commercial infant foods are used in the two different approaches to feeding, as well as exploring the longer-term influence of the baby-led approach on new food acceptance during childhood.

Women in this study who identified as following a baby-led approach tended to be value-driven, as opposed to women following a conventional approach who were more pragmatic in their decision making. It appeared that women identifying as following a baby-led approach showed an inherent infant-centred approach to complementary feeding. Infant enjoyment, independence and exploration of foods was valued by women adopting a baby-led approach. Better-quality support practices can be derived from a deeper understanding of the similarities and differences between women's experiences, and the values and thoughts that underpin their decision-making when introducing solid foods. Focus groups were held in the time frame from immediately after and up to 3 months after photograph collection. This may have extended the period of some experiences discussed by women to later feeding experiences, increasing recall bias. However, the use of photographs to prompt recall of experience is likely to have limited the impact of this on our findings. Additionally, as participation was voluntary, the sample may be skewed to women who were interested in complementary feeding and nutrition. Although the sample size was small, and a specific sample was captured (predominantly highly educated, married, multiparous women), a variety of views were captured, and findings offer an original insight to Australian mothers' complementary feeding experiences. Further work targeting disadvantaged women would be useful in eliciting differences demographic characteristics. As with qualitative research, our research offers important insight into the diversity of experiences and has highlights common and outlying experiences.

Approaches to introducing solids can shape future appetite control, food preferences[9] and eating behaviours. This study investigated the experience of women at the point of first introducing solid foods to their infant. Our findings provide insight into the ways that women approach complementary feeding and navigate key decisions at this time. Longitudinal investigation is warranted to follow the long-term eating behaviours of children based on early approaches to complementary feeding. Further investigation of how to support women in making these crucial decisions with confidence, whilst capturing their desire for ease and convenience is also needed.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

This study was conceptualised by the first and third author. All authors were involved in data collection, analysis and interpretation of the data. All authors drafted the manuscript, revised it critically and provided final approval of the version to be published.

ORCID

Libby Swanepoel https://orcid.org/0000-0002-5551-897X

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ORIGINAL RESEARCH

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Neonatal dietitian resourcing and roles in New Zealand and Australia: A survey of current practice

Barbara Cormack MHSc, NZRD, Clinical Lead, PhD Candidate[1,2] | Colleen Oliver, MNutDiet Neonatal Dietitian[3] | Shelley Farrent BND, Senior Paediatric and Neonatal Dietitian[4] | Jacqui Young MNutDiet, Dietitian[5] | Keryn Coster GradDipHSci (Hum Nut), Clinical Specialist Dietitian[6] | Melissa Gilroy Dip N&D, APD, Neonatal Dietitian and Paediatric Dietitian[7] | Denise Page BHSc (N&D), APD, Neonatal Dietitian and Paediatric Dietitian[7] | Helen Little Dip HSc, NZRD, Interim Director of Allied Health[8] | Gemma McLeod PhD, APD, Senior Clinical and Research Neonatal Dietitian, Senior Clinical Lecturer[9,10] on behalf of the Australasian Neonatal Dietitians Network (ANDiN)

[1]Starship Child Health, Auckland City Hospital, Auckland, New Zealand

[2]Liggins Institute, University of Auckland, Auckland, New Zealand

[3]The Royal Women's Hospital, Melbourne, Victoria, Australia

[4]Flinders Medical Centre, Adelaide, South Australia, Australia

[5]Sunshine Hospital, Melbourne, Victoria, Australia

[6]The Royal Children's Hospital, Melbourne, Victoria, Australia

[7]Mater Health, Mater Mothers and Mater Mothers Private Hospitals, Brisbane, Queensland, Australia

[8]Christchurch Women's Hospital, Christchurch, New Zealand

[9]King Edward Memorial and Princess Margaret Hospitals, Perth, Western Australia, Australia

[10]The University of Western Australia, Perth, Western Australia, Australia

Correspondence
Barbara Cormack, Starship Child Health Directorate, Room 81038, Level 8, Building 1, Private Bag 92024, Auckland City Hospital, Auckland 1023, New Zealand; Liggins Institute, University of Auckland, 85 Park Road, Grafton, Auckland 1023, New Zealand.
Email: bcormack@adhb.govt.nz

Abstract

Aim: Dietitian-led implementation of evidence-based nutrition support practices improves nutrient intakes, clinical outcomes and growth, decreases length of stay and related costs, and reduces intravenous nutrition costs and prescription errors. We aimed to investigate current neonatal dietitian resourcing and roles in New Zealand and Australian neonatal units, and to compare this with dietitian workforce recommendations and previously reported survey data.

Methods: A two-part electronic survey was emailed to 50 Australasian Neonatal Dietitians Network members and other dietitians working in neonatal intensive care or special care baby units in New Zealand and Australia. The survey ran from July to October 2018. Descriptive statistics were used to examine the distribution of responses. Responses were compared with other similar surveys and British Dietetic Association workforce recommendations.

Results: There was an 88% response rate for Part 1. Forty-eight percent of respondents had worked in neonatology for more than 5 years. Ward rounds were attended weekly or more often by 43% of respondents. One-third regularly attended neonatal conferences or grand rounds. The majority spent less than 25% of their neonatal service allocation on teaching, developing policy or research. All respondents reported their unit had written enteral feeding guidelines. The neonatal dietitian workforce is at 23% of recommended levels.

Conclusions: Australasian neonatal dietitians have great potential to add value in neonatal units which has not yet been fully realised. Funding reallocation, upskilling and on-going professional development are needed to ensure the neonatal dietitian workforce is at the recommended level to be safe, sustainable and effective.

KEYWORDS

dietitian, heath resource, neonatal, nutrition

1 | INTRODUCTION

The ultimate goal of neonatal intensive care unit (NICU) is optimal growth, neurodevelopment and long-term health for survivors.[1] Neonatal dietitians are the NICU team members with both advanced, specialised nutritional expertise and a primary focus on the evidence-based, individualised nutrition care and growth of preterm babies. In addition to optimising nutrition care for all NICU babies by developing and implementing nutrition protocols, there are many situations where neonatal dietitians improve outcomes, such as in selecting optimal specialised nutrition support for babies with congenital or metabolic abnormalities, short gut syndrome, initiating strategies to minimise intestinal failure associated liver disease and identifying and treating those at risk of malnutrition and acquired vitamin and mineral deficiencies. Preterm babies are more vulnerable to malnutrition than any other hospital population due to their low nutrient stores at birth, immature nutrient absorption, physiological immaturity, delayed initiation and advancement of intravenous and enteral nutrition and neonatal complications during a time of potentially extremely rapid growth and very high nutritional requirements. Malnutrition results in faltering growth,[2] and both are associated with adverse long-term neurodevelopmental outcomes.[3] Emerging evidence confirms that for preterm babies optimising nutrition and growth, especially in the first few days and weeks after birth, is vital.[3,4]

While clear evidence for the optimal postnatal nutrition strategy to achieve this neonatal care goal is lacking, systematic reviews, international consensus nutrition recommendations and best practice guidelines based on the available evidence have been published.[5-7] However, surveys of neonatal nutrition practice in the United States, Britain, Europe, New Zealand and Australia demonstrate most neonatal units do not achieve the recommended nutrient intakes for preterm babies.[8,9] There are two likely causes for this. One is a lack of confidence that the guidelines are evidence-based. This is well founded and high quality randomised controlled trials are urgently needed to provide the evidence for neonatal nutrition guidelines. The other reason is a lack of standardised neonatal unit policies and the practical knowledge of neonatal nutrition to enable internationally recommended intakes to be achieved in clinical practice. Neonatal dietitians have this knowledge and the skills to help prevent malnutrition through the development of standardised feeding guidelines, screening, identifying babies at risk and targeting nutritional strategies to prevent malnutrition occurring.[10,11] A previous survey of neonatal units in Australian and New Zealand conducted 10 years ago reported wide variation in enteral feeding practices and identified that over 50% of units did not have written enteral feeding guidelines. Many neonatal units did not have access to a neonatal dietitian.[9] The aim of this survey of neonatal dietitians was to investigate and report on neonatal dietitian resourcing and roles in Australasian neonatal units a decade later, and to compare this with published evidence, neonatal dietitian workforce recommendations and previously reported data.

2 | METHODS

On 16 July 2018, a link to an electronic pretested survey (Survey Monkey), consisting mainly of multiple choice

questions was emailed to 50 Australasian Neonatal Dietitians Network (ANDiN) members. Part 1 was aimed at individual dietitians and Part 2 related to hospital site details and policy (Supplementary file 1). All ANDiN members who were practising neonatal dietitians and working in NICU or special care baby unit (SCBU) in New Zealand and Australia were invited to participate. In addition, non-ANDiN member neonatal dietitians practising in New Zealand or Australia were also invited to participate. Non-responders were sent a reminder email after 4 weeks, and again prior to the survey closing. If no response was received from a Level 3 NICU site listed in the Australian and New Zealand Neonatal Network (ANZNN) directory, an email was sent to a neonatologist at the site to request the email address for the site dietitian or to confirm that they did not have a neonatal dietitian. The survey was closed on 10 October 2018. Responses were stored in a password protected online site. The Checklist for Reporting Results of Internet E-Surveys (CHERRIES) statement guideline was followed for reporting the survey results.

Descriptive statistics were used to examine the distribution of responses. Percentages were calculated for categorical variables. Where appropriate, responses were compared with a 2013 survey of Australasian neonatologists.[9] The British Association of Perinatal Medicine (BAPM) Service Standards for Hospitals Providing Neonatal Services[12] dietetic section workforce figures recommended by the British Dietetic Association,[13] Table 1, were used to calculate the recommended dietitian full time equivalent (FTE) using the following formula: Recommended dietitian FTE = SUM(Level 3 cots $\times 0.05$) + (Level 2 $\times 0.025$) + (Level 1 $\times 0.017$). The lower recommendation of the range in Table 1 was used for all calculations and comparisons. Where participants gave the answer <0.1 FTE, the figure used for the calculations was 0.1 FTE.

According to the Northern B Health and Disability Ethics Committee Ethics Committee guidelines, ethics approval was not required for this survey as it did not involve a change to any form of treatment, intervention or approach to babies or their parents. Institutional ethics approval for the survey was obtained by the primary investigator from the Auckland District Health Board Research Review Committee (ID A+8146). Participants were informed that survey submission was deemed to be consent.

3 | RESULTS

There were 44 responses to Part 1 (88%), 10 (23%) New Zealand and 34 (77%) Australian dietitians. For Part 2, 23 site survey responses were received from the 29 ANZNN Level 3 NICU sites in New Zealand and Australia. One response covered two NICU sites. We confirmed one New Zealand and three Australian Level 3 NICUs had no neonatal dietitian. There were also nine site responses from ANDiN members currently working in Level 2 units, making a total of 35 Part 2 responses, 10 (29%) from New Zealand and 25 (71%) from Australian sites.

TABLE 1 Recommended neonatal dietitian full time equivalents

BAPEN and British Dietetic Association[13]	
Level of care	**Full time equivalent dietitians per cot**
Intensive care cots	0.05-0.1
High Dependency cots	0.025-0.05
Special care cots	0.017-0.033
U.S. News & World Report's Best Children's Hospitals[14]; Allocation of points for commitment to best practice	
Full time equivalent dietitians per cot	
0.05 or less (1 point allocated)	
>0.05 (2 points allocated)	

The majority of neonatal dietitians were over 41 years of age (55%), and 48% had worked in neonatology for more than 5 years, Table 2. Thirty percent spent 10 to 20 hours per week in neonatal care but only a few (10%) spent more than 20 hours per week. Ward rounds were attended at least weekly by 43%, and never attended by half the respondents. Almost one-third of respondents regularly attended neonatal conferences, participated in grand rounds or research (Figure 1). Most dietitians spent 50% to 100% of their neonatal clinical service FTE in direct patient care. Less than 30% of neonatal dietitians reported regularly spending neonatal time on activities such as presenting grand rounds, developing "standards of care/recommended best practice" documents or conducting audits, research or publication.

There were 35 site survey responses. Of the 28 respondents who answered the question, 100% reported their unit had written guidelines for enteral feeding, and most also had guidelines for intravenous feeding and vitamin and mineral supplementation (Table 2).

Most (90%) of the 39 sites had at least one neonatal dietitian ranging from <0.1 to 1.8 FTE. The comparison of actual dietitian FTE in each hospital with British Association for Parenteral and Enteral Nutrition (BAPEN) recommended FTE is shown in Figure 2. Only 10% of

TABLE 2 Survey responses

Age of neonatal dietitians	N = 44	
20 to 30 years	4	9%
31 to 40 years	16	36%
41 to 50 years	17	39%
51 to 60 years	5	11%
61 to 70 years	2	5%
Years of neonatal experience		
≤1 year	3	7%
>1 to 2 years	7	16%
>2 to 5 years	13	30%
>5 to 10 years	8	18%
>10 to 15 years	7	16%
>15 to 20 years	4	9%
>20 years	2	5%
Number of hours per week spent in neonatal nutrition care		
1 hour or less	7	16%
2 to 5 hours	13	30%
5 to 10 hours	6	14%
10 to 20 hours	13	30%
20 to 30 hours	4	10%
Neonatal ward round attendance		
Daily (or every day that I work)	6	14%
Three times per week	1	2%
Twice a week	3	7%
Weekly	9	20%
Fortnightly	1	2%
Monthly	2	5%
Never	22	50%
Feeding policy	N = 28	
Does your unit have a written policy on the following		
Enteral feeding	28	100%
Intravenous feeding	25	89%
Vitamin and mineral supplementation (inpatient)	24	86%
Withholding feeds	14	50%
Gastric aspirate volumes	14	50%
Screening criteria for dietitian referral	11	39%
Skipped	7	
Total inpatient neonatal dietitian FTE per site	N = 35	
<0.1 FTE	7	20%
0.1 FTE	7	20%
0.2 FTE	6	17%
0.3 FTE	2	6%
0.4 FTE	6	17%
0.5 FTE	3	8%
0.6 FTE	Nil	
0.7 FTE	Nil	
0.8 FTE	2	6%
0.9 FTE	1	3%
1.0 FTE	Nil	
>1.0 FTE	1	3%

Abbreviation: FTE, full time equivalent.

New Zealand and 7% of Australian hospitals met BAPEN recommended neonatal dietitian FTE. The mean current neonatal dietitian FTE is at 24% (range: nil to 100%) for New Zealand and 23% (range: nil to 180%) for Australia, of the BAPEN recommended level (Figure 2).

4 | DISCUSSION

The British National Health Service, National Quality Board recommends "all units have access to a neonatal or paediatric dietitian competent in neonatal nutrition and who can access a specialist neonatal dietitian if required".[15] Our 2018 survey shows all but four (86%) Level 3 NICUs had access to a neonatal dietitian. This is a change since 2008 when only 33% of Australian and 50% of New Zealand neonatal units had access to a neonatal dietitian.[9] In 2008, Australasian NICUs were well behind both North America and the United Kingdom in the employment of neonatal dietitians when 55% of British neonatal units[16] and 79% of 145 North American NICUs[17] reported employing a neonatal dietitian. Although the majority of survey participants were relatively experienced practitioners, around half had worked in neonatology for less than 5 years and the majority spent less than 10 hours per week on neonatal care. This may reflect the relatively recent entry of dietitians into neonatal units in some hospitals which often starts with less than four neonatal hours per week allocated to a paediatric dietitian covering other areas.

Of more concern, especially given the inexperience of the neonatal dietitian workforce, is that less than a third of respondents attended neonatal conferences or participated in grand rounds or research. Neonatology is a complex and demanding area in which to work. Neonatal care is provided to highly vulnerable patients with complex medical conditions in an intensive care environment with a large multidisciplinary team. Regular ongoing

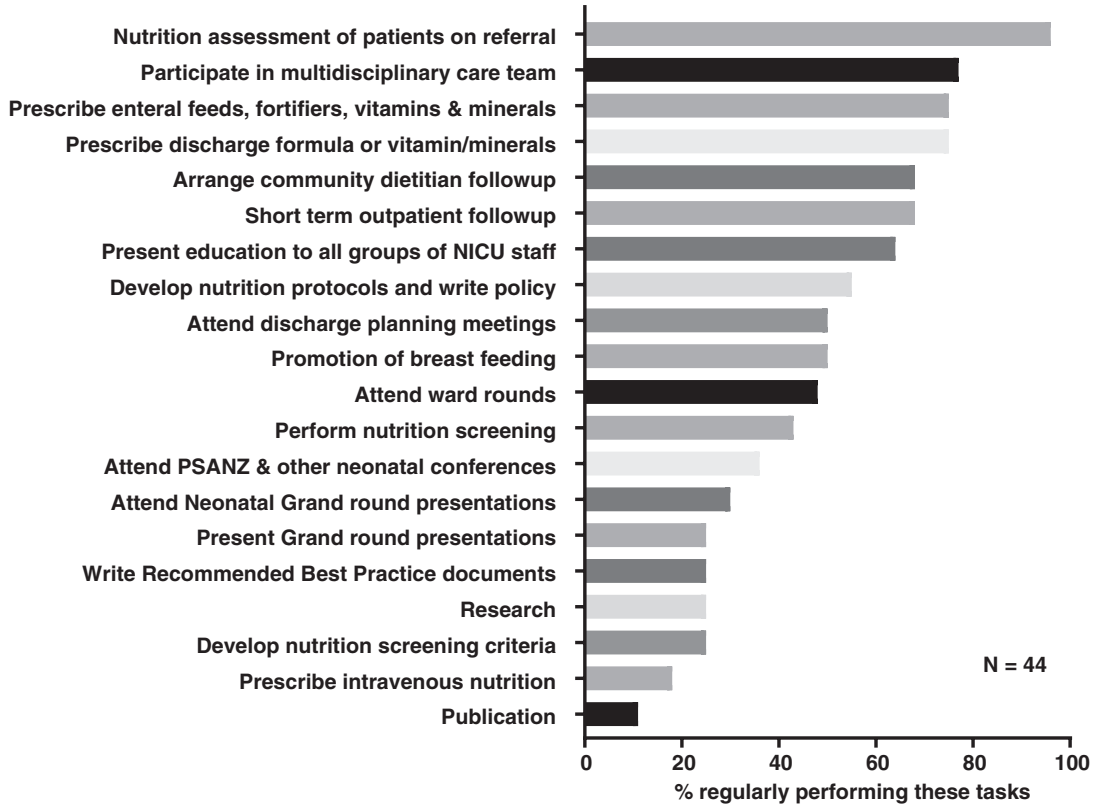

FIGURE 1 Bar chart showing percentage of neonatal dietitians regularly performing these tasks

professional development is vital to ensure neonatal dietitians achieve and maintain the core competencies to practice in neonatology. BAPM best practice principles recommend: "Dietitians providing neonatal care should be experienced paediatric dietitians who have completed the British Dietetic Association Paediatric Dietetic Masters Module 2 or demonstrate an equivalent level of knowledge and skills." Currently, no specific training

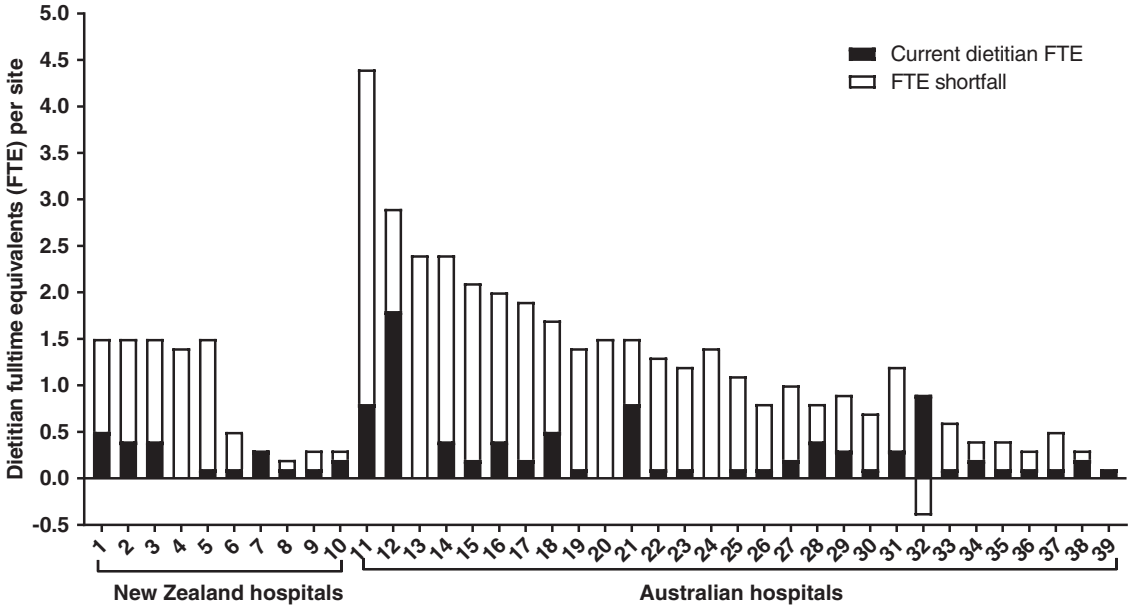

FIGURE 2 Bar chart showing reported current neonatal dietitian full time equivalent per hospital site as a proportion of British Association of Perinatal Medicine[12] British Dietetic Association[13] recommendations

course exists in Australasia to establish core competencies and requirements for practice as a specialist neonatal dietitian. It is therefore essential that neonatal dietitians are supported both professionally and financially to attend neonatal conferences and participate in grand rounds and research in order to achieve and maintain clinical competence in neonatal nutrition and maximise effectiveness in their roles. Hence, networking and educational opportunities such as ANDiN, to raise the skill level of neonatal dietitians through peer support, plays a crucial role for this workforce.

While consensus nutrition recommendations for preterm babies are available,[5-7] universally accepted neonatal nutrition practice guidelines do not exist. However, there is good evidence that NICU site-specific standardised feeding protocols are beneficial and improve neonatal outcomes.[18-24] Patole et al showed that instituting standardised feeding guidelines could reduce necrotising enterocolitis (NEC) by 87% in babies weighing <2500 g and 29% in those weighing <1500 g.[21] A standardised approach to feeding preterm babies also has the potential to improve nutrition and growth outcomes as well as decreasing complications such as sepsis[20] and decreasing costs. Dietitian-led implementation of evidence-based better nutrition support practices has been shown to improve nutrient intake, clinical outcomes[25] and growth,[26,27] reduce length of stay[28] and related costs[29] reduce intravenous nutrition costs[29] and prescription errors.[30] Neonatal units who employ dietitians are more likely to monitor growth and to use optimum nutrition practices.[10] All these aspects of neonatal care are clinically significant and either improve outcomes, reduce costs or both.

Neonatal dietitians, therefore, as part of the neonatal team, can have a significant impact on standardising neonatal nutrition care, by designing and encouraging consistent nutrition protocols and practice and by monitoring growth and other outcomes which in turn results in costs savings for the hospital through reduction in days on intravenous nutrition, length of stay and NEC. In 2009, the majority of Australasian neonatal units did not have a written enteral feeding/nutrition policy.[9] This was also the case in the 2007 British survey.[16] Our 2018 survey indicates that along with greater access to a neonatal dietitian there has also been a huge improvement in the area of written enteral feeding policy and also that many units now have other important written nutrition-related policies.

The recent publication of criteria for the diagnosis of malnutrition in preterm babies and neonates by the Academy of Nutrition and Dietetics and the American Society for Parenteral and Enteral Nutrition, means that the diagnosis of malnourished neonates is standardised internationally.[11] This increases awareness of malnutrition in preterm babies and also the possibility of improving the level of diagnosis related reimbursement the hospital receives if the word "malnutrition" is written in the clinical notes by a dietitian and picked up by clinical coders. While a diagnosis of malnutrition may not increase the reimbursement for most very preterm babies during the birth episode of care, the addition of malnutrition to the code list can make a funding difference for late preterm, term surgical or cardiac neonates.

There is ample evidence that the addition of a neonatal dietitian to the neonatal intensive care team is beneficial as well as cost-effective. This is supported by NICU best practice recommendations[6,31] and our 2018 survey finding that almost all Australasian NICUs now have a neonatal dietitian. Various workforce recommendations exist for the safe, sustainable and effective provision of neonatal dietitian FTE per cot. In 2000, Groh-Wargo recommended at least 0.03 FTE per cot.[32] More recently, the BAPM[12] and the British Dietetic Association[13] recommended 0.05 FTE per Level 3 cot (Table 1). A similar ratio is also recommended as best practice by the U.S. News & World Report's Best Children's Hospitals.[14]

Our survey shows current neonatal dietitian FTE in both countries is far from meeting these recommendations and on average less than 25% of the recommended FTE per cot. Of 35 sites surveyed, only one site met recommended minimum staffing levels. This explains the emphasis on direct patient care and lack of time for ward rounds, teaching, training, orientation, developing policy guidelines audit, or research. While some survey participants were leading the development of best practice guidelines, prescribing intravenous nutrition and conducting research, the majority spent most of their neonatal time on direct patient care. In contrast to our results, a 2000 survey of 55 Canadian neonatal units, where the mean dietitian FTE per neonatal unit was 0.2 to 0.5 FTE, reported 79% participated in ward rounds, 82% provided education to other health professionals and 68% participated in research projects, initiating the majority of these projects themselves.[33] There is much scope for Australasian neonatal dietitians to expand their roles but if they are to reach their full potential to improve neonatal nutrition care, improve health outcomes and reduce costs, there must be a substantial increase in the allocation/reallocation of resources to this very important area of practice. When the dietitian workforce is at recommended levels, dietitians are able to perform nutrition specific tasks such as prescribing enteral and intravenous nutrition which releases medical staff time. This is likely to be cost neutral or cost saving.

A strength of this survey is that the response rate for NICUs was very high. Weaknesses are the lower response rate for SCBUs and it is possible that some dietitians

working in SCBUs were not known to ANDiN. The survey did not specifically ask about other activities such as the management of breast milk banking or formula production facilities or other activities which may have been included in the neonatal FTE allocations reported at some sites, although some dietitians reported these activities.

In conclusion, Australasian neonatal dietitians have great potential to add value as members of the neonatal intensive care team, which has not yet been fully realised. Additional and reallocation of funding is needed to ensure the neonatal dietitian workforce reaches the recommended level in order to be safe, sustainable and effective. In the absence of formal training courses in Australasia for specialist neonatal dietitians, dedicated funding for neonatal conference attendance, ongoing professional development and networking opportunities such as ANDiN are crucial.

CONFLICT OF INTEREST

All the authors are currently working as neonatal dietitians. The Australasian Neonatal Dietitians Network (ANDiN) meeting in 2018 where this survey was pretested was supported by an unconditional grant from the Nestle Nutrition Institute.

AUTHOR CONTRIBUTIONS

B.C. and G.M. conceived the survey concept. All authors participated in drafting the survey. B.C. obtained ethical approval. B.C. and G.M. drafted the manuscript and all authors commented on and approved the final manuscript. All authors are in agreement with the manuscript and declare that the content has not been published elsewhere. We wish to thank all the dietitians who participated in the survey.

ORCID

Barbara Cormack https://orcid.org/0000-0003-2329-8287

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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