2016

Exploring Australian women's level of nutrition knowledge during pregnancy: a cross-sectional study

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Publication Details

Bookari, K., Yeatman, H. & Williamson, M. (2016). Exploring Australian women's level of nutrition knowledge during pregnancy: a cross-sectional study. International Journal of Women's Health, 8 405-419.

Exploring Australian women's level of nutrition knowledge during pregnancy: a cross-sectional study

Abstract

Background: The Australian Guide to Healthy Eating (AGHE) for pregnancy provides a number of food- and nutrition-related recommendations to assist pregnant women in optimizing their dietary behavior. However, there are limited data demonstrating pregnant women's knowledge of the AGHE recommendations. This study investigated Australian pregnant women's knowledge of the AGHE and related dietary recommendations for maintaining a healthy pregnancy. The variations in nutrition knowledge were compared with demographic characteristics. **Methods:** A cross-sectional study assessed eight different nutrition knowledge domains and the demographic characteristics of pregnant women. Four hundred women across Australia completed a multidimensional online survey based on validated and existing measures. **Results:** More than half of the pregnant women surveyed (65%) were not familiar with the AGHE recommendations. The basic recommendations to eat more fruit, vegetables, bread, and cereals but less meat were poorly understood. An in-depth investigation of knowledge of nutrition information revealed misconceptions in a range of areas, including standard serving size, nutrients content of certain foods, energy density of fat, and the importance of key nutrients in pregnancy. Univariate analysis revealed significant demographic variation in nutrition knowledge scores. Multiple regression analysis confirmed the significant independent effects on respondents' nutrition knowledge score ($P<0.000$) of the education level, income, age, stage of pregnancy, language, and having a health/nutrition qualification. The model indicated that independent variables explained 33% (adjusted R^2) of the variance found between respondents' knowledge scores. **Conclusion:** Australian pregnant women's knowledge regarding AGHE for pregnancy and other key dietary recommendations is poor and varies significantly with their demographic profile. The setting of dietary guidelines is not sufficient to ensure improvement in their nutrition knowledge. It is essential that women receive support to achieve optimal and healthy diets during pregnancy.

Keywords

sectional, cross, pregnancy, during, study, knowledge, exploring, nutrition, australian, level, women

Disciplines

Education | Social and Behavioral Sciences

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International Journal of Women's Health

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ORIGINAL RESEARCH

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This article was published in the following Dove Press journal:
International Journal of Women's Health
16 August 2016
Number of times this article has been viewed

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Methods: A cross-sectional study assessed eight different nutrition knowledge domains and the demographic characteristics of pregnant women. Four hundred women across Australia completed a multidimensional online survey based on validated and existing measures.

Results: More than half of the pregnant women surveyed (65%) were not familiar with the AGHE recommendations. The basic recommendations to eat more fruit, vegetables, bread, and cereals but less meat were poorly understood. An in-depth investigation of knowledge of nutrition information revealed misconceptions in a range of areas, including standard serving size, nutrients content of certain foods, energy density of fat, and the importance of key nutrients in pregnancy. Univariate analysis revealed significant demographic variation in nutrition knowledge scores. Multiple regression analysis confirmed the significant independent effects on respondents' nutrition knowledge score ($P<0.000$) of the education level, income, age, stage of pregnancy, language, and having a health/nutrition qualification. The model indicated that independent variables explained 33% (adjusted R^2) of the variance found between respondents' knowledge scores.

Conclusion: Australian pregnant women's knowledge regarding AGHE for pregnancy and other key dietary recommendations is poor and varies significantly with their demographic profile. The setting of dietary guidelines is not sufficient to ensure improvement in their nutrition knowledge. It is essential that women receive support to achieve optimal and healthy diets during pregnancy.

Keywords: Australian Guide to Healthy Eating for pregnancy, nutrition knowledge, pregnancy, health

Introduction

An optimally nourishing diet is important for health during pregnancy. Poor diet places women at a higher risk of unhealthy gestational weight gain,[1] which can negatively impact mothers' and babies' health, causing a range of poor maternal and infant outcomes.[2] Exposure of the unborn baby to maternal obesity, diabetes, and excessive gestational weight gain can increase his/her risk of developing childhood obesity and

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Dovepress
http://dx.doi.org/10.2147/IJWH.S110072

chronic diseases later in life.[3,4] Yet, many women do not sustain an optimal diet prior to and during pregnancy. Some pregnant women's diets lack key nutrients, including folate, fiber, and iron.[5] Their diets do not comply with official dietary guidelines with respect to consumption of some major food groups (including bread and cereals, fruit, vegetables, grains, and protein foods [nuts, beans, eggs, and fish]), and many are characterized as being high in processed meat, soft drinks, and takeaway foods.[5–10]

A number of behavioral change theories such as the planned behavior theory,[11] social cognitive theory,[12] and transtheoretical model[13] recognize the important role that nutrition knowledge, attitudes, and motivations can play in the process of food choices. Such theories assume a rational relationship in the intersection of beliefs, attitudes, intentions, and behaviors for "volitional behavior". Sapp[14] argued that for individuals to adopt a rational approach to food intake, they first needed to reach a "high threshold level of 'how-to' and 'awareness' nutrition knowledge". Conversely, incomplete knowledge and false beliefs can lead to ill-formed intentions and nonrational nutrition behavior. The same could be said for dietary behavior in pregnancy. Women's accurate knowledge of dietary guidelines during pregnancy may assist them to make appropriate food choices and to achieve a balanced diet for themselves and their unborn babies as it may assist them to reject false or nonevidence-based messages or uninformed advice from family, friends, and social media.

Pregnancy is an important time to increase women's awareness about healthy eating.[15] Pregnant women recognize diet as important to fetal health and are more likely to be mindful of nutrition, seek health advice, and modify their diets.[16] Nutrition knowledge has been positively associated with maternal dietary behavior[17,18] and use of supplements.[19] Nutrition education also has been shown to have beneficial effects on pregnancy outcome,[20] reducing the number of infants born >4 kg, reducing the incidence of respiratory distress syndrome, and producing shorter length of stay in hospitals.[21]

Many countries around the world[22,23] have established dietary guidelines to improve eating habits of individuals through their lifespan. Dietary guidelines are considered a foundation of any strategy to promote the consumption of healthy foods.[9] In Australia, the Australian Dietary Guidelines[24] provide recommendations on health, weight management and nutrition, and food safety for the general population and specific information for pregnant women.[25,26] The revised Australian Dietary Guidelines were published in 2013 and included changes to the information provided for pregnant women, such as the recommended number of serves of fruit, vegetables, bread and cereals, dairy, and meat and its alternatives, and the standard serve size for bread and cereals group. The revised Australian Guide to Healthy Eating (AGHE) for pregnant women references the Institute of Medicine's guidelines for weight gain during pregnancy.[25] A number of Australian government websites provide useful, evidence-based information on healthy eating, weight management, management of discomfort, staying active, the need for and potential dangers of supplementation, and the importance of key nutrients and food safety during pregnancy.[25–28]

Having information available does not necessarily translate into increases in pregnant women's nutrition knowledge. Little has been reported on Australian women's knowledge of these guidelines and other food- and nutrition-related recommendations. The existing studies have focused on investigating either women's awareness of specific single nutrients required during pregnancy[29–31] or their knowledge of AGHE recommendations for adults in the general population.[8] Women's knowledge of food handling practices and weight gain during pregnancy has also been examined separately in the previous studies.[32,33] Understanding pregnant women's level of knowledge of the AGHE and specific nutrition and dietary recommendations during pregnancy is important for guiding the development of effective approaches to support women in maintaining a healthy diet and avoiding harmful excessive weight gain during pregnancy.

A number of studies have noted demographic variations in nutrition knowledge. Identifying groups of pregnant women who might be at risk of having inadequate nutrition knowledge could permit the adoption of well-targeted and effective communication strategies regarding pregnancy nutrition. A study[32] indicated that higher levels of knowledge about "high *Listeria* risk foods" were associated with a number of sociodemographic characteristics of pregnant women. These included first language (English), planned pregnancy, and household income (>AU$50,000/yr). Other studies[8,29] found that women with higher educational levels demonstrated the highest levels of "nutrition knowledge", "knowledge about the consequences of folic acid deficiency" and "knowledge about the adverse health outcomes associated with low iodine intake" during pregnancy.

The purpose of this study was to:

1. survey pregnant women's level of knowledge of the AGHE for pregnancy and relevant dietary and nutrition recommendations for maintaining a healthy pregnancy; and

2. identify demographic differences related to knowledge levels.

Methods

Study design

To recruit pregnant women, this cross-sectional study used convenience sampling. To minimize the potential for social desirability bias, the survey was designed to be administered online and self-completed and the participation was anonymous.

Survey development

A multidimensional survey was developed for this study based on an existing survey[34] and components from four validated surveys.[32,35–37] The survey explored five major dimensions using a total of 109 items. The dimensions assessed were pregnant women's:

1. reported adherence to the five food groups and extras (six items);
2. attitudes toward key nutrition topics (17 items);
3. level of motivation to maintain a healthy diet (four items);
4. knowledge of the AGHE during pregnancy and a range of diet-related matters (70 items); and
5. knowledge of guidelines for weight gain and its management during pregnancy (12 items).

Demographic characteristics recorded included prior pregnancies, stage of pregnancy, planned pregnancy, age, marital status, level of education, household income, first language, possession of a health/nutrition-related qualification, whether seen by a dietitian/nutritionist, and the classification of women's body mass index (BMI) based on Institute of Medicine 2009 guidelines.

The survey instrument was developed in early 2012 and implemented between October 2012 and July 2013. As a check on face validity, the survey questions were reviewed individually by a supervisory team (one with an expertise in public health nutrition and another with midwifery expertise) and four accredited practising dietitians (including a maternal health dietitian) to ensure they reflected the AGHE recommendations for pregnant women published prior to February 2013 and the dietary and nutrition recommendations for maintaining a healthy pregnancy as provided on the Australian government website (prior to the same date). A statistician (an accredited practicing dietitian and expert on question construction) then reviewed the survey to ensure that it did not contain common errors (eg, leading, confusing, or double-barreled questions).

The survey was pilot tested first with five researchers (dietitians) from the School of Health Science at the University of Wollongong (UOW). This was followed by pilot testing of the survey with a small convenience sample of ten pregnant women to determine time for survey completion, identify items that lacked clarity, and ensure that the instructions and contents were easily comprehensible and layout was acceptable.[38] Modifications were consequently made to some existing questions (for clarity), and a few items were added. The UOW Human Research Ethics Committee, which included a dietitian, reviewed and approved the survey. All authors were involved in revising the final version of the survey and making changes based on the feedback received during pilot testing.

The reliability was calculated for three dimensions of the survey, including "women's attitudes toward key nutrition topics", "women's level of motivation to maintain a healthy diet", and "women's knowledge of the AGHE during pregnancy and a range of diet-related matters". Each dimension was explored using a set of items intended to assess different aspects of that single attribute. The reliability test was not calculated for the remaining dimensions, which included "women's reported adherence to the five food groups and extras" and "women's knowledge of guidelines for weight gain and its management during pregnancy", as these two dimensions contained multidimensional scale questions (eg, open-ended questions, multiple choice). For the other three dimensions, the α coefficients were slightly >0.8, which suggests that the scales had good internal consistency. The information about the five dimensions of the survey and the reliability results is presented in Table 1.

This article reports only on the fourth dimension: women's knowledge of the AGHE during pregnancy and a range of diet-related matters. The nutrition knowledge section contained eight domains assessing nutrition knowledge (consisting of 70 items). Details of the survey domains relating to nutrition knowledge and demographic information collected and reported on in this study are in Table 2. Knowledge was assessed with multiple-choice questions, with a majority of questions (67) having one correct response option, while two questions (on multivitamins and supplements in pregnancy) had more than one correct response option. The respondents were asked to choose from a range of different scales answers such as "true, false, don't know"; "yes, no, not sure"; "high, low, not sure"; "less than one serve, one serve, more than one serve, not sure"; or a choice of four different food options and "not sure". To score the survey, correct responses to nutrition knowledge questions

Table 1 The composition and α coefficient of the five dimensions of nutrition during pregnancy survey

No	Dimension	Total no of items[a]	Type of question	Reference	No of newly added items[b]	No of modified items[c]	α coefficient
1	Women's reported adherence to the five food groups and extras	6	Open-ended, six-question tool	Hoerr et al[37]	3	–	–[d]
2	Women's attitudes toward key nutrition topics	17	5-point Likert scale	Worsley et al[36]	10	4	0.805[e]
3	Women's level of motivation to maintain a healthy diet	4	Three questions: 10-point Likert scale One question: 5-point Likert scale	Skouteris et al[34]	–	1	0.807[e]
4	Women's knowledge of the AGHE during pregnancy and a range of diet-related matters	70	Multiple-choice questions	Hendrie et al[35] Worsley et al[36] Bondarianzadeh et al[32]	15	12	0.801[f]
5	Women's knowledge of guidelines for weight gain and its management during pregnancy	12		Hendrie et al[35]	8	4	–[d]

Notes: [a]Total number of items, including items that have been taken from the validated surveys without any modification, modified items, and newly added items. [b]Number of new items that were devised for this survey. [c]Number of items that have been taken from the validated surveys and been modified to suit the study aim. [d]Reliability test was not calculated for the first and fifth dimensions because they contained multidimensional scale questions (eg, open-ended questions, multiple-choice questions). [e]Cronbach's alpha was calculated to measure reliability of measurements with scale type of questions. [f]K–R 20 was calculated to measure reliability of measurements with dichotomous choices.
Abbreviations: AGHE, Australian Guide to Healthy Eating; K–R 20, Kuder and Richardson Formula 20.

were scored as 1, while incorrect and "not sure" responses were scored as 0. Responses for each domain were added to give a total domain score, and the eight domain scores were added to give an overall nutrition knowledge score, with a maximum possible score of 72.

Survey administration

All data were obtained online using an online survey instrument. Recruitment took place between October 2012 and July 2013. To maximize response rates, different recruitment strategies were used to invite pregnant women to complete the online survey independently (Figure 1). The pregnant women were recruited either through verbal invitation or via distribution of invitation leaflets. Women were approached directly at two pregnancy/baby expos (fairs) held in Wollongong and at antenatal clinic waiting rooms of the participating hospitals. Seven public hospitals with antenatal clinics in New South Wales (NSW), Australia, were invited to participate with all but two responding and agreeing to participate. The pregnant women were provided with information verbally on the purpose of the survey and informed that participation was voluntary. If they agreed to participate, they were provided with an iPad to complete the survey at the time without any input from researcher or given an information leaflet with a link to complete the survey online at a later time.

The study invitation leaflets were distributed at two baby stores located in NSW and in the Australian "Bounty Mother To Be Bags". These bags contained product samples and information for the pregnant women and were distributed at hospitals/pharmacists/chemists across NSW. Additional women from across Australia participated via an unplanned snowball effect in which survey respondents promoted the survey to their friends verbally and through social media (Facebook and pregnancy website/discussion boards).

Measures and outcomes

This article reports on the eight domains of nutrition knowledge of pregnant women and on the relationship of demographic variation to knowledge levels.

Statistical analysis

Raw data were downloaded from the SurveyMonkey website and the iPads and transferred to the Statistical Package for the Social Sciences software (Version 22.0; IBM Corporation, Armonk, NY, USA). For the purposes of analysis for this study, only results from fully completed surveys were included. Comparisons between the study cohorts were not

Table 2 The composition of the fourth dimension of nutrition during pregnancy survey: women's knowledge of the AGHE during pregnancy and a range of diet-related matters

No	Nutrition knowledge domain	Description	No of items	Correct responses (score)
1	Recommended intakes of five food groups and extras	One question asked women if they were familiar with the AGHE for pregnancy	1	NA[a]
		The recommended number of serves of the five core food groups (fruit, vegetables, dairy foods, meat and its alternatives, and bread and cereals) and extras[b] based on AGHE for pregnancy	5	5
2	Food sources of nutrients	Foods high or low in sugar, salt, dietary fiber, and saturated fat Macronutrient (fat) has the highest energy density Food items that are rich sources of vitamin A, iron, iodine, and omega-3 fatty acids	22	22
3	Vitamins and other supplements during pregnancy	Mandatory supplements (ie, folic acid and iodine) during pregnancy Micronutrients that may pose a risk when taken during pregnancy	2	5[c]
4	Healthy meal proportion and serving size	Identification of food group proportions for a healthy meal pattern Portion size of certain food items from each food group	14	14
5	Choosing everyday food	Healthier and best options for foods that are: – Low-fat, high-fiber, light meal – Healthier serving options for spaghetti Bolognese (more carbohydrate in spaghetti than fat in the sauce) – Low in sugar	3	3
6	Diet–health relationship	Management of pregnancy-related symptoms: – Nausea and vomiting – Heartburn – Constipation	12	12
7	Importance of key nutrients in pregnancy	Nutrient function in the body and risk of nutrients' deficiency (for iodine and omega-3 fatty acids)	2	2
8	Food safety practice in pregnancy	Safe food to consume in pregnancy Safe and unsafe food preparation and storage practice Perception of listeriosis Safe fish option to consume in pregnancy	9	9

Notes: [a]Not applicable as this question was not included in the scoring process; the women were given two answers (yes or no) to choose from. [b]Extras or "discretionary choices", including energy-dense but nutrient-low foods such as confectionery, jam, cakes, meat pies, and pastries. [c]These two items had more than one correct response options; the first question had two possible correct answers (folic acid and iodine) and the second one had three possible correct answers (vitamins A, D, and B_6).
Abbreviations: AGHE, Australian Guide to Healthy Eating; NA, not applicable.

possible as no record was kept of the different methods of data collection. Cronbach's alpha and Kuder and Richardson Formula 20 were calculated to measure reliability of measurements with scale type of questions and with dichotomous choices, respectively.

Scores were calculated for each domain and also for the overall nutrition knowledge (a total of the eight domains). Women's prepregnancy BMIs were calculated based on the self-reported prepregnancy weight and height.[39] Descriptive and inferential statistics were used to describe and analyze the data. One-way ANOVA and independent *t*-test were used to assess the variations in the mean total scores of nutrition knowledge based on categories of demographic factors. Predictors of women's nutrition knowledge were identified via multiple linear regression analyses. Given the relatively high number of factors, only factors that were significantly associated with women's nutrition knowledge (in one-way ANOVA and independent *t*-test, $P<0.05$) were included in the regression analysis to prevent overcomplicated presentation of the results.[40] Then the association of each predictor with the nutrition knowledge score when adjusted for other predictors was identified using multiple linear regression analyses. Significance was identified at $P<0.05$.

Ethical approval

The study was approved by the UOW Human Research Ethics Committee, South Eastern Sydney and Illawarra Area Health Service, and South Western Sydney Local Health District sites (Campbelltown/Liverpool hospitals). Participant's information sheet was included in the first page of the on-line survey. The consent was implicitly taken by including the following statement at the same page "By completing the survey you agree to take part in the study".

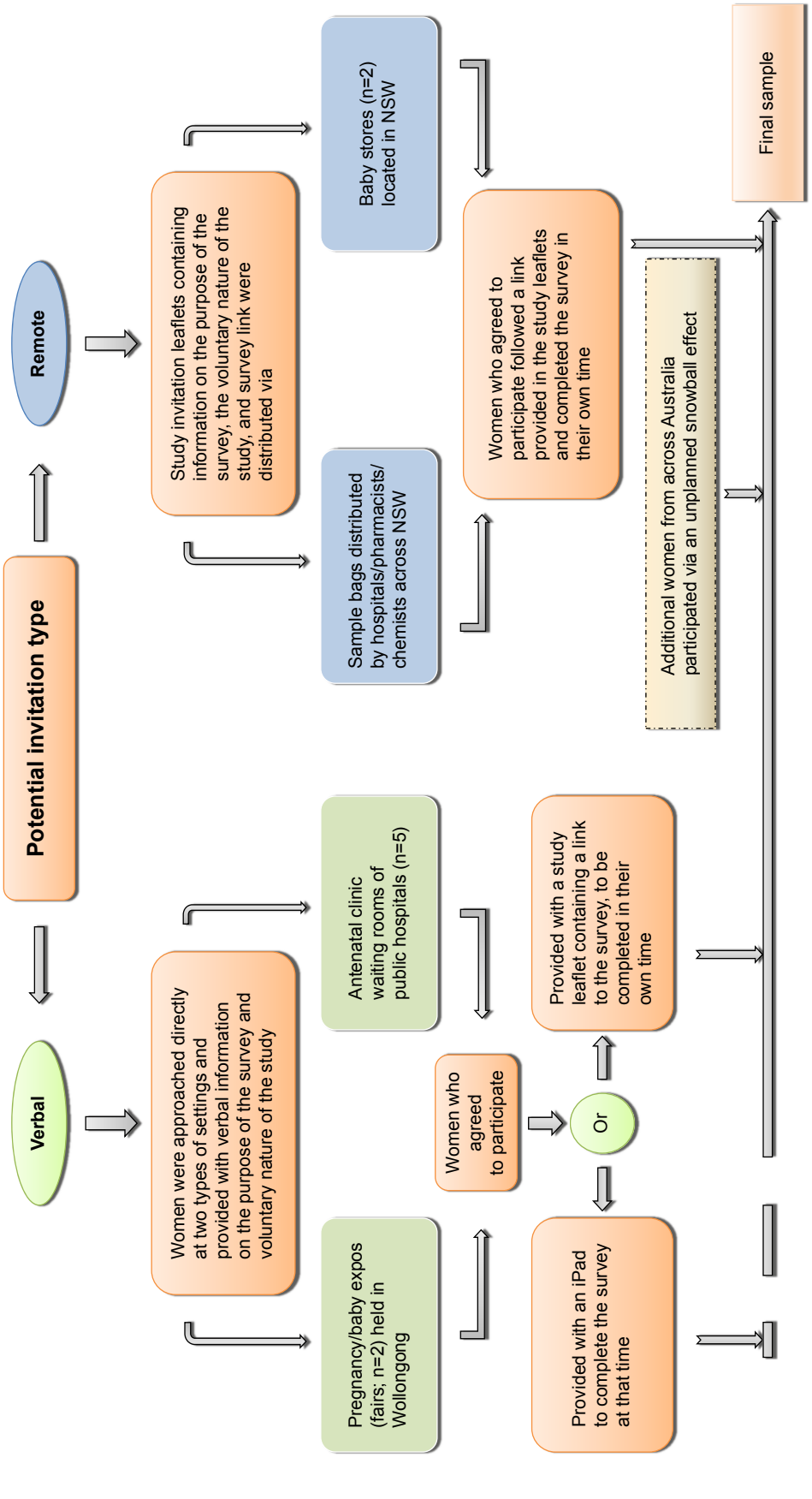

Figure 1 The study recruitment strategy.
Abbreviation: NSW, New South Wales.

Results

Study sample characteristics

Responses were received from 472 pregnant women, 72 of whom did not fully complete the survey. The demographic characteristics of survey respondents are presented in Table 3. Of the 400 women who fully completed the questionnaire, 328 (82%) were from the state of NSW, the majority spoke English as their first language (83%), and more than half (53.3%) held a university degree. Just over half (52.2%) were in their third trimester, 37.8% were in their second trimester and the remainder (10%) in their first trimester. For approximately half of respondents (49%), this was their first pregnancy. Approximately 40% of the respondents were classified as either "overweight" (20.5%; BMI 25–29.9 kg/m^2) or "obese" (19.3%; BMI ≥30 kg/m^2).

Table 3 Characteristics of the study sample

Characteristics	Entire sample (N=400)	%
Prior pregnancies		
None	196	49
One	129	32.2
Two and more	75	18.8
Stage of pregnancy		
First trimester	40	10
Second trimester	151	37.8
Third trimester	209	52.2
Planned pregnancy		
Yes	325	81.2
No	75	18.8
Age		
<20 years	12	3
20–29 years	195	48.8
30–39 years	178	44.5
≥40 years	15	3.7
Marital status		
Single	23	5.8
Married/de facto	372	93
Separated/divorced/widowed	5	1.2
Education		
Some high school or less	26	6.5
High school completed	57	14.2
TAFE	104	26
Tertiary education	213	53.3
Household income		
<AU$25,000/yr	51	12.8
AU$25,000–AU$50,000/yr	97	24.2
>AU$50,000/yr	252	63
First language		
English	332	83
Other	68	17
Having health and nutrition-related qualification		
Yes	67	16.8
No	333	83.2
Seen by dietitian and/or nutritionist		
Yes	122	30.5
No	278	69.5
Prepregnancy BMI	% (n=326)[a]	Total =81.5[a]
Underweight	15	3.8
Normal	152	38
Overweight	82	20.5
Obese	77	19.3

Note: [a]Prepregnancy BMI was calculated for only 319 respondents as 69 out of 388 respondents did not provide either prepregnancy self-reported height or weight.
Abbreviations: TAFE, Technical and Further Education; yr, year; BMI, body mass index.

Summary of descriptive statistics of the eight nutrition knowledge domains

Table 4 summarizes the mean score achieved by respondents across each of the eight nutrition knowledge domains assessed. The percentage of mean score (the average percentage of the score relative to the total possible score) is provided for each domain to enable the interdomain comparison. The respondents showed the highest levels of knowledge for "food safety practice in pregnancy" (84.22% correct), "diet–health relationship" (71.16% correct), and "nutrient sources" (66.81% correct). Lowest scores were achieved for knowledge of the "multivitamin and supplements during pregnancy" (48.40% correct) and "importance of key nutrients in pregnancy" (46.50% correct).

Recommended intakes of five food groups and extras

Approximately two-thirds (65.2%, n=261) of respondents stated they were not familiar with the AGHE for pregnant women. Although 34.8% (n=139) of respondents indicated that they were familiar with the AGHE recommendations, analysis indicated that there was no difference in their awareness of recommended intake of the five major food groups compared to those who answered that they were not aware of the AGHE ($P<0.63$). The respondents were asked to identify, from a list of multiple-choice options, the correct number of serves/day of each of the five major food groups in the AGHE. The respondents demonstrated a high level of awareness of recommended intake for the "extras" (86.5%, n=346) but less awareness of recommended intake of dairy foods (56.5%, n=226). Less than half of the respondents were aware of the recommended intakes for fruit and vegetables (45%, n=179), bread and cereals (34.5%, n=138), and meat and its alternative food groups (28.5%, n=114).

Food sources of nutrients

In this domain, the respondents' understanding of food sources of certain macro- and micronutrients and energy density of fat was assessed (Table 5). The majority of respondents could successfully identify food sources

Table 4 Descriptive statistics of women's nutrition knowledge domains

Nutrition knowledge domain	% mean (correct answers)	Mean	Total score	SD
Food safety practice in pregnancy	84.22	7.58	9	1.72
Diet–health relationship	71.16	8.54	12	2.18
Food sources of nutrients	66.81	14.70	22	3.23
Choosing everyday food	58.00	1.74	3	0.66
Recommended intakes of five foods groups[a] and extras or "discretionary choices"[b]	50.20	2.51	5	1.01
Healthy meal proportion/serving size	49.50	6.93	14	2.22
Multivitamin and supplements during pregnancy	48.40	2.42	5	1.11
Importance of key nutrients in pregnancy	46.50	0.93	2	0.71

Notes: [a]Fruit, vegetables, dairy foods, meat and its alternatives, and bread and cereals. [b]Including energy dense but nutrient-low foods such as confectionery, jam, cakes, meat pies, and pastries.
Abbreviation: SD, standard deviation.

as high or low in added sugar for most items, including strawberry yoghurt (69.8%, n=279), muesli bar (79.2%, n=317), bananas (83.2%, n=333), and 35% orange juice (89.2%, n=357). Some misperceptions were evident for a number of areas: salt content of pasta, with only 55.2% (n=221) identifying it as low in salt; dietary fiber content of cornflakes, with only 56.5% (n=226) identifying it as a low source of fiber; and saturated fat content of avocado, with only 60% (n=240) of respondents identifying it as a low source of saturated fat. When asked to identify food sources high or low in salt, half of the items were answered correctly, including sausages as high in salt (87.2%, n=349) and spinach as low in salt (90.8%, n=363); however, only 12.8% (n=51) of the pregnant women correctly identified wholegrain bread as high in salt.

The respondents were able to identify food sources high in iron (63.7%, n=255), iodine (65.2%, n=261), and omega-3 fatty acids (90%, n=360) but less able to correctly identify foods that were a high source of vitamin A (38%, n=152). The majority of women (62%, n=248) did not identify liver as a high source of vitamin A, among a list including cheese and sweet potato. Seventy-eight percent of respondents (n=314) were unable to recognize that fat is the macronutrient that has the most kilojoules (calories) compared to sugar and alcohol.

Table 5 Women's awareness of food sources of certain macro- and micronutrients and energy density of fat

Food source is high/low of following nutrients	Correct answers	Correct, n (%)	Incorrect, n (%)
Sugar			
Bananas	Low	333 (83.2)	67 (16.8)
Strawberry yoghurt	High	279 (69.8)	121 (30.2)
Orange 35% juice	High	357 (89.2)	43 (10.8)
Muesli bar	High	317 (79.2)	83 (20.8)
Salt			
Sausages	High	349 (87.2)	51 (12.8)
Pasta	Low	221 (55.2)	179 (44.8)
Spinach	Low	363 (90.8)	37 (9.2)
Wholegrain bread	High	51 (12.8)	349 (87.2)
Dietary fiber			
Cornflakes	Low	226 (56.5)	174 (43.5)
Bananas	High	300 (75)	100 (25)
Wholegrain bread	High	368 (92)	32 (8)
Fish	High	258 (64.5)	142 (35.5)
Saturated fat			
Lean red meat	Low	323 (80.8)	77 (19.2)
Whole milk	High	258 (64.5)	142 (35.5)
Avocado	Low	240 (60)	160 (40)
Vegetarian pastry	High	246 (61.5)	154 (38.5)
Select the most energy dense macronutrient	Fat	86 (21.5)	314 (78.5)
Food source rich in following micronutrients			
Vitamin A	Liver	152 (38)	248 (62)
Iron	Red meat	255 (63.7)	145 (36.3)
Iodine	Sea food	261 (65.2)	139 (34.8)
Omega-3 fatty acids	Oily fish	360 (90)	40 (10)

Healthy meal proportion and serving size

The respondents were asked to identify correct constituent proportions for a healthy meal from pictures showing plates with different proportions of the various food groups. The respondents were also asked to identify the standard portion size of certain food items from each food group. The majority of the women (75.5%, n=302) were able to recognize the plate that represented a healthy dinner plate. The respondents were unable to identify the standard serving size of the following food items: grapes (54% incorrect, n=216), cheese (64.8%, n=259), strawberries (74%, n=296), cooked rice/pasta (82.5%, n=330), and yogurt (90%, n=360). Just over half of the respondents were able to select the standard serving size for breakfast cereal flakes or porridge (50.5%, n=203) and chocolate bars (55.8%, n=223), while 67% (n=268) correctly identified the standard serve size for meat pie.

Choosing everyday foods

The maximum possible score for knowledge about choosing everyday foods was 3. Most respondents (73.8%, n=295) were able to answer two out of three questions correctly. The question answered incorrectly by the majority of the respondents (86.5%, n=346) related to the healthier serving options of pasta and sauce (amounts and proportions) of spaghetti bolognese.

Vitamins and other supplements in pregnancy

Women's awareness about the recommendations for supplements in pregnancy was explored, including vitamins and other recommended supplements (folic acid and iodine), as well as those vitamins for which there were dangers associated with excessive doses (vitamin A, vitamin D, and vitamin B_6). The National Health and Medical Research Council message for women to take folic acid supplements during pregnancy was understood by the majority of the respondents (93.5%, n=374); however, only half of the respondents (51.7%, n=207) were aware of the correct recommendation for iodine supplementation during pregnancy.

The women were asked to identify micronutrients for which there was a risk associated with excessive intake, from a list including zinc, vitamin A, magnesium, vitamin D, and vitamin B_6. Three in ten women indicated that they were not aware of any micronutrients that posed a risk associated with excessive intake. Half of the respondents were able to correctly identify one (n=205) nutrient, and only 11% correctly identified two nutrients (n=46) out of possible three. Less than one-third of the women (30%) correctly identified all the three nutrients (vitamin A, vitamin D, and vitamin B_6) as micronutrients that may pose a risk when taken during pregnancy. The highest level of awareness was for vitamin A (56.3%, n=225) and the lowest for vitamin D (17.5%, n=70).

Diet–health relationship

Domain six explored respondents' knowledge of dietary behaviors that can assist in managing some common pregnancy discomforts, including nausea/vomiting, heartburn, and constipation. Most respondents correctly identified that eating "less fatty and spicy foods" (79.8%, n=315), "eating smaller meals more often" (88%, n=352), as well as "avoiding regular large snacks" (90.2%, n=361) would help minimize the effect of nausea and vomiting during pregnancy. Inversely, more than half of the respondents (56.5%, n=226) incorrectly indicated that eating sweet biscuits in the morning would help in managing morning sickness.

A large proportion of respondents were aware of the potential to minimize the effect of heartburn during pregnancy by "avoiding lying down shortly after eating" (77.8%, n=311) and eating "small frequent meals and nutritious snacks" (83%, n=332) and "less fatty and spicy foods" (86%, n=344). Conversely, only 27.2% (n=109) of the respondents correctly identified that eating less sugar would not help in managing heartburn discomfort.

The majority of the respondents were aware that "exercising regularly" (89.2%, n=357) and "eating more fruit and vegetables" (92.8%, n=371) could assist in resolving constipation in pregnancy. However, more than two-third (69.5%, n=278) incorrectly identified that "eating less spicy and salty foods" would assist in resolving constipation.

Importance of key nutrients during pregnancy – iodine and omega-3

Just over half (57%; n=228) of the respondents identified iodine as an important micronutrient for healthy development of the fetal brain, while only 36% (n=144) identified omega-3 fatty acids as a nutrient that could help in the development of a fetus's eyes, brain, and nervous system.

Food safety practice in pregnancy

In the final survey domain, the respondents' knowledge of issues related to food safety was assessed. The questions focused on personal hygiene (hand washing), food preparation/storage (using the same surface for cutting raw meat and vegetables, reheating food, storage of food at appropriate temperature, storage of raw meat in refrigerator, correct temperature of refrigerator), and safe foods and fish to consume, as well as *Listeria* contamination issues in pregnancy. All the questions were answered correctly by the majority of the respondents, ranging from 95.2% (n=381) for hand washing to 78.5% (n=314) for reheating food. When presented with a list of options of unsafe and safe foods to eat, 93.5% (n=374) of the respondents identified the correct response. Similarly, when presented with a list of safe and unsafe fish to eat during pregnancy, 74% (n=296) of the women answered correctly.

Demographic variation in nutrition knowledge

Descriptive statistics

From a univariate analysis, the women who scored highest in a number of knowledge domains and in the overall knowledge score were in their first trimester (μ=48.80, standard deviation [SD] =4.71, $P<0.001$), had one child (μ=46.21,

SD =6.70, $P<0.001$), had planned their pregnancy (μ=46.21 vs μ=41.60, $P<0.000$), had higher education (μ=48.14, SD =6.34, $P<0.000$), identified English as their first language (μ=46.20 vs μ=41.18, $P<0.000$), were married/de facto (μ=45.73, SD =7.43, $P<0.001$), aged 30–39 years (μ=47.05, SD =6.75, $P<0.000$), and had annual household incomes of ≥AU$50,000 ($\mu$=47.67, SD =6.56, $P<0.000$).

The respondents with a health/nutrition-related qualification had significantly greater levels of overall nutrition knowledge (μ=48.60 vs μ=44.69, $P<0.000$). Of 67 respondents, only 58 provided their qualification details. These included 22 with allied health qualifications, including one with a master degree in exercise rehabilitation and nutrition and dietetics; 17 nurses and one midwife; two participants with medical degrees; two dentists; two with a health degree/Bachelor of Arts; two with a public health degree; one immunologist; and one veterinarian. Of the remaining eight participants, one had a certificate in children's services, one had a first aid certificate, one had a food safety certificate, one had certificates III and IV in fitness, one had studied a subject on ecotrophology, one was a food technology teacher, one was a pastry chef, and one was a chef by trade.

There was no significant difference in the respondents' knowledge in most of the domains (seven out of eight) between women who accessed a dietitian and/or nutritionist and those who had not. The latter respondents scored higher only in the "choosing everyday foods" domain (μ=1.80 vs μ=1.58, $P<0.002$). The reasons for seeing a nutritionist/dietitian varied, including gestational diabetes management (54.9%, n=67), weight management (18.8%, n=23), dietary management during pregnancy (4.9%, n=6), or other reasons (general health and well-being, gallstones, low iron, irritable bowel syndrome, lactose intolerance, acne control, bad eating, and dietary management for teenager; 19.6%, n=24). The respondents indicated that they had seen a dietitian and/or nutritionist either within the last month (26.23%, n=32/122) or from between 1 and 6 months (27.05%, n=33/122) or >6 months (46.72%, n=57/122) from the time they completed the survey. Further analysis revealed that the respondents who had access to a nutritionist/dietitian for managing their gestational diabetes were the only group that scored significantly lower than the other groups in "recommended intakes for the five food groups" (μ=2.07, SD =0.95, $P<0.001$), "food choices" (μ=1.34, SD =0.72, $P<0.000$), and on their total score of nutrition knowledge (μ=42.54, SD =7.33, $P<0.013$). There was not any statistically significant difference between the respondents according to their BMI categories.

Multivariate analysis

Multiple linear regression analysis was undertaken to confirm the independent relationships between demographic factors and respondents' knowledge of nutrition in pregnancy (Table 6). Only the significant factors from the univariate analysis were included in the final model. The independent factors significantly associated with better nutrition knowledge scores (at the 0.05 level) were as follows: highest household income category (≥AU$50,000; β=0.214, $P<0.000$), highest education category (tertiary and higher; β=0.225, $P<0.000$), English as mother's first language (β=–0.216, $P<0.000$), age (β=0.154, $P<0.001$), first trimester for pregnancy (β=–0.101, $P<0.016$), having a health/nutrition-related qualification (β=–0.099, $P<0.020$), and having one child (β=–0.096, $P<0.028$).

The model indicates that independent variables explain 32% (adjusted R^2) of the variance found between respondents' knowledge scores (Table 6). The highest category of education and household income were correlated with better nutrition knowledge. Women who indicated that English was their first language, had one child, and held a health/

Table 6 Multiple regression analysis of selected demographic factors

Predictors	Nutrition knowledge		
	Unstandardized β	Standardized β	*P*-value
Household income	2.389	0.214	0.000
Education	1.574	0.225	0.000
Language	–4.453	–0.216	0.000
Age	1.926	0.154	0.001
Stage of pregnancy	–1.127	–0.101	0.016
Having health/nutrition-related qualification	–2.046	–0.099	0.020
Prior pregnancy	–0.973	–0.096	0.028
	Multiple R=0.584	Adjusted R^2=0.326	F=22.477, $P<0.000$

Note: β, beta coefficient.

nutrition-related qualification had a greater level of nutrition knowledge. However, nutrition knowledge was lower among women who were in the third trimester of pregnancy and fell within the younger age group.

Discussion

To our knowledge, this is the first study to conduct an in-depth investigation into Australian pregnant women's pregnancy-specific nutrition knowledge of the AGHE and other relevant dietary and nutritional recommendations for maintaining a healthy pregnancy. The findings of this study indicate a lack of knowledge among pregnant women in most of the nutrition knowledge areas, such as the AGHE recommendations and basic messages of eating more fruit and vegetables as well as bread and cereals but less meat. The pregnant women also held misconceptions in a range of areas, including standard serving sizes, nutrient content (salt, dietary fiber, saturated fat, and vitamin A) of certain foods, energy density of fat, and the importance of key nutrients in pregnancy. The pregnant women who had a lower education level, had a lower income, were in a younger age group, were in the third trimester of pregnancy, had more than one child, and had English as their second language were least knowledgeable. Although knowledge alone is not sufficient to make changes in the dietary behavior, it can be a key factor to initiate such changes.

For this study, the survey questions on the recommended serves of fruit/vegetables (4/5–6 serves/d), bread/cereal (4–6 serves/d), meat and its alternatives (1.5 serves/d), and dairy (2 serves/d) reflected the AGHE for pregnant women at the time of implementing the survey. The updated AGHE recommends 2/5 serves/d for fruit/vegetables, 8.5 serves/d for bread/cereals, 3.5 serves/d for meat and its alternatives food group, and 2.5 serves/d for dairy foods. The other key change in the 2013 AGHE was to the standard serving sizes for bread/cereals, which were approximately halved. As the data collection of the current study commenced prior to the release of the updated AGHE, the results of this study report on the pregnant women's knowledge of the earlier AGHE. However, as the levels of knowledge were found to be low (only 34.8% of women were familiar with the AGHE), the subsequent changes to the AGHE for pregnant women are likely to result in even lower levels of knowledge of current dietary recommendations for a healthy pregnancy, at least initially.

Knowledge is one of many factors required to change a person's behavior,[14] and maternal nutrition knowledge is significantly associated with the nature of the maternal diet.[18] In this study, the pregnant women showed high level of knowledge about the issues related to food safety, "diet–health relationship", and "nutrients sources" and deficit level of knowledge on topics including "choosing everyday food", "recommended daily intakes of five food groups", "serving size", "supplements during pregnancy", and "importance of key nutrients in pregnancy". Even when the knowledge of the daily recommended intakes of certain food groups (dairy, for example) was averaged (56.5% had the correct answer), understanding of the standard serve size details within these groups was quite low (cheese, 35% and yoghurt, 10%). These findings are in line with the earlier Australian studies that explored knowledge of recommended dietary practice in pregnancy[8,41] and more generally within a community sample.[35] The low awareness of the dietary guidelines (recommended daily intakes of core food groups and standard serving sizes) is of concern. This may hinder pregnant women's ability to consume a balanced diet in recommended amounts of core food groups, resulting in their having poor dietary intakes.

High consumption of salt, sugar, and fat, and insufficient intake of fiber by pregnant women have been reported in a number of Australian studies.[7,33,42] In this study, a high proportion of the pregnant women were unaware of the energy density of fat (78%), the type of foods low or high in fat (86%), and the salt content of bread (87%). This may indicate that pregnant women's poor knowledge of some common aspects of nutrition may result in suboptimal diets. The greater availability of energy-dense, nutrient-poor products[43] further increases the importance of educating women regarding the foods with high-energy density, high fat, and salt.

There was variation in the women's knowledge of the importance of omega-3 and iodine and their recognition of the need for supplementing with folic acid and iodine. They also varied in their ability to identify foods containing high levels of key nutrients (namely, omega-3 fatty acids, iron, vitamin A, and iodine). In Australia, the NHMRC recommends supplementation with folic acid and iodine during pregnancy.[26] Consistent with other studies,[29,30] most of the women (90%) in this study were aware of the need for folic acid supplementation, but less than half (48.3%) were aware of the recommendation for iodine supplementation. The recommendation for supplementing with iodine was only introduced in 2010 as opposed to 1992 for folic acid,[44] which may explain the difference in awareness. This low level of knowledge of the need for iodine supplementation may result from health care professionals not discussing iodine

supplementation with pregnant women, perhaps reflecting their own poor levels of knowledge.[30,45] Maternal health care professionals should be supported and encouraged to provide such information to pregnant women, particularly as studies have shown that pregnant women expect nutrition information from their health care professionals.[33,46]

Fish contains important nutrients like omega-3 fatty acids, which are important for the development of a fetus's brain, eyes, and nervous system.[47,48] For pregnant women, it is recommended to consume two to three serves (1 serve =50 g) per week of any fish and seafood, excluding any large and predatory fish that may contain high levels of mercury.[49] In this study, a majority of women were aware of the safest fish type and sources of omega-3 fatty acids; however, they had poor knowledge of their importance during pregnancy. Earlier national and international studies have reported a similar lack of knowledge on the importance of omega-3 fatty acids for women during pregnancy.[31,50] Although health care professionals' advice and accessible resources played a vital role in women's decision about fish consumption during pregnancy,[50] studies have reported a shortage of available education resources and lack of communication between health care professionals and pregnant women about omega-3 fatty acids and their importance during pregnancy.[31,50,51] Improved strategies to increase awareness of such information among pregnant women are required.

The low level of knowledge relating to food that is a rich source of vitamin A (liver) is concerning, especially during pregnancy. Although liver is a rich source of key nutrients such as iron and folate, avoiding it in pregnancy is recommended as it contains a high level of vitamin A and the upper safer limit is uncertain.[52] A high dose of vitamin A in pregnancy poses a serious risk of birth defects.[53] Although our study did not provide information on how this low awareness of vitamin A-rich source food could affect pregnant women's food choices, written comments (open text sections of the survey) in the present study indicated that some women may be influenced by some of nonevidence-based information. For example, a few women added comments that were in favor of the "Paleo diet", and they thought it the healthiest dietary pattern they could follow. This may reflect the influence of contemporary popular media (including social media), which contains many articles advertising and promoting nonevidence-based dietary practices such as the "Paleo diet" that may encourage pregnant women to consume organ meat such as liver.[54] Adopting such a diet could put women's and their babies' health at risk. Women are more likely to change their diet if they believe it benefits their baby.[55] However, it is important that pregnant women's nutrition and dietary knowledge is evidence based.

Developing evidence-based dietary guidelines provides a foundation for promoting healthy eating, but it is important to ensure that the target audiences become knowledgeable about them in order to achieve beneficial results. The results of this study indicate that important information about the AGHE for pregnancy and other key public health nutrition messages need to be made more available to women. This could be achieved by using mass media that provides several powerful avenues for such communication.[24] In addition, health professionals may be considered an important avenue for communication of evidence-based dietary guidelines. They have regular contact with pregnant women, are considered as trusted and preferred sources of information,[16] and women gain more support when health professionals emphasize educational resources.[46,56] However, practitioners have been found to have low level of nutrition knowledge[45] and may not be equipped to assist their patients. How best to support health professionals to become effective nutrition educators would be a valuable area of further research.

In line with other studies on general populations[35] and pregnant women,[8] this study found that pregnant women's nutrition knowledge was positively associated with age, household income, and education level. Nutrition knowledge has been reported to be positively associated with pregnant women's self-reported dietary behavior.[17,18] Other studies and reports suggest that a lack of nutrition knowledge may reflect a social gradient, with poor nutrition knowledge linked with lower diet quality and thus to poorer health outcomes.[8,57] Nutrition education is needed to target those in high-risk groups.

In this study, latter trimesters in pregnancy were found to be negatively associated with the maternal nutrition knowledge score, with the pregnant women in their first trimester having the highest levels of knowledge. Recent studies in Australia have shown that women's interest in receiving nutrition information is highest in early pregnancy.[33,41] Thus, the provision of timely, evidence-based nutritional education for women during pregnancy might be of benefit, especially at the very early stage of pregnancy when critical fetal development is occurring. Ongoing nutrition education throughout the pregnancy may also be warranted, given the lower nutrition knowledge scores of women who are more advanced in their pregnancy and who may be particularly vulnerable to unwelcome weight gain. The observed relationship between lower nutrition knowledge of women with gestation diabetes who had seen a dietitian/nutritionist

is new and needs additional exploration. This finding may suggest that individual dietary counseling for these women may focus more on carbohydrate counts and glycemic control, which may differ from the general dietary advice for healthy pregnant women. These disparities were not assessed in this study.

Limitation and strength

The limitations of this study should be noted. The results of this study cannot be generalized due to the nonrepresentative nature of the convenience, cross-sectional sample obtained mostly from NSW, Australia. Language may have been a barrier that excluded non-English-speaking women who may be at higher risk of low knowledge compared to English-speaking women. Categorizing the demographic questions limits the ability to compare the current study sample's demographic characteristics to the state and national profiles. The strength of our research is that the results provide valuable insights into the level of understanding of maternal-related nutrition information in a large sample of Australian pregnant women that can be used to inform interventions for this group.

If pregnant women are to be better informed of the nutritional needs and practices required for the health of themselves and their children, studies investigating the sources of information and forms of support preferred by pregnant women need to be undertaken. This would provide important information for the development of effective education programs for pregnant women to establish and motivate positive dietary behavior change.

Conclusion

The findings of this study indicate a lack of knowledge among pregnant women in most of the nutrition knowledge areas. Although knowledge alone cannot ensure dietary behavioral changes, it can be a key factor in the initiation of such changes. The establishment of official dietary guidance is not sufficient to ensure that women are equipped with the knowledge necessary to optimize their diets for the health of themselves and their unborn babies. Health care providers have an important role in promoting knowledge of healthy eating for pregnant women.

Acknowledgments

The authors wish to acknowledge the Saudi Arabian Higher Education Ministry for PhD scholarship funding; the South East Sydney and Illawarra Area Health Services, South Western Sydney Local Health District sites, and midwives who assisted with the recruitment of the respondents; all pregnant women who participated in this study; Associate Professor Marijka Batterham for statistical advice; Doctor Joanna Russell for her comments on the primary data analysis stage; Doctor Alexis St George for constructive comments on earlier drafts of this manuscript; Ms Elaine Newby who assisted in the editing of this article; and Doctor Gilly Hendrie for her cooperation and great readiness to help. The abstract of this article with interim findings was presented at the 30th ICM Triennial Congress – Midwives[58] and at the Australian College of Midwives Biennial Conference.[59] The current article includes work based on the PhD thesis submitted by the main author, Khlood Bookari, and parts of it have been published.[17,60]

Author contributions

K Bookari is the main author and is responsible for designing study survey, collecting and analyzing data, writing the initial manuscript, and revisions. All authors contributed toward data analysis, drafting and critically revising the paper and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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