

Original Article

Online nutrition information for pregnant women: a content analysis

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Abstract

Pregnant women actively seek health information online, including nutrition and food-related topics. However, the accuracy and readability of this information have not been evaluated. The aim of this study was to describe and evaluate pregnancy-related food and nutrition information available online. Four search engines were used to search for pregnancy-related nutrition web pages. Content analysis of web pages was performed. Web pages were assessed against the 2013 Australian Dietary Guidelines to assess accuracy. Flesch–Kincaid (F-K), Simple Measure of Gobbledygook (SMOG), Gunning Fog Index (FOG) and Flesch reading ease (FRE) formulas were used to assess readability. Data was analysed descriptively. Spearman's correlation was used to assess the relationship between web page characteristics. Kruskal–Wallis test was used to check for differences among readability and other web page characteristics. A total of 693 web pages were included. Web page types included commercial ($n = 340$), not-for-profit ($n = 113$), blogs ($n = 112$), government ($n = 89$), personal ($n = 36$) and educational ($n = 3$). The accuracy of online nutrition information varied with 39.7% of web pages containing accurate information, 22.8% containing mixed information and 37.5% containing inaccurate information. The average reading grade of all pages analysed measured by F-K, SMOG and FOG was 11.8. The mean FRE was 51.6, a 'fairly difficult to read' score. Only 0.5% of web pages were written at or below grade 6 according to F-K, SMOG and FOG. The findings suggest that accuracy of pregnancy-related nutrition information is a problem on the internet. Web page readability is generally difficult and means that the information may not be accessible to those who cannot read at a sophisticated level. © 2016 John Wiley & Sons Ltd

Keywords: pregnancy, nutrition, internet, online, accuracy, readability.

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Introduction

Optimal nutrition in pregnancy is important and is a key determinant of a range of health-related outcomes. Excess weight gain (Kramer & Kakuma 2003; Lagiou *et al.* 2004), gestational diabetes (Hoffman *et al.* 1998), preeclampsia (Hofmeyr *et al.* 2014), anaemia (Mahomed 1998) and preterm birth or miscarriage (Woteki 2001) are all associated with a poor quality diet during pregnancy. Infant outcomes include inadequate growth and development (Lumley *et al.* 2001), low birth weight (Cogswell *et al.* 2001), preterm birth (Villar *et al.* 2006), macrosomia (Hoffman *et al.* 1998) and an increased risk of chronic disease later in life (Darnton-

Hill *et al.* 2004). Research indicates that pregnant women may have increased awareness regarding concepts of healthy eating (Szwajcer *et al.* 2005). Studies have reported that pregnant women are interested in receiving nutrition information during pregnancy (Wilkinson & Tolcher 2010) and have been known to actively seek nutrition-related information (Szwajcer *et al.* 2007; Szwajcer *et al.* 2008). This is especially true for women in their first trimester (Szwajcer *et al.* 2008). Informational support about nutrition is therefore important to equip women with accurate information to inform healthy eating practices.

The internet provides an extensive range of health and nutrition information to users. In the pregnant

population, the literature has shown the internet to be a popular source of health information (Gao *et al.* 2013; Szwajcer *et al.* 2008), partly because of its anonymity (Lagan *et al.* 2011) and convenience (Szwajcer *et al.* 2005). However, the quality of health information online has been a concern for over a decade. Women have previously reported trusting the pregnancy-related health information they find online (Huberty *et al.* 2013; Kavlak *et al.* 2012; Larsson 2009). This is despite previous studies reporting that general health information available on the internet is not always reliable or current (Eysenbach *et al.* 2002; Kunst *et al.* 2002). In a systematic meta-analysis of general health website evaluations, 70% of studies concluded that quality was a problem on the internet (Eysenbach *et al.* 2002). However, it is unknown whether this is also a problem among pregnancy-related health web pages or more specifically pregnancy-related nutrition web pages.

The readability of health information on the internet is also a reported issue. Numerous studies have assessed the readability of online health information and found that it is often written at a high school reading level or higher (Cheng & Dunn 2015; Colaco *et al.* 2013; Edmunds *et al.* 2014; Gorczynski *et al.* 2013; McInnes & Haglund 2011; Patel *et al.* 2013; Polishchuk *et al.* 2012; Vargas *et al.* 2014; Walsh & Volsko 2008). This exceeds the recommended sixth grade reading level proposed by the American Medical Association and National Institute of Health (Eltorai *et al.* 2014; National Institute of Health 2013). Forty-four percent of Australian adults have low literacy skills (literacy being the ability to read and write) (Australian Bureau of Statistics 2013). Previous studies have linked poor literacy to poor health care outcomes (Friedman & Tanner 2007; Hibbard *et al.* 2007; Ownby 2006).

Therefore, it is paramount that health information is presented at a readability level that accommodates the wide range of literacy skills among the general population.

Other web page characteristics including web page type, country of origin and writing style could potentially influence the accuracy of information and how easy it is to read. Studies have previously explored the readability of web page types (Cheng & Dunn 2015; Risoldi Cochrane *et al.* 2012) and writing style (Kreuter *et al.* 2007; Dunlop *et al.* 2010); however, no studies have investigated country of origin or whether these web page characteristics influence accuracy of information. In regards to writing style, health information is typically written in a non-narrative writing style despite research signifying that narrative communication can result in positive health outcomes (Kreuter *et al.* 2007; Dunlop *et al.* 2010). Kreuter *et al.* (2007) defines narrative communication as having “an identifiable structure, is bounded by space and time, and contains implicit or explicit messages about the topic being addressed” (p.222). Conversely, non-narrative communication “presents proportions in the form of reasons and evidence supporting a claim” (p.222) (Kreuter *et al.* 2007). In the current literature, studies have not compared the readability of narrative and non-narrative writing styles among pregnancy-related web pages pregnancy-related health web pages or pregnancy-related nutrition web pages.

The overarching aim of this study was to describe and evaluate pregnancy-related food and nutrition information available online. To achieve this aim, the following objectives were developed: (1) to describe the characteristics of web pages containing pregnancy-related nutrition information, including web page type,

Key messages

- The accuracy and readability of pregnancy-related nutrition information online is a problem.
- Approximately 60% of pregnancy-related nutrition web pages contain inaccurate information or proportions of inaccurate information, and
- The readability of pregnancy-related nutrition web pages is considered fairly difficult, with the mean readability of online pregnancy-related nutrition information being six grades above the recommended reading level.

country of origin, writing style, accuracy and readability and (2) to determine if web page type, country of origin or writing style are associated with accuracy and/or readability of pregnancy-related nutrition information online.

Materials and methods

Sample

Common pregnancy-related nutrition search terms were identified. Google Trends and a recent study by Robichaud *et al.* (2014) looking at common search terms and phrases used by pregnant women to access pregnancy-related nutrition information online were used. Google Trends is an online database that provides information about the queries searched by users of Google and ranks these terms according to popularity (Vaughan & Romero-Frias 2014). Terms and derivations were entered into Google Trends, and the three most popular search terms for each topic were included. Using both these methods, a total of 64 search terms were identified altogether. Search terms stemmed from the following categories: 'pregnancy nutrition/diet/food', 'mercury/salmonella/listeria', 'iron/folate/iodine', 'supplement use', 'food safety' and 'pregnancy weight gain and nutrition guidelines/recommendations'.

Each search term was entered into four search engines (Google Australia, Google Blogs, Yahoo Australia and Bing) in July 2014. We chose these search engines because they represent over 90% of searches performed on the internet, according to Experian

Marketing Services (nd). Where available, the Australian version of each search engine was used. This process was completed by all three researchers on different computers to account for variation in results retrieved. The results from the first two pages of each search engine were included in the study because research has shown that consumers rarely look beyond the first two pages when searching for health information on the internet (Zhang 2012). Excluded web pages included duplicates, links to videos and documents, news and journal articles, discussion forums, non-English web pages, web pages that did not contain nutrition information and web pages that could not be located when followed up for analysis. The remaining web pages were included and analysed. It is important to note that we only analysed the page retrieved from the search engine and not the website in its entirety.

Data collection

The country of origin, web page type (Table 1), review date (the date the web page was last updated) and writing style (assessed as either narrative, non-narrative or both) of each web page were recorded in Microsoft Excel. A content analysis of each web page was undertaken to assess accuracy and readability. Ethics approval was not required for this study.

Accuracy of pregnancy-related nutrition web pages

Accuracy of each web page was assessed against the 2013 Australian Dietary Guidelines (ADG); the

Table 1. Definition of web page types

Web page type	Definition
Government	A web page funded and run by the local, state or federal government of a country.*
Educational	A web page created for the purpose of education by an academic institution.*
Commercial	A web page created by a private company with the intention to make a profit.*
Personal	A web page created by an individual that includes content of a personal nature and is not associated with any company, organisation or institution.*
Organisational	A web page created by an organisation that is not for profit.*
Blog	A web page typically written by an individual or small group that is written in an informal or conversational style.†

*Petch 2004.

†Oxford Dictionaries unknown.

recommended daily intake (RDI) of energy, protein, folate, iodine and iron; food source examples for protein, folate, iodine and iron for pregnancy and pregnancy supplement recommendations for folate, iodine and iron (Australian Government: National Health and Medical Research Council 2013). Web page content was coded against the guidelines (1 = accurate information, 2 = mixed information, 3 = inaccurate information and 4 = no information). This approach was adapted from a similar Canadian study (Ostry *et al.* 2008). Whether or not other vitamins and minerals were discussed was also assessed.

The tool developed for assessing accuracy and writing style was piloted independently by two of the researchers to determine the reliability of the data collection tool and to assess similarity between answers of each researcher. Changes were implemented as necessary.

Readability of pregnancy-related nutrition web pages

A software program by Readability Studio was used to calculate the readability of web pages (Oleander Software 2012). The Flesch–Kincaid (F-K), Simple Measure of Gobbledygook (SMOG) and Gunning Fog Index (FOG) formulas were used. The three readability measures utilised are based on formulas assessing sentence length and word complexity (Ley & Florio 1996). F-K, SMOG and FOG scores each represent the American school grade level (fourth grade through to college level) required to understand a passage of text. To increase reliability of the results, an average of the three scores was calculated to take into account variation among formulas (Plan Language Works L 2011). A second readability score was calculated using the Flesch reading ease (FRE) formula. FRE formula produces a reading score of 0 to 100, with 0 representing the hardest to read and 100 as the easiest to read score (Ley & Florio 1996). These four formulas have been validated against the McCall-Crabbs Standard Test Lessons in reading (Ley & Florio 1996).

Statistical analysis

All data was entered into Microsoft Excel 2011 and then imported into IBM SPSS Version 23 for analysis.

Descriptive statistics were calculated as percentages for categorical data and means for readability data. Spearman's correlation was used to assess the relationship between accuracy of pregnancy-related nutrition information and web page type, country of origin and writing style, and readability of pregnancy-related nutrition information and web page type, country of origin and writing style. A non-parametric test, Mann–Whitney, was used to check for differences between accuracy among government and other web page types, and Kruskal–Wallis was used to check for differences in readability among web page types, country of origin and writing style. Significance was set at p values of 0.05 for all statistical tests.

Results

Following a search of 64 key pregnancy-related nutrition terms, a total of 1278 different web pages were generated. Based on the selection criteria, 466 (36.5%) did not meet inclusion criteria based on content and 119 (9.3%) were excluded as the web page was unable to be located for follow-up analysis, resulting in a final sample of 693 (54.2%) web pages.

Web page types, country of origin and writing style

The majority of web pages reviewed were commercial web pages ($n = 340$, 49.1%). This was followed by web pages authored by not-for-profit organisations ($n = 113$, 16.3%), blogs ($n = 112$, 16.2%), government organisations ($n = 89$, 12.8%), personal web pages ($n = 36$, 5.2%) and educational establishments ($n = 3$, 0.4%). Additionally, the majority of web pages analysed were American ($n = 304$, 43.9%), followed by web pages originating in Australia ($n = 182$, 26.3%), UK ($n = 55$, 7.9%), Canada ($n = 21$, 3.0%), India ($n = 13$, 1.9%), New Zealand ($n = 9$, 1.3%) and 'other' ($n = 15$, 2.2%). There were also 94 (13.6%) web pages that did not state their country of origin. There was no relationship found between country of origin and web page type.

A total of 287 (41.4%) web pages presented information using a combination of both narrative and non-narrative writing styles, while 262 (37.8%) web pages presented information in a narrative writing style only and 91 (13.1%) web pages presented information in a

non-narrative writing style. Commercial web pages, personal web pages and blogs were primarily written using a narrative writing style (51.5, 50.0 and 48.1%, respectively), while web pages authored by educational establishments, not-for-profit organisations and government organisations frequently used a combination of narrative and non-narrative writing styles (66.7, 66.4 and 60.2%, respectively). Pages that were written purely in a non-narrative writing style were less common across all web page types. Despite this, there was no statistical relationship between web page type and writing style or between country of origin and writing style.

Accuracy of pregnancy-related nutrition web pages

Overall, 275 (39.7%) web pages contained accurate pregnancy-related nutrition advice, 260 (37.5%) contained inaccurate advice and 158 (22.8%) contained a mix of both accurate and inaccurate advice. Accuracy of information was analysed by web page type and country of origin (Figs. 1 and 2). As Figs. 1 and 2 indicate, each web page type and country of origin contained accurate, mixed and inaccurate information, excluding educational establishments, which contained either accurate or inaccurate information only. Government web pages provided the highest percentage of accurate (46.1%) and mixed (31.5%) information of all web page types (Fig. 1).

Web pages originating from New Zealand provided the highest percentage of accurate information (66.7%). Indian-based web pages accounted for the highest

percentage of mixed information (38.5%), and American web pages accounted for the highest percentage of inaccurate information (46.7%) (Fig. 2). There was no statistically significant relationship found between accuracy and web page type, country of origin or writing style. We grouped educational, commercial, personal, not-for-profit and blogs into one group called other and assessed whether there was a difference between the accuracy of this group and government web pages. A Mann-Whitney test indicated that the accuracy of pregnancy-related nutrition web pages was significantly greater for government web pages than for other ($U = 22\,849.00$; $p = 0.014$).

Food intake guidelines

Of the five guidelines in the ADG, guideline 5, which includes information on listeria, mercury, salmonella, food preparation and food storage (30.6, 28.0, 18.5, 18.5 and 9.2%, respectively), was the most commonly discussed topic from the ADG (Table 2). Mercury was the topic that had the highest percentage of mixed information (51.5%). One hundred percent of information analysed on weight gain, vegetables, breastfeeding, food storage and food preparation was accurate when compared with the ADG (Table 2). The topic with the highest percentage of inaccurate information was serves for vegetables, fruit, grains, meat and dairy included in guideline 2 (Table 2). Monounsaturated and polyunsaturated fatty acid serves also contained a high percentage of inaccurate information (44.4%) (Table 2).

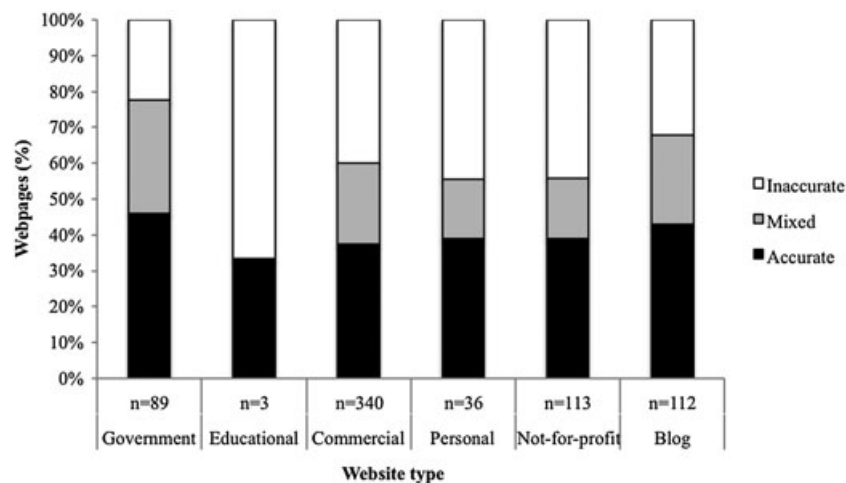


Fig. 1 Percentage (%) of web pages offering accurate, mixed and inaccurate pregnancy-related nutrition information by web page type.

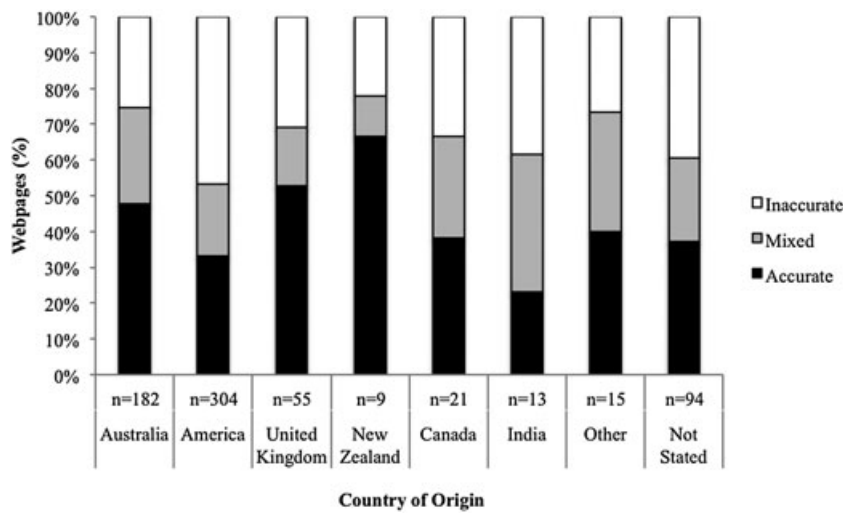


Fig. 2 Percentage (%) of web pages offering accurate, mixed and inaccurate pregnancy-related nutrition information by country of origin.

Table 2. Number (%) of web pages providing accurate, mixed and inaccurate information on the Australian Dietary Guidelines (ADG)

	Web pages, n (%)	Accurate, n (%)	Mixed, n (%)	Inaccurate, n (%)
Guideline 1				
Weight gain	53 (7.6)	53 (100.0)	0 (0.0)	0 (0.0)
Weight gain recommendations	95 (13.7)	41 (43.2)	35 (36.8)	19 (20.0)
Guideline 2				
Vegetables	123 (17.7)	123 (100.0)	0 (0.0)	0 (0.0)
Vegetable serves	45 (6.5)	15 (33.3)	8 (17.8)	22 (48.9)
Fruit	128 (18.5)	125 (97.7)	2 (1.6)	1 (0.8)
Fruit serves	47 (6.8)	15 (31.9)	11 (23.4)	21 (44.7)
Grains	112 (16.2)	109 (97.3)	2 (1.8)	1 (0.9)
Grain serves	34 (4.9)	8 (23.5)	12 (35.3)	14 (41.2)
Meat	104 (15.0)	101 (97.1)	2 (1.9)	1 (1.0)
Meat serves	32 (4.6)	9 (28.1)	5 (15.6)	18 (56.3)
Dairy	92 (13.3)	86 (93.5)	3 (3.3)	3 (3.3)
Dairy serves	41 (5.9)	8 (19.5)	13 (31.7)	20 (48.8)
Water	68 (9.8)	37 (54.4)	17 (25.0)	14 (20.6)
Guideline 3				
SFA	61 (8.8)	57 (93.4)	3 (4.9)	1 (1.6)
MUFA	41 (5.9)	21 (51.2)	13 (31.7)	7 (17.1)
MUFA serves	9 (1.3)	3 (33.3)	2 (22.2)	4 (44.4)
Added salt	36 (5.2)	34 (94.4)	0 (0.0)	2 (5.6)
Added sugar	70 (10.1)	68 (97.1)	1 (1.4)	1 (1.4)
Alcohol consumption	130 (18.8)	116 (89.2)	10 (7.7)	4 (3.1)
Guideline 4				
Breastfeeding	22 (3.2)	22 (100.0)	0 (0.0)	0 (0.0)
Guideline 5				
Store food	64 (9.2)	64 (100.0)	0 (0.0)	0 (0.0)
Prepare food	128 (18.5)	128 (100.0)	0 (0.0)	0 (0.0)
Listeria	212 (30.6)	202 (95.3)	6 (2.8)	4 (1.9)
Salmonella	128 (18.5)	125 (97.7)	2 (1.6)	1 (0.8)
Mercury	194 (28.0)	26 (13.4)	100 (51.5)	68 (35.1)

Nutrients

Folate was the most discussed nutrient among web pages analysed (41.4%). Iron (35.6%) was the next most discussed followed by calcium (30.0%), protein (25.8%), vitamin A (19.8%), iodine (18.5%), vitamin D (17.2%), energy (16.7%), vitamin C (16.3%) and vitamin B12 (15.0%). An additional 20 nutrients were also assessed; however, these were discussed in fewer than 10% of sites.

Pregnancy specific nutrients – energy, protein, folate, iodine and iron, were analysed further to assess advice given on RDIs, food source examples and supplement recommendations (micronutrients only). RDIs were discussed less frequently than food source examples and supplement recommendations (Table 3). Of these topics, iron food source examples were the most discussed of web pages analysed (25.7%), followed by folate food source examples (25.1%), folate supplementation (21.6%) and protein food source examples (19.9%) (Table 3). Iodine was discussed less frequently than other nutrients analysed (Table 3).

Of web pages analysed, iodine food source examples accounted for the highest percentage of accurate information (99.0%), followed closely by protein food source examples (98.6%) (Table 3). The RDI for

energy in second and third trimesters accounted for the highest percentage of mixed information (74.2 and 81.8%, respectively) (Table 3). The RDI for energy in the first trimester accounted for the highest percentage of inaccurate information (61.7%) (Table 3).

Readability of pregnancy-related nutrition web pages

Results from Spearman's correlation showed a strong, negative correlation between F-K, FOG and SMOG and FRE ($\rho = -0.897$), indicating that there is a relationship between readability and reading ease formulas. The mean grade level of all web pages calculated by F-K, FOG and SMOG was 11.8 ± 2.48 , a score representing a high school grade level, and the mean FRE was 51.6 ± 12.38 , a score considered 'fairly difficult'. A web page from the Queensland Government about healthy eating during pregnancy aimed at Aboriginal women scored the lowest score with a grade level of 4.8 and easiest to read with a FRE score of 88. On the other hand, a Wikipedia article on folic acid had the highest grade of 19 and a FRE score of 0, indicating very high level of difficulty. According to grade level based on F-K, FOG and SMOG, only three (0.5%) web pages were at or below the recommended reading level of patient education material of grade 6.

Table 3. Number (%) of web pages providing accurate, mixed and inaccurate advice on recommended daily intakes (RDI), food source examples and supplement recommendations for pregnancy specific nutrients

		Web pages, <i>n</i> (%)	Accurate, <i>n</i> (%)	Mixed, <i>n</i> (%)	Inaccurate, <i>n</i> (%)
RDI					
Energy	First trimester	94 (13.6)	36 (38.3)	0 (0.0)	58 (61.7)
	Second trimester	97 (14.0)	17 (17.5)	72 (74.2)	8 (8.2)
	Third trimester	99 (14.3)	17 (17.2)	81 (81.8)	1 (1.0)
Protein		43 (6.2)	14 (32.6)	9 (20.9)	20 (46.5)
Folate		78 (11.3)	43 (55.1)	8 (10.3)	27 (34.6)
Iodine		60 (8.7)	33 (55.0)	3 (5.0)	24 (40.0)
Iron		83 (12.0)	57 (68.7)	11 (13.3)	15 (18.1)
Food source					
Protein		138 (19.9)	136 (98.6)	2 (1.4)	0 (0.0)
Folate		174 (25.1)	155 (89.1)	19 (10.9)	0 (0.0)
Iodine		98 (14.1)	97 (99.0)	1 (1.0)	0 (0.0)
Iron		178 (25.7)	130 (73.0)	47 (26.4)	1 (0.6)
Supplementation					
Folate		150 (21.6)	94 (62.7)	41 (27.3)	15 (10.0)
Iodine		64 (9.2)	52 (81.3)	5 (7.8)	7 (10.9)
Iron		101 (14.6)	60 (59.4)	17 (16.8)	24 (23.8)

Based on the FRE, only 42 (6.6%) web pages recorded scores higher than 70, an easy to read score for information targeted at the general population.

Readability by web page type

A statistically significant difference was found by Kruskal–Wallis test for readability (average score of F-K, FOG and SMOG) between web page types ($\chi^2(2) = 12.992$; $df = 5$; $p = 0.023$). Commercial web pages were significantly harder to read than government web pages ($\chi^2(2) = 6.699$; $p = 0.010$) and blogs ($\chi^2(2) = 4.209$; $p = 0.040$). Additionally, web pages authored by educational establishments were significantly harder to read than blogs ($\chi^2(2) = 4.820$; $p = 0.028$). No statistical significant differences were observed across web page types for FRE scores. Further investigation into each web page type revealed that government web pages had the lowest mean grade reading level (11.3 ± 0.33), followed by blogs (11.5 ± 0.23), personal web pages (11.8 ± 0.45), not-for-profit organisations (11.9 ± 0.25) and commercial web pages (12.0 ± 0.13). In comparison, web pages authored by educational establishments had the highest mean grade reading level (14.1 ± 0.37). The mean FRE for not-for-profit web pages (49.8 ± 1.30), personal web pages (51.4 ± 2.26), commercial web pages (51.5 ± 0.65), government web pages (52.5 ± 1.56) and blogs (53.2 ± 1.17) was considered fairly difficult, and the mean FRE for web pages authored by educational establishments (39.3 ± 3.18) was difficult.

Readability by writing style

Kruskal–Wallis test for readability and writing style and reading ease (FRE) and writing style revealed statistically significant differences ($\chi^2(2) = 100.728$; $df = 2$; $p = 0.000$ and $\chi^2(2) = 47.616$; $df = 2$; $p = 0.000$, respectively). Narrative writing style was found to be significantly harder to read than both narrative and non-narrative ($\chi^2(2) = 48.796$; $p = 0.000$ and $\chi^2(2) = 21.959$; $p = 0.000$, respectively) and non-narrative only ($\chi^2(2) = 80.145$; $p = 0.000$ and $\chi^2(2) = 40.366$; $p = 0.000$, respectively). Additionally, both narrative and non-narrative was found to be significantly harder to read than non-narrative ($\chi^2(2) = 25.033$; $p = 0.000$ and $\chi^2(2) = 10.986$; $p = 0.001$, respectively). The lowest mean

grade reading level for writing style was non-narrative (10.1 ± 0.24), followed by both narrative and non-narrative (11.5 ± 0.14) and finally narrative that had the highest mean grade reading level for writing style (12.8 ± 0.14). The mean FRE for both narrative and non-narrative (53.0 ± 0.70) and non-narrative (57.1 ± 1.18) writing styles was fairly difficult, and the mean FRE for narrative writing style (48.1 ± 0.76) was difficult. Despite these differences, there was no statistical relationship between readability and web page type or readability and writing style.

Discussion

This is the first known study to assess accuracy and readability of pregnancy-related nutrition information online. The findings suggest that a large percentage of web pages covering pregnancy-related nutrition information on the internet are inaccurate or contain proportions of inaccurate information and are fairly difficult to read. These findings align with previous studies conducted to evaluate the accuracy and readability of online health information (Eysenbach *et al.* 2002; Cheng & Dunn 2015; Colaco *et al.* 2013; Edmunds *et al.* 2014; Gorczynski *et al.* 2013; McInnes & Haglund 2011; Patel *et al.* 2013; Polishchuk *et al.* 2012; Vargas *et al.* 2014; Walsh & Volsko 2008).

Government web pages were found to be significantly more accurate than other web page types. A possible explanation for this is that when evaluating government web pages, the information was usually current, sourced by scientific literature and aimed to educate the public on a particular topic in an unbiased approach rather than post for commercial gain. As a result, studies have recommended using government web pages when searching for health information (Scullard *et al.* 2010). However, government web pages were also shown to contain proportions of mixed and inaccurate advice that is concerning as they are perceived as the most reliable and trustworthy website type by pregnant women (Hearn *et al.* 2013; Huberty *et al.* 2013; Lagan *et al.* 2010). It is the responsibility of the government to ensure that they regularly review and revise the information they offer to ensure that it is accurate.

Although the Australian version of Google and Yahoo were used, it was interesting to note that American web pages were the most common country of origin in our study. Each country of origin sampled contained mixed and inaccurate advice on pregnancy-related nutrition information, with American web pages providing the highest percentage of inaccurate advice overall. Each of the countries recorded in this study have their own dietary guidelines. As a result, the variation in accuracy could be because of differing nutritional recommendations for pregnancy in each country, and therefore, the information analysed on non-Australian web pages may not align with Australian recommendations. Nonetheless, search engines are designed to provide the most popular and relevant sites first (Scullard *et al.* 2010), irrelevant of country of origin; therefore, pregnant women may be retrieving nutrition information from non-Australian websites.

Inconsistencies in country-specific nutritional recommendations were particularly evident when evaluating advice on mercury during pregnancy, which was the topic with the highest percentage of mixed and inaccurate information. Recommendations for fish species high in mercury in Australia are different to recommendations for fish species high in mercury in other countries. Australian women should therefore seek recommendations for fish consumption on Australian web pages only. Furthermore, although the advice from guideline 2 of the ADG was generally accurate, it is concerning that inaccuracies and mixed advice were found regarding the number of serves for each food group. This advice is the basis for assisting pregnant women to achieve elevated nutrient intakes required during pregnancy. Previous research indicates that while pregnant women often desire to follow health guidelines, contradicting advice and information can create confusion and lead to disengagement (Ferrari *et al.* 2013; Maher & Lowe 2015) and potentially prevent behaviour change.

When exploring the readability of web pages, commercial web pages were found to be significantly harder to read than government web pages and blogs and educational web pages significantly harder to read than blogs. Our results are consistent with Risoldi Cochrane *et al.* (2012) work who compared the readability of health information on government and

commercial web pages and found that commercial web pages were significantly harder to read than government web pages. Despite this, none of the mean grade levels for web page type matched the benchmark of grade 6 and were calculated at a high school reading grade or higher. Similarly, narrative writing style was found to be significantly harder to read than non-narrative writing style. Theoretically, this was expected, as non-narrative writing style comprises of short, concise sentences, sometimes in the form of bulleted and numbered lists, making it easier to read. Conversely, a narrative writing style is structured and can be quite lengthy, therefore making it harder to read (Kreuter *et al.* 2007; Murphy *et al.* 2013). Although, like web page type, none of the mean grade writing styles matched the recommended sixth grade reading level, in which they were also written at a high school reading level or higher.

The findings from the current study indicate that a very limited amount of online nutrition information for pregnant women is readable for low-literacy users, with only 0.5% of web pages overall being below the recommended sixth grade reading level. The limited availability of 'easy to read' nutrition information suggests that pregnant women may not be benefiting from the convenience of the internet. Readers may misinterpret the information they read online, which could potentially lead to inappropriate health decisions (Walsh & Volsko 2008), or readers may become confused regarding unclear messages and thus hinder behaviour change. Readability of written information can easily be measured using websites or software programs. This may be a strategy that website authors could implement to check the readability of their materials before publishing online. Health professionals should also take readability into account when recommending websites containing nutrition information to clients.

There are several limitations with the current study. The search terms used in this study were identified via self-report and Google Trends; however, they are not necessarily the actual search terms of pregnant women in a specific time and place. The search for pregnancy-related nutrition web pages was undertaken in July 2014; however, content analysis of each web page occurred over a 12-month period following the original search. As a result, the uniform resource locator of

some web pages was no longer available when searched for. A third limitation is that there is a degree of observer bias with evaluating web pages. To overcome this, a pilot study was undertaken in which results obtained by two of the researchers were compared to assess whether there was similarity between answers. Additionally, the sample of some web page types and countries was small; therefore, it is unknown whether these results can be generalised.

Furthermore, we only evaluated web pages on the first two pages of each search engine. It is possible that accurate web pages may not have been included in our evaluation. Nevertheless, previous research indicates that users are more likely to view a site within the first two pages making it unlikely that pregnant women would encounter web pages that we did not evaluate. Readability formulas only assess linguistic characteristics and cannot evaluate other influential factors such as images, tables, charts, layout and personal background (Buccini *et al.* 2010; Doak *et al.* 1996). As such, they are not able to capture all the elements that may influence user engagement. The use of grade 6 as the benchmark represents another limitation. In the absence of Australian readability guidelines, American-based guidelines were used for the purpose of this research.

The results from this study indicate that accuracy of pregnancy-related nutrition information on the internet is a problem. There is potential concern for the health of pregnant women and their baby if they take on nutrition advice from inaccurate sources. We found that neither web page type, country of origin or writing style influenced accuracy. However, we did find a significant difference between web page type and readability, and writing style and readability. Despite this, the mean readability of online pregnancy-related information was six grades above the recommended reading level. This suggests that nutrition information may be inaccessible to women with low literacy skills.

At this time, no known effective strategies exist to ensure that online information is accurate. However, it would be beneficial to modify current Australian resources so they are accurate and understandable. This would help to ensure that women are receiving the right information to enable them to make good dietary decisions during pregnancy. Additionally, a

quantifiable guideline is needed to ensure that health information on the internet accommodates the reading needs of Australians to effectively use the internet as an enabler of health literacy. Future studies could explore the user interface design and experience of nutrition information on the internet and determine whether or not these characteristics influence the use of online information sources.

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Conflict of interest

The authors declare that they have no conflict of interest.

Contributions

TS assisted in the design of the project, collected and analysed the data and wrote the first and final drafts of the manuscript. JM conceptualised the study and designed the project, and assisted in data collection and analysis, and critically reviewed all drafts. ES assisted in data collection and analysis and critically reviewed all drafts. All authors approved the final version of the manuscript.

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