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What do Pregnant Women Know About the Healthy Eating Guidelines for Pregnancy? A Web-Based Questionnaire

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Abstract *Objectives* This study explored nutrition knowledge of pregnant women, and how it correlated with participant characteristics, their main sources of information and changes to their diet since becoming pregnant. *Methods* Pregnant women residing in Australia accessing pregnancy forums on the internet were invited to complete a web-based questionnaire on general nutrition and pregnancy-specific nutrition guidelines. *Results* Of the 165 eligible questionnaire responses, 114 were complete and included in the analysis. Pregnancy nutrition knowledge was associated with education ($r_s = 0.21$, $p < 0.05$) and income ($r_s = 0.21$, $p < 0.05$). Only 2 % of pregnant women achieved nutrition knowledge scores over 80 %. Few women received nutrition advice during their pregnancy, of which most were advised by their doctor. Dietary changes adopted since becoming pregnant included consuming more fruit, vegetables, dairy and high fibre foods. *Conclusions for Practice* Pregnant women in this study had limited knowledge of the dietary guidelines for healthy eating during pregnancy. Furthermore, nutrition counselling in maternity care appears to be infrequent. One approach to optimising maternal diets and subsequently preventing adverse health outcomes is to enhance their knowledge of the pregnancy nutrition guidelines through the provision of nutritional counselling. Furthermore, research exploring the access and use of nutrition resources, and nutrition advice provided to pregnant women is recommended to understand how knowledge impacts on dietary behaviour.

Keywords Pregnancy · Nutrition knowledge · Dietary guidelines · Antenatal · Online questionnaire

Significance

Maternal diets do not meet nutritional recommendations and this has been linked to poor nutritional knowledge. To our knowledge, there are no comprehensive published studies assessing pregnancy nutrition guideline knowledge in relation to energy requirements, recommended daily servings of core foods groups other than fruit and vegetables, fluid requirements, and food safety guidelines regarding vitamin A toxicity, mercury and health risks of listeriosis, salmonellosis and toxoplasmosis. Several studies have assessed select components of guideline knowledge in isolation such as folic acid, iodine, weight gain or Listeria. This study highlights that pregnant women have limited knowledge of the pregnancy nutrition guidelines, and demonstrates specific areas of the guidelines that are poorly understood. This study also highlights that few women reported receiving nutrition advice as part of their pregnancy care. The results of this study can be used to advocate for efficacious nutrition programs/campaigns, to ensure a healthy start to life, and to promote routine nutrition counselling as part of pregnancy care.

Introduction

The National Health and Medical Research Council (NHMRC) Australian Dietary Guidelines [34] promotes healthy eating to maximise the health and wellbeing of

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both the woman and fetus during pregnancy. Diet and nutrition during pregnancy has been shown to influence pregnancy outcomes. For example, inadequate intakes of folic acid and iodine have been associated with preventable birth defects [9] and impaired cognitive outcomes [2], respectively. Consuming foods that are high risk for Listeria contamination, increases the risk of listeriosis which has been associated with miscarriage, premature birth, or in rare cases, stillbirth [20]. Poorer quality maternal diets have been associated with higher risks for preterm delivery [15]. Furthermore, extremes in birthweight for gestational age, as a result of poor maternal diet poor maternal diet during pregnancy has been associated with increased risks of cardiovascular disease, impaired glucose metabolism, obesity, dyslipidaemia and high blood pressure in later life [5].

Due to these potential health risks, it is preferable that women adhere to the guidelines for healthy eating during pregnancy [34]. Unfortunately, although women reported making positive changes to their lifestyle during pregnancy, such as reductions in smoking, alcohol and caffeine consumption, dietary intakes have been demonstrated to not meet the recommended food and nutrient intakes for pregnancy [8, 38, 40].

Dietary behaviour can be influenced by a variety of factors. Knowledge is one factor considered to be necessary for behaviour change [33] and was the focus of this study. Not adhering to pregnancy-specific nutrition guidelines has been associated with lower nutritional knowledge levels in pregnant women [4, 6, 7]. Several observational studies have been published examining pregnant women's knowledge of isolated aspects of the nutritional guidelines for pregnancy such as the recommended daily servings of fruit and vegetables [11]; gestational weight gain targets [10, 37, 41]; requirements of iodine [32] and folic acid [7]; and recommendations regarding Listeria [4]. These studies all reported limited knowledge of the respective nutrition guidelines they explored. No studies have been identified that have measured knowledge of other aspects of the pregnancy nutrition guidelines such as energy requirements, recommended daily servings of core foods groups other than fruit and vegetables, fluid requirements, and food safety guidelines regarding vitamin A toxicity, mercury and health risks of listeriosis, salmonellosis and toxoplasmosis.

Most women are motivated to improve their lifestyle during pregnancy [17]. Women have reported seeking dietary information for themselves, particularly since nutrition counselling by pregnancy care providers have been perceived to be limited [13, 39]. Women described relying on the internet to access pregnancy-related nutrition information [13, 28, 39]. However, the quality of nutrition information published on the internet can be variable and may have limited value in guiding women's decisions about diet during pregnancy. Furthermore, information on the internet can be region-specific, based on personal opinions, and/or may not be regularly updated and hence may not reflect the recently updated Australian Dietary Guidelines. It is unclear what information women seek on the internet with regards to nutrition during pregnancy and how it impacts on their knowledge and subsequent food behaviour. In relation to the Australian Dietary Guidelines and nutritional recommendations, this exploratory study examined: (1) knowledge of pregnancy nutrition guidelines and correlations with participant characteristics, (2) main sources of nutrition information used by pregnant women, and (3) changes to dietary intake since becoming pregnant.

Materials and Methods

Questionnaire Design

To assess knowledge of pregnancy-specific guidelines, a Pregnancy Nutrition Knowledge Questionnaire (PNKQ) was developed, based on the pregnancy and diet brochures/factsheets produced by the NHMRC and Food Standards Australia New Zealand [18–20, 34]. The questionnaire included 76 short answer and multiple choice items relating to nutrient supplementation, food sources of nutrients, high risk foods, alcohol recommendations, healthy food choices, and healthy weight gain during pregnancy.

Face and content validity was assessed by a sample ($n = 21$) of dietitians, midwives, an obstetrician, pregnant women, and postnatal women. This resulted in the addition of eight items relating to energy requirements, iron requirements, vitamin A (recommendations for food and supplements, food sources and risks) and Toxoplasma (sources of contamination). A further nine items required editing to improve flow and clarity. To reduce the likelihood of guessing the answer, an option to select "not sure" was provided on all items.

Test–retest reliability in a separate sample ($n = 23$) of women of reproductive age confirmed appropriate and consistent interpretation of the items ($r = 0.93$, $p < 0.01$). Further piloting of the PNKQ was conducted with dietitians ($n = 211$) which resulted in the adaption of three short answer items into multiple choice items for enhanced precision and ease of scoring. Criterion validity was assessed using the general nutrition knowledge questionnaire: sections 1 to 3 [25].

Changes to dietary intake were measured by asking: *Since becoming pregnant are you eating more, the same, or less of: vegetables, fruit, carbohydrate/grain foods, meat, dairy, sugary foods, fatty foods, high fibre foods, and salty*

foods? The wording of this item was based on the previously mentioned validated nutrition knowledge questionnaire [25] with the substitution of 'starchy' for 'carbohydrate/grain', in line with the Australian Dietary Guidelines. The objective of including other food categories was to confirm dietary changes to the core food groups as it was assumed that if a participant consumed more fruit, vegetables and/or grains, they were also consuming more high fibre foods. The item relating to sugary, fatty and salty food intakes was an arbitrary measure of the consumption of discretionary foods.

Six items were constructed to measure sources of new information: Women were asked if they were advised to change what they ate because of the pregnancy and by whom; if they had taken any formal nutrition courses; if they had they seen a dietitian, and if so for what reason. Women were asked to rank in order (1 = 1st choice) their top three sources of nutrition information from the following: obstetrician, GP/family doctor, midwife, dietitian/nutritionist, childbirth education class, academic journals, magazines/books, friends, parents, other, and internet. When women ranked the internet in their top three sources of information, they were prompted to list the websites they had visited. Demographic information such as age, gestation, nationality, highest level of education completed, and net income was collected.

The final format of the questionnaire used, included three sections: (1) General Nutrition Knowledge Questionnaire [25], (2) PNKQ, and (3) sources of information and demographic items. The questionnaire was uploaded into Qualtrics (Version December 2013, Provo, UT) and a web-link created.

Study Participants and Data Collection

A convenience sample of Australian pregnant women were invited to participate between 2nd December 2013 and 20th January 2014. The inclusion criteria were: women having a singleton pregnancy, being proficient in written English, and living in Australia. Women having higher order pregnancies were excluded as the current nutrition guidelines are specific to singleton pregnancies. The web-link was posted, and re-posted 4 weeks later, in four pregnancy forums: Bub hub; Baby Center; Essential baby; and Huggies. The choice of websites was selected from a google search for "pregnancy forum Australia". An incentive to participate was offered in the form of a draw for one of three $50 gift cards for those who completed the questionnaire and provided their mobile number or email contact. Consent was implied via completion of the questionnaire. When women accessed the questionnaire, they were directed to a webpage containing information about the study and a discriminating statement "I agree to participate in the study and I am living in Australia and pregnant with one baby". Responding 'yes' directed the participant to the questionnaire and responding 'no' directed them to a webpage thanking them for their interest in the study. This study was approved by the La Trobe University College Human Ethics Sub-Committee (FHEC 13/191).

Data Analysis

The responses were exported from Qualtrics into SPSS (Version 22, IBM, NY 2014) for coding and analysis. Survey responses that were mostly blank or contained blank sections were excluded. The data was coded as correct response (1) or incorrect response (0). A missing values analysis was conducted and found to be non-significant which deems the missed items to be random, and thus coded as incorrect. The sum of correct items provided a knowledge score. Nutrition knowledge items with correct responses obtained by greater than 80 % of participants were defined as 'well known'. The cut-offs have been based on university assessment grading. Descriptive statistics were calculated using frequencies, percentages, mean and standard deviation. Data was explored for normality using Kolmogorov-Smirnov tests for normality, and found to be violated. Due to data not being normally distributed and nominal variables, Spearman's correlation (two-tailed) assessed criterion validity and the relationship between pregnancy nutrition knowledge score and participant characteristics. The level of significance was set at $p < 0.05$.

Results

One hundred and sixty-five eligible responses were retrieved from Qualtrics. Incomplete responses were excluded leaving a sample of 114. This represented a completion response rate of 69 %. The mean (SD) age of participants was 32.8 (4.3) years with 54 % experiencing their first pregnancy. The participants' characteristics are presented in Table 1.

Dietary Changes

Based on the frequencies, women indicated that they consumed more fruit, vegetables, dairy and high fibre foods since becoming pregnant (Fig. 1).

General Nutrition and Pregnancy Nutrition Knowledge

There was a strong positive correlation observed between general nutrition and pregnancy nutrition knowledge scores ($r_s = 0.51$, $p < 0.001$) indicating a satisfactory degree of

Table 1 Characteristics of participants, n = 114

Variable	Number of women (%)
Age in years, $n = 107$	
<25	2 (2 %)
25–29	23 (21 %)
30–34	42 (39 %)
35–39	33 (31 %)
40+	7 (7 %)
Gestation	
1st trimester (0–12 weeks)	42 (37 %)
2nd trimester (13–27 weeks)	35 (31 %)
3rd trimester (28–40 weeks)	37 (32 %)
Number of children	
0 (first pregnancy)	63 (55 %)
1	38 (33 %)
2	9 (8 %)
3+	4 (4 %)
Nationality—birth place	
Australia	102 (90 %)
England	6 (5 %)
Other	6 (5 %)
Highest level of education achieved	
Year 12 or less	8 (7 %)
TAFE or equivalent	24 (21 %)
University	82 (72 %)
Income[a]	
Low ≤ $407	2 (2 %)
Medium $408–$2036	53 (47 %)
High > $2 037	56 (49 %)

[a] Based on Australian Bureau of Statistics average weekly equivalised disposable income—6523.0 Household Income and Wealth 2013–2014

criterion validity for PNKQ. A small positive correlation was found between pregnancy nutrition knowledge and level of education ($r_s = 0.21$, $p < 0.05$) and income ($r_s = 0.21$, $p < 0.05$). No relationships were found between nutrition knowledge and age, gestation, or number of children.

The proportion of women in this study scoring over 80 % for general nutrition was 31 % (35/114) and 2 % (2/114) for pregnancy nutrition. The frequencies of correct responses for PNKQ are shown in Table 2. The majority of women indicated they were aware of the Australian Dietary Guidelines for healthy eating during pregnancy. Across all responses, there was limited knowledge regarding weight gain targets; recommendations for food groups during pregnancy; when to take iodine supplementation; the role of folic acid in preventing birth defects other than spina bifida; amount and timing of folic acid supplementation; food sources of folic acid and iodine; and mistaking low risk for high risk foods in relation to mercury and Listeria. The items that women knew well included: the populations at risk of foodborne contamination; the need for folic acid supplementation; the health risks of eating contaminated foods; high risk foods regarding mercury and listeria; and abstaining from alcohol during pregnancy.

Nutrition Information Sources

Less than a third (30 %) of women indicated they were given advice to change their eating habits as a result of being pregnant, and nearly all who did receive advice stated it came from their doctor. Few women indicated they had undertaken a formal nutrition course (4 %) or seen a dietitian during the pregnancy (11 %). The main reasons

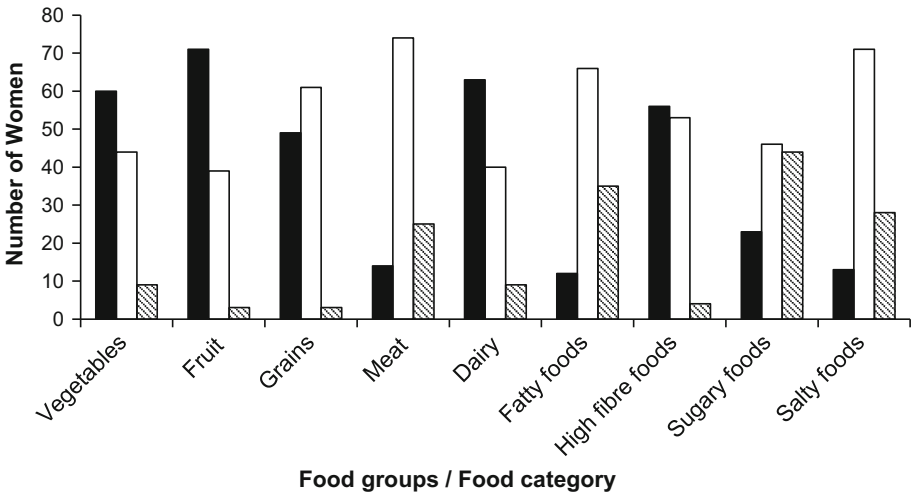

Fig. 1 Dietary changes (*filled square* more, *open square* same, *cross line with square* same less) made by women since becoming pregnant according to food groups and food categories, n = 113. Food group: vegetables, fruit, grains, meat and dairy. Food category: fatty foods, high fibre foods, sugary foods and salty foods

Table 2 Frequency of correct responses for each item relating to the pregnancy nutrition guidelines, $n = 114$

Item	Correct answer	*n*	%
Which foods do you think experts recommend eating more or the same of during pregnancy?			
Vegetables	Same	24	21
Meat	More	24	21
Grains	More	34	30
Fruit	Same	65	57
Dairy products	Same	34	30
Fluids	More	108	95
How many servings of fruit and vegetables a day do you think experts are advising pregnant women to eat?	2 Fruit	70	61
	5 Vegetables	65	57
How much extra fluid is recommended for pregnant women each day?	750–1000 ml	45	40
Which vitamin or mineral supplement do experts recommend for all pregnant women to take?			
Calcium	No	41	36
Folic acid	Yes	114	100
Iron	No	31	27
Iodine	Yes	83	73
Vitamin C	No	50	44
Vitamin B12	No	42	37
Vitamin D	No	42	37
Zinc	No	46	40
What do experts recommend about when to take iodine supplements?	When pregnant and breastfeeding	38	33
What do experts recommend about when to take folic acid supplements?	1 month before pregnancy and first 3 months	52	46
What are the reasons why folic acid supplements are recommended?	To prevent spina bifida	114	100
	To prevent cleft lip	14	12
	To prevent heart defects	10	9
What dose of folic acid supplement do you think is usually recommended?	400 micrograms	43	38
To meet energy needs throughout pregnancy women need to:	Eat more energy each trimester	78	68
To meet energy needs during the first 3 months of pregnancy, pregnant women need:	No extra energy	89	78
How much extra food should a pregnant woman eat each day to meet energy needs in the 2nd trimester?	A tub of yogurt and piece of fruit	89	78
How much weight is recommended for women of a healthy weight before pregnancy to gain during pregnancy?	11.5–16 kg	23	20
During pregnancy women who are overweight before they are pregnant are recommended to:	Gain some weight	56	49
For women who are pregnant or planning a pregnancy, not drinking is the safest option	Agree	114	100
How many alcoholic drinks are safe to drink during pregnancy?	None	110	97
It is recommended for pregnant women to limit their intake of liver because of its high vitamin A content	Agree	86	75
During pregnancy it is recommended to avoid taking multivitamins containing vitamin A	Agree	90	79
During pregnancy too much vitamin A from food and supplements can lead to:	Birth defects	88	77
Do you think these foods are high or low in folate/folic acid?			
Meat	Low	73	64
Fruit juice	High	21	18
Milk	Low	65	57
Spinach	High	103	90
Peanuts	High	18	16
Plain sweet biscuit	Low	102	90
Branflakes	High	57	50
Which food is not a good source of iodine? (*other choices: egg, canned pink salmon, milk*)	Steak	25	22
How much extra iron is needed during pregnancy?	1.5 times extra	56	49

Table 2 continued

Item	Correct answer	*n*	%
If you wanted to increase the amount of iron in your diet, which serving of food would be the best choice? (*other choices: pasta carbonara, lentil soup, egg sandwich*)	Tuna salad	23	20
If you wanted to increase the amount of calcium in your diet, which serving of food would be the best choice? (*other choices: baked beans, spinach, steak*)	Sardines	66	58
Do these fish or seafood have high amounts of mercury?			
Canned tuna	No	77	68
Flake	Yes	103	90
Orange roughy	Yes	52	46
Snapper	No	55	48
Swordfish	Yes	93	82
Barramundi	No	58	51
Prawns	No	82	72
During pregnancy fish with high levels of mercury should be limited to:	Once a fortnight	72	63
Are the following groups of people at risk of infections from Listeria, Toxoplasma or Salmonella?			
Older people	Yes	95	83
Pregnant women	Yes	102	90
Sports people	No	98	86
Unborn children	Yes	103	90
Young people	No	49	43
What are the possible health risks when eating foods contaminated with Listeria, Toxoplasma or Salmonella?	Birth defects	63	55
	Premature birth	101	89
	Miscarriage	110	97
	Stillbirth	99	87
	Food poisoning	109	96
Are these foods high risk for Listeria infection?			
Long life milk	No	101	89
Smoked salmon	Yes	101	89
Steak, well cooked	No	113	99
Lunch meat	Yes	114	100
Feta	Yes	105	92
Cream cheese	No	64	56
Pizza with ham	No	69	61
Rice	No	43	38
Which bacteria will continue to grow on contaminated foods stored in the refrigerator?	Listeria	67	59
The advice to avoid mayonnaise made from raw eggs is because of the higher risk of infection from:	Salmonella	63	55
The advice to avoid undercooked meat is related to:	Toxoplasma	26	23
The advice to avoid cleaning the cat litter is related to:	Toxoplasma	112	98
Which food would be most likely to have high risk for Listeria contamination? (*other choices: vegetarian sushi roll, cheeseburger, spinach and ricotta pastry*)	Prawn cocktail salad	75	66
Which food is the safest choice from Salmonella? (*other choices: hollandaise sauce, poached egg, chocolate mousse*)	Quiche	88	77

for seeing a dietitian during the pregnancy was for gestational diabetes ($n = 6$), weight management ($n = 4$), and assessment of nutritional adequacy in the setting of intense exercise and previous surgery ($n = 2$).

Women in this study acquired nutrition information from multiple sources. The general practitioner, obstetrician, midwife and internet were the most frequently relied upon sources of information (Fig. 2). The websites most frequently visited included unspecified Australian government websites, Essential baby, Babycenter and Google. One woman listed the "NHMRC" as her source of nutrition information.

Discussion

Whilst the majority of women in this study reported being aware of the Australian Dietary Guidelines for healthy eating during pregnancy, few women in this study had good knowledge regarding the details of the pregnancy nutrition guidelines. Based on the behaviour change wheel [33], acquiring knowledge is important for building an individual's capacity for behavioural change. Additionally, enhancing knowledge has been shown to change dietary behaviour [12, 14]. Emmett et al. [14] developed a pamphlet and a wallet sized shopping card to increase intake of omega-3 fatty acids. A majority of women that received these education materials significantly enhanced their knowledge of omega-3 rich food sources and the benefits in pregnancy. Women also significantly increased their intake of fish and actively shopped for omega-3 enriched food products. Similarly, Dodd et al. [12] developed an antenatal dietary and lifestyle program encouraging women to reduce their intake of foods high in refined carbohydrates and saturated fats, and increase their intake of fruits, vegetables and dairy. Women who received this lifestyle advice significantly increased the number of daily servings of fruits and vegetables and significantly reduced their intake of saturated fats compared to women receiving standard care.

Areas of limited nutrition knowledge, as identified in the current study, are important issues that need to be addressed in order to prevent potential adverse health outcomes, as discussed below. A large proportion of women (80 %) had incorrect knowledge of the weight gain targets, which may increase the likelihood of inappropriate weight gain and have implications for excess weight gain and postpartum weight retention [10]. Women's lack of knowledge of the gestational weight gain targets in this study was consistent with findings from other studies reporting between 11.7 and 47 % of women correctly identifying their gestational weight gain targets [10, 37, 41]. Consequently, women who have incorrect knowledge of their gestational weight gain targets are reportedly more likely to gain weight above their weight gain targets [26].

With the exception of the guideline to increase fluids during pregnancy, few women in this study were able to identify whether it is recommended they consume more or the same of each food group to meet their increased requirements. Women consuming inappropriate dietary intakes during pregnancy may have increased risks of their baby being born small or large for gestational age and increased risks of developing pre-eclampsia and iron-deficient anaemia [34]. Over half of the women in this study correctly identified the recommended daily servings of 2 fruit and 5 vegetables, which is a positive finding compared to a previous observational study reporting only 8 and 35 % respectively identifying the recommended daily servings for 2 fruit and 5 vegetable [11].

Women's knowledge of folic acid was limited, and although all the women in this study were aware they needed to take a folic acid supplement to prevent spina bifida, less than half knew at what dose and when to supplement folic acid. These results were comparable to other studies assessing pregnant womens' knowledge and practice of folic acid supplementation. Conlin et al. [7] surveyed 304 South Australian pregnant women and found that 73 % of women were aware of the role of folic acid in pregnancy, 82 % were aware of when to supplement, and only 18 % knew the recommended dose. Whilst Sen's et al. [36] survey of 300 pregnant women reported high awareness of the role of folic acid, and 76 % of women knew when to take it. Women's knowledge of iodine in this study

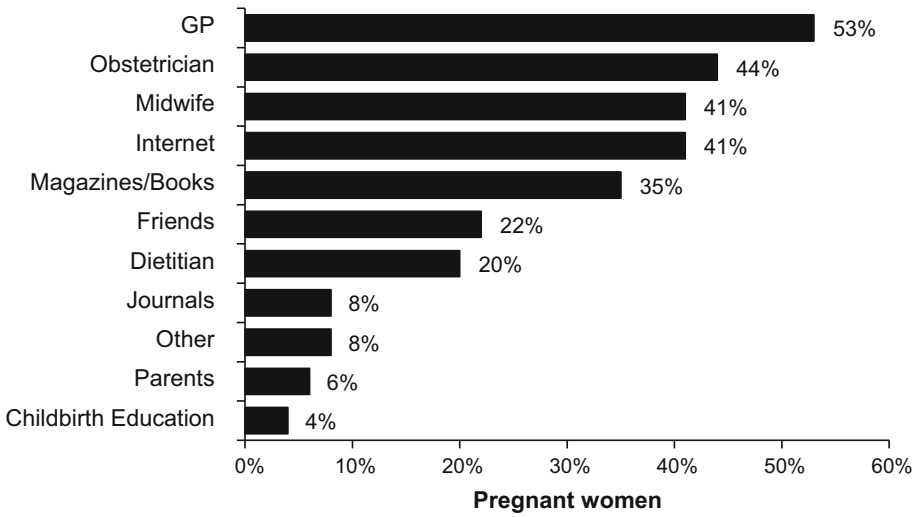

Fig. 2 Top 3 sources of information pregnant women rely on regarding nutrition, $n = 113$. Values do not total 100 % as women could choose more than one source of information

was limited which has also been demonstrated in other Australian studies. Martin et al [32] surveyed 200 pregnant women and found that while 55 % of women had heard about the importance of increasing iodine during pregnancy, only 19 % indicated they needed iodine supplementation. Similarly, Lucas et al [31] assessed nutrition knowledge of 142 pregnant women. Although 94 % of pregnant women were aware of the risk of health problems associated with iodine deficiency during pregnancy, there was poor knowledge of the food sources of iodine and potential health outcomes related to iodine deficiency.

The majority of women (>89 %) in this study were aware of the potential harm to the unborn child caused by Listeria infection and correctly identified foods that are high risk for Listeria contamination. However, women also indicated they believed that some safe foods such as rice, cream cheese and pizza with ham were high Listeria risk foods. Avoiding foods deemed to be safe could further compromise the nutritional status of pregnant women, especially when they are already not meeting their nutritional needs [8, 40].

The associations between participant characteristics and nutrition knowledge were varied. This study observed associations between higher levels of education and incomes with higher nutrition knowledge, which aligns with past research findings [29, 35, 42]. Nuss et al. [35] also found a positive association between age and nutrition knowledge, however this was not observed in this study: perhaps because the women in the previous study were younger than those in this study. Furthermore, with only two participants aged less than 25 years participating in this study, any association between knowledge and age might have been attenuated. The lack of association observed between gestational age, and nutrition knowledge, in this study could be due to women not receiving ongoing nutrition information after the first antenatal appointment [21]. However, it may also be that the women themselves described needing nutrition information earlier in the pregnancy [39], as nutrition information was perceived to be less relevant later in the pregnancy, possibly because participants thought that their eating habits no longer influenced pregnancy outcomes [22, 27]. Past research has indicated that parents with two or more children are observed to have greater nutrition knowledge [24] but this was not observed in our study. One possible explanation for this lack of difference, previously suggested by Downs et al. [13], could be that health care professionals might assume women who have previously been pregnant would have prior knowledge of pregnancy nutrition and therefore did not provide further nutrition education to these women.

Many women in this study indicated they mostly relied upon health care providers such as the general practitioner, obstetrician and midwife, to obtain nutrition information. Unfortunately, few reported receiving nutrition advice and/or education. It has been suggested that limited pregnancy nutrition knowledge may be due to nutrition advice not being routinely provided [16, 27]. When dietary advice from health care providers was perceived to be inadequate, women sought information for themselves [13, 27]. Other studies exploring experiences of dietary advice during pregnancy observed that books, social supports, and the internet were common ways to learn about nutrition [23, 28, 30, 39]; and they were also reported as important sources of nutrition information for women in this study.

Women in this study reported increasing their intake of fruit, vegetables, dairy and high fibre foods since becoming pregnant, which was similar to other findings. Blumfield et al. [3] assessed the intakes of women from the Australian Longitudinal Study on Women's Health cohort and found pregnant women had higher intakes of fruit and dairy compared to non-pregnant women. Huberty et al. [28] also described an increased intake of fruit and vegetables during pregnancy. Our study did not specifically assess dietary intake, and therefore was unable to compare maternal diets to the Australian Dietary Guidelines.

There are limitations to consider when interpreting the results of this study. Women who completed the questionnaire were likely to have had a greater interest in nutritional issues and therefore more likely to complete the questionnaire, possibly overestimating nutrition knowledge of Australian pregnant women. Women in this study had a higher level of tertiary education compared to the Australian female population [1], which limits generalisability. The questionnaire was only available online and in English, limiting the accessibility of the questionnaire to other pregnant women who would not usually access the internet for pregnancy-related nutrition information or for women who were not literate in English. The questionnaire was self-administered possibly introducing self-reporting bias. Furthermore, items in the questionnaire could have been misconstrued, limiting the interpretation of the results. This was minimised by piloting the questionnaire for test–retest reliability and face and content validity. The study findings are also limited by the small sample size. The relationship between nutrition knowledge and maternal diet could not be analysed without actual dietary intake data, however, the reported findings of low nutrition knowledge scores are important as they demonstrated limited nutrition knowledge in this sample population.

Findings of this study shows there is a need for greater emphasis on nutritional counselling and education to optimise maternal diets as women have limited nutritional knowledge, which may lead to poorer nutritional intakes. As primary care providers, and the womens' preferred sources of information in this study and others [23, 32],

general practitioners, obstetricians and midwives are well placed to provide nutrition information. Further research exploring the approaches to nutrition education, and the access and use of nutrition resources by both women and health care providers is recommended, to find more targeted strategies to enhance knowledge of the pregnancy nutrition guidelines. Finally, even though the majority of women in this study reported being aware of the Australian Dietary Guidelines, women's responses to the questionnaire suggest that they have limited knowledge of the dietary guidelines for healthy eating during pregnancy. Even though women report making positive changes to their eating habits, it may not be enough to meet dietary requirements during pregnancy, therefore more research into how knowledge and other factors influence food choices is recommended.

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Compliance with Ethical Standards

Conflict of interest There are no conflicts of interest to declare.

References

1. Australian Bureau of Statistics. (2014). 6227.0—Education and work, Australia, May 2014. ABS. http://www.abs.gov.au/AUSSTATS/abs@.nsf/Previousproducts/6227.0Main%20Features2May%202014?opendocument&tabname=Summary&prodno=6227.0&issue=May%202014&num=&view. Accessed 6 May 2016.
2. Bath, S. C., Steer, C. D., Golding, J., Emmett, P., & Rayman, M. P. (2013). Effect of inadequate iodine status in UK pregnant women on cognitive outcomes in their children: Results from the Avon Longitudinal Study of Parents and Children (ALSPAC). *Lancet, 382*(9889), 331–337.
3. Blumfield, M. L., Hure, A. J., Macdonald-Wicks, L. K., Patterson, A. J., Smith, R., & Collins, C. E. (2011). Disparities exist between National food group recommendations and the dietary intakes of women. *BMC Womens Health, 11*, 37.
4. Bondarianzadeh, D., Yeatman, H., & Condon-Paoloni, D. (2007). Listeria education in pregnancy: Lost opportunity for health professionals. *Australian and New Zealand Journal of Public Health, 31*(5), 468–474.
5. Canani, R. B., Costanzo, M. D., Leone, L., Dedogni, G., Brambilla, P., Cianfarani, S., et al. (2011). Epigenetic mechanisms elicited by nutrition in early life. *Nutrition Research Reviews, 24*(2), 198–205.
6. Charlton, K., Yeatman, H., Lucas, C., Axford, S., Gemming, L., Houweling, F., et al. (2012). Poor knowledge and practices related to iodine nutrition during pregnancy and lactation in Australian women: Pre- and post-iodine fortification. *Nutrients, 4*(9), 1317–1327.
7. Conlin, M. L., MacLennan, A. H., & Broadbent, J. L. (2006). Inadequate compliance with periconceptional folic acid supplementation in South Australia. *Australian and New Zealand Journal of Obstetrics and Gynaecology, 46*(6), 528–533.
8. Crozier, S. R., Robinson, S. M., Borland, S. E., Godfrey, K. M., Cooper, C., Inskip, H. M., et al. (2009). Do women change their health behaviours in pregnancy? Findings from the Southampton Women's Survey. *Paediatric and Perinatal Epidemiology, 23*(5), 446–453.
9. De-Regil, L. M., Fernandez-Gaxiola, A. C., Dowswell, T., & Pena-Rosas, J. P. (2010). Effects and safety of periconceptional folate supplementation for preventing birth defects. *The Cochrane Database of Systematic Reviews, 10*, CD007950.
10. de Jersey, S. J., Nicholson, J. M., Callaway, L. K., & Daniels, L. A. (2012). A prospective study of pregnancy weight gain in Australian women. *Australian and New Zealand Journal of Obstetrics and Gynaecology, 52*(6), 545–551.
11. de Jersey, S. J., Nicholson, J. M., Callaway, L. K., & Daniels, L. A. (2013). An observational study of nutrition and physical activity behaviours, knowledge, and advice in pregnancy. *BMC Pregnancy and Childbirth, 13*, 115.
12. Dodd, J. M., O'Brien, C. M., & Grivell, R. M. (2015). Modifying diet and physical activity to support pregnant women who are overweight or obese. *Current Opinion in Clinical Nutrition and Metabolic Care, 18*(3), 318–323.
13. Downs, D. S., Savage, J. S., & Rauff, E. L. (2014). Falling short of guidelines? Nutrition and weight gain knowledge in pregnancy. *Journal of Womens Health Care, 3*(5), 184.
14. Emmett, R., Akkerskyk, S., Yeatman, H., & Meyer, B. J. (2013). Expanding awareness of docosahexaenoic acid during pregnancy. *Nutrients, 5*(4), 1098–1109.
15. Englund-Ogge, L., Brantsaeter, A. L., Sengpiel, V., Haugen, M., Birgisdottir, B. E., Myhre, R., et al. (2014). Maternal dietary patterns and preterm delivery: Results from large prospective cohort study. *British Medical Journal, 348*, g1446.
16. Ferrari, R. M., Siega-Riz, A. M., Evenson, K. R., Moos, M. K., & Carrier, K. S. (2013). A qualitative study of women's perceptions of provider advice about diet and physical activity during pregnancy. *Patient Education and Counseling, 91*(3), 372–377.
17. Ferraro, Z., Rutherford, J., Keely, E. J., Dubois, L., & Adamo, K. B. (2011). An assessment of patient information channels and knowledge of physical activity and nutrition during pregnancy. *Obstetric Medicine, 4*(2), 59–65.
18. Food Standards Australia New Zealand. (2011). Mercury in Fish. http://www.foodstandards.gov.au/consumer/chemicals/mercury/pages/default.aspx. Accessed 20 March 2013.
19. Food Standards Australia New Zealand. (2011). Pregnancy and healthy eating. http://www.foodstandards.gov.au/consumer/generalissues/pregnancy/pages/default.aspx. Accessed 20 March 2013.
20. Food Standards Australia New Zealand. (2012). Listeria and food. http://www.foodstandards.gov.au/consumer/safety/listeria/pages/default.aspx. Accessed 20 March 2013.
21. Fowles, E. R. (2002). Comparing pregnant women's nutritional knowledge to their actual dietary intake. *MCN The American Journal of Maternal Child Nursing, 27*(3), 171–177.
22. Garnweidner, L., Sverre Pettersen, K., & Mosdol, A. (2013). Experiences with nutrition-related information during antenatal care of pregnant women of different ethnic backgrounds residing in the area of Oslo, Norway. *Midwifery, 29*(12), e130–e137.
23. Grimes, H. A., Forster, D. A., & Newton, M. S. (2014). Sources of information used by women during pregnancy to meet their information needs. *Midwifery, 30*(1), e26–e33.
24. Hendrie, G. A., Coveney, J., & Cox, D. (2008). Exploring nutrition knowledge and the demographic variation in knowledge levels in an Australian community sample. *Public Health Nutrition, 11*(12), 1365–1371.
25. Hendrie, G. A., Cox, D. N., & Coveney, J. (2008). Validation of the general nutrition knowledge questionnaire in an Australian community sample. *Nutrition and Dietetics, 65*(1), 72–77.

26. Herring, S. J., Nelson, D. B., Davey, A. D., Klotz, A. A., Dibble, L. V., Oken, E., et al. (2012). Determinants of excessive gestational weight gain in urban, low-income women. *Womens Health Issues, 22*(5), e439–e446.
27. House, E., & Coveney, J. (2013). 'I mean I expect that it's pretty safe': Perceptions of food trust in pregnancy—implications for primary health care practice. *Australasian Medical Journal, 6*(7), 358–366.
28. Huberty, J., Dinkel, D., Beets, M. W., & Colemna, J. (2013). Describing the use of the internet for health, physical activity, and nutrition information in pregnant women. *Maternal and Child Health Journal, 17*(8), 1363–1372.
29. Lando, A. M., Fein, S. B., & Choiniere, C. J. (2012). Awareness of methylmercury in fish and fish consumption among pregnant and postpartum women and women of childbearing age in the United States. *Environmental Research, 111*(3), 442–450.
30. Lewallen, L. P. (2004). Healthy behaviors and sources of information among low income pregnant women. *Public Health Nursing, 21*(3), 200–206.
31. Lucas, C. J., Charlton, K. E., Brown, L., Brock, E., & Cummins, L. (2014). Antenatal shared care: Are pregnant women being adequately informed about iodine and nutritional supplementation? *Australian and New Zealand Journal of Obstetrics and Gynaecology, 54*(4), 515–521.
32. Martin, J. C., Savige, G. S., & Mitchell, E. K. L. (2014). Health knowledge and iodine intake in pregnancy. *Australian and New Zealand Journal of Obstetrics and Gynaecology, 54*(4), 312–316.
33. Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science, 6*, 42.
34. National Health and Medical Research Council. (2013). Eat for Health: Australian Dietary Guidelines. http://www.eatforhealth.gov.au/. Accessed 2 February 2013.
35. Nuss, H., Freeland-Graves, J., Clarke, K., Klohe-Lehman, D., & Milani, T. J. (2007). Greater nutrition knowledge is associated with lower 1 year postpartum weight retention in low income women. *Journal of the American Dietetics Association, 107*(10), 1801–1806.
36. Sen, S., Manzoor, A., Deviasumathy, M., & Newton, C. (2001). Maternal knowledge, attitude and practice regarding folic acid intake during the periconceptional period. *Public Health Nutrition, 4*(4), 909–912.
37. Shub, A., Huning, E. Y.-S., Campbell, K. J., & McCarthy, E. A. (2013). Pregnant women's knowledge of weight, weight gain, complications of obesity and weight management strategies in pregnancy. *BMC Research Notes, 6*, 278.
38. von Ruesten, A., Brantsaeter, A. L., Haugen, M., Meltzer, H. M., Mehliq, K., Winkvist, A., et al. (2014). Adherence of pregnant women to Nordic dietary guidelines in relation to postpartum weight retention: Results from the Norwegian Mother and Child Cohort study. *BMC Public Health, 14*, 75.
39. Wennberg, A. L., Lundqvist, A., Hogberg, U., Sandstrom, H., & Hamberg, K. (2013). Women's experiences of dietary advice and dietary changes during pregnancy. *Midwifery, 29*(9), 1027–1034.
40. Wilkinson, S. A., Miller, Y. D., & Watson, B. (2009). Prevalence of health behaviours in pregnancy at service entry in a Queensland health service district. *Australian and New Zealand Journal of Public Health, 33*(3), 228–233.
41. Wilkinson, S. A., Walker, A., & Tolcher, D. (2013). Re-evaluation of women's nutritional needs, knowledge and behaviours in a tertiary maternity service: Are we meeting women's needs yet? *Nutrition and Dietetics, 70*(3), 181–187.
42. Wong, L. F., Ismail, K., & Fahy, U. (2013). Listeria awareness among recently delivered mothers. *Journal of Obstetrics and Gynaecology, 33*(8), 814–816.