Overview of a new eHealth intervention to promote healthy eating and exercise in pregnancy: initial user responses and acceptability

Internet Interventions 25 (2021) 100393

Contents lists available at ScienceDirect

Internet Interventions

journal homepage: www.elsevier.com/locate/invent

Overview of a new eHealth intervention to promote healthy eating and exercise in pregnancy: Initial user responses and acceptability

Mary Carolan-Olah [a,*], Vidanka Vasilevski [b], Cate Nagle [c], Nigel Stepto [d]

[a] Victoria University, College of Health and Biomedicine, St Alban's Campus, PO Box 14228, Melbourne 8001, Australia
[b] Research Fellow, School of Nursing & Midwifery – Western Health Partnership, Faculty of Health, Deakin University, 221 Burwood Hwy, Burwood, VIC 3125, Australia
[c] James Cook University and Townsville Hospital and Health Service, Townsville, QLD 4814, Australia
[d] Victoria University, Institute of Sport Exercise and Active Living (ISEAL), Footscray Campus, PO Box 14228, Melbourne 8001, Australia

ARTICLE INFO

Keywords:
Diet
Exercise
Pregnancy
Website
Education

ABSTRACT

Purpose: The purpose of this project was to develop and evaluate an eHealth intervention to promote healthy lifestyle for pregnant women. The setting was a low socio-economic and multi-ethnic area in Melbourne, Australia.

Methods: This paper briefly describes the development of the eHealth intervention, which was aimed at a low level of literacy, and the evaluation of the intervention by pregnant women. A basic descriptive survey was undertaken to evaluate user friendliness, usefulness and acceptability of the intervention.

Results: The intervention was developed by a team of experts and forty pregnant women participated in the evaluation. Results indicated that participants found the intervention informative, useful and easy to navigate. They also identified some minor areas for improvement which will be addressed prior to proceeding to a formal controlled evaluation.

Conclusion: Results from this evaluation are encouraging and suggest that women found the intervention convenient, trustworthy and engaging. Most enjoyed navigating the website information. As such, it is likely to prove a useful support for delivering dietary and exercise information to pregnant women in the local low socio-economic area. Further formal evaluation will test the efficacy of the website in improving diet and exercise outcomes during pregnancy.

1. Introduction

The rapid development of web-based technology has seen a rise in online resources and interventions to promote a healthy lifestyle for a range of groups, including individuals living with illness, (Schneider et al., 2020) and those at risk of developing chronic conditions, such as diabetes (Ferrara and Ehrlich, 2010). Different patterns of use are associated with different users, with majority status and higher education considered to be predictors of greater engagement with health interventions (Graham et al., 2017).

Pregnant women, in general, are considered to be ardent internet users (Sayakhot and Carolan-Olah, 2016) and are especially motivated to seek out information on pregnancy related topics such as nutrition, listeria infection (Lobo et al., 2020) and fetal development (Sayakhot and Carolan-Olah, 2016). Earlier studies, such as Lagan et al. (2010) also suggest that women use the internet to supplement and clarify information received from health care providers. In this way, internet searching has an important impact on confidence and decision making in pregnancy (Lagan et al., 2010). Overall, pregnant women particularly value the immediacy of access and use online sources for information and reassurance (Lupton, 2016) and many express a preference for online information (Kennedy et al., 2017a; Lau et al., 2018). Such preferences appear to be consistent across culturally and socioeconomically diverse groups of women (Kennedy et al., 2017a; Waring et al., 2014). In Australia, particularly in metropolitan areas, most pregnant women, have access to a mobile phone and internet (AIFS, 2013). This level of access and engagement (Lupton, 2016) make digital interventions a useful medium for health messages in pregnancy.

The evidence suggests that many pregnant women have limited knowledge of healthy diet and required physical activity in pregnancy

* Corresponding author.
E-mail addresses: mary.carolan@vu.edu.au (M. Carolan-Olah), vidanka.vasilevski@deakin.edu.au (V. Vasilevski), cate.nagle@jcu.edu.au (C. Nagle), nigel.stepto@vu.edu.au (N. Stepto).

https://doi.org/10.1016/j.invent.2021.100393
Received 8 September 2020; Received in revised form 25 March 2021; Accepted 12 April 2021
Available online 19 April 2021

(de Jersey et al., 2013; Wilkinson et al., 2018). This is a serious concern as more than half of all women, in developed countries, gain excess weight in pregnancy (Goldstein et al., 2018) and excessive weight gain is linked a number of adverse pregnancy outcomes such as gestational diabetes (Barton et al., 2015; Goldstein et al., 2017), pregnancy related hypertension (Macdonald-Wallis et al., 2013) and macrosomia (excessive infant size) (Heery et al., 2013), which predisposes to childhood obesity.

Low levels of knowledge are especially the case for women from low income backgrounds (de Jersey et al., 2013; Hackley et al., 2014). Limited English language skills may also limit access to information and individuals with low health literacy (limited ability to read and understand health related material) may need direction and assistance to source information pitched at an appropriate level of comprehension (Mitsutake et al., 2020). There is also a concern about the quality of pregnancy related nutritional information freely available on the internet and Storr et al. (2017) give a clear example of the dangers. During a content analysis of internet websites providing nutritional advice in pregnancy, these authors found that less than 40% of websites provided accurate information (Storr et al., 2017).

Other difficulties in the provision of dietary information may relate to sensitivities around discussing overweight and obesity (Lindqvist et al., 2014; Lucas et al., 2014), limited time during antenatal appointments (Duthie et al., 2013) and the unclear role health professionals, such as midwives and clinicians, play in offering nutritional advice during pregnancy (Arrish et al., 2014; Lee et al., 2018).

At this stage, there is no clear consensus on the value of online interventions to promote healthy lifestyle in pregnancy or to reduce excessive gestational weight gain, particularly in low socio economic or diverse communities. This is likely related to the low volume of interventions developed for these groups and the heterogeneity of existing interventions. A recent systematic review (Rhodes et al., 2020), which reviewed 11 studies on digital health interventions targeting diet, physical activity and gestational weight gain, in pregnancy, found that the evidence was insufficient to support the effectiveness of exclusively digital interventions to improve pregnancy outcomes. However, the meta-analysis was limited by the wide range of study outcomes, and the number of pilot studies, with small samples, included in the review. Similarly, Walker et al. (2018), who conducted a broad based meta-analysis of interventions to prevent excessive weight-gain in pregnancy, found that eHealth interventions did not improve outcomes. They concluded that such interventions have the potential to reach to younger women but cautioned about the need for further evaluation (Walker et al., 2018).

On the other hand, a recent study by Hayman et al. (2017), found that the delivery of a computer based intervention to increase physical activity in pregnancy is feasible and likely to improve outcomes. Similarly, Phelan et al. (2017, 2019), found that internet interventions had positive effects on postpartum weight loss and normal weight gain in infants, among low income women.

Against this background of unclear results, best outcomes seem to be linked to interventions that are visually appealing, with interactive components, that are supported by educational principles and endorsed by healthcare staff (Lau et al., 2018). Cultural specificity is also likely to be important (Nitsos et al., 2017).

In the study setting, a pregnancy clinic at a major metropolitan hospital, earlier studies indicated that pregnant women did not clearly know or understand the components of a healthy lifestyle (Carolan et al., 2012; Carolan et al., 2010; Poth and Carolan, 2013). They additionally indicated a need for clear specific guidelines about diet and exercise in pregnancy including examples of recommended foods, serving sizes and safe exercises for pregnancy (Carolan-Olah et al., 2015). Most indicated that generic educational material did not satisfy their information needs. Similar findings have been reported elsewhere, with pregnant women requesting more personalized information about healthy lifestyle in pregnancy, including recipes, cooking demonstrations and exercise advice and videos (Kennedy et al., 2017a; Costa et al., 2015). With all of these difficulties in mind, the current project aimed to develop an online diet and exercise eHealth intervention and to conduct an evaluation of the program, via an initial user-response survey.

2. Methods

2.1. Study setting

This study was conducted in the Western region of Melbourne, a socially disadvantaged area by Australian standards (ABS, 2011). A number of factors adversely affect pregnancy health in this region such as limited employment, low levels of education, financial disadvantage and limited knowledge of nutrition (Poth and Carolan, 2013). High rates of obesity, physical inactivity and gestational diabetes are also common (Women's Health West, 2015) and these issues are significantly associated with adverse pregnancy outcomes (Aviram et al., 2011). As many as 60% of the local population are migrants who speak a language other than English at home (ABS, 2019). This population is at greater risk of poor birth outcomes, related to inadequate access to perinatal health education and services (Brown et al., 2011).

2.2. Development of the website

Development of the website was guided by an expert panel, including a medical doctor, midwife, diabetes educator, dietitian, exercise physiologist, and literacy expert. The CONSORT EHEALTH checklist (beta-V.1.5) was used to ensure the website was compliant with expected eHealth standards. The literacy expert advised adopting a number of measures to improve access for women with low levels of health literacy. These measures included: multiple photos and illustrations, minimal text and no more than one idea per slide. A quiz was included at the end of each module to allow women to check their knowledge. Similar approaches have previously been successfully used to promote health literacy (Negarandeh et al., 2013).

The development of modules and intervention content was informed by 32 earlier interviews with pregnant women attending for care at the hospital pregnancy clinic. Interview findings (as yet unpublished) indicated that women encountered a number of barriers to eating well and exercising in pregnancy, including: competing time demands, a lack of motivation, fears about safety of foods and exercise in pregnancy, and dietary restrictions such as vegetarianism.

2.2.1. Theoretical framework for developing the website

The overall goal of the website was to provide pregnant women with the necessary information and motivation to make healthy choices in pregnancy. The website was developed using elements of social cognitive theory (Bandura, 2001), such as: outcomes expectations; self-efficacy; facilitation; and self-regulation (MacAllister et al., 2008). Table 1 shows each component of social cognitive theory and how it links to components of the website. Barriers were also addressed in the development of the intervention, for example providing recipes for quick healthy meals and encouraging women to make incremental exercise changes such as parking the car further away from their destination to increase daily physical activity.

2.2.2. Overview of the website

The website includes 4 modules: (1) Introduction: Healthy eating and exercise in pregnancy; (2) What is healthy eating?; (3) Exercise in pregnancy; (4) Your baby's development. Links are also provided to a number of external sites such as the Australian Department of Health dietary guidelines (NHMRC: National Health and Medical Research Council, 2012). There is a further link to downloadable pdfs of recipes and ethnicity specific meal plans. Based on census data indicating high proportion of these groups in the geographical area, recipes and links were provided for common Vietnamese and Indian foods, in addition to

Table 1
Links between social cognitive theory and website components.

Social cognitive theory	Description	Specific modules and resources
Outcome expectations: addressed by clearly outlining the benefits of healthy diet and exercise to both mother and baby.	Supported by numerous photos of babies. In our earlier studies, we found that women were highly motivated to maximize the infant's health (Carolan-Olah et al., 2017; Carolan et al., 2012). Most women found the photos of healthy infants to be especially motivating.	• Modules 1, 3 and 4
Self-efficacy: addressed by promoting women's beliefs in their ability to improve their health outcomes	Supported by improving women's knowledge about healthy diet and exercise, goal setting, and providing sample menus and links to easy recipes, suitable for the family.	• Modules 1, 2 and 3 • End of module quizzes • Additional resources (meal plans, recipes and goal setting)
Facilitation: addressed by providing resources to encourage behavior change.	Supported through the provision of items such as the BMI calculator, dietary advice, and exercise videos.	• Modules 1, 2, 3 and 4 • Additional resources (meal plans, recipes and goal setting)
Self-regulation: addressed by promoting the control of oneself through goal setting and feedback	Supported by providing advice for incremental behavior changes such as including a single serve of vegetables at dinner to slowly increase vegetable consumption with an ultimate aim of including five serves of vegetables daily. For women who wished to undertake a systematic approach to self-regulate, goal setting tools and templates were included as additional resources.	• Modules 1, 2 and 3 • End of module quizzes • Additional resources (goal setting)

more usual Australian foods.

Module 1. Introduction: Healthy Eating and Exercise in Pregnancy.

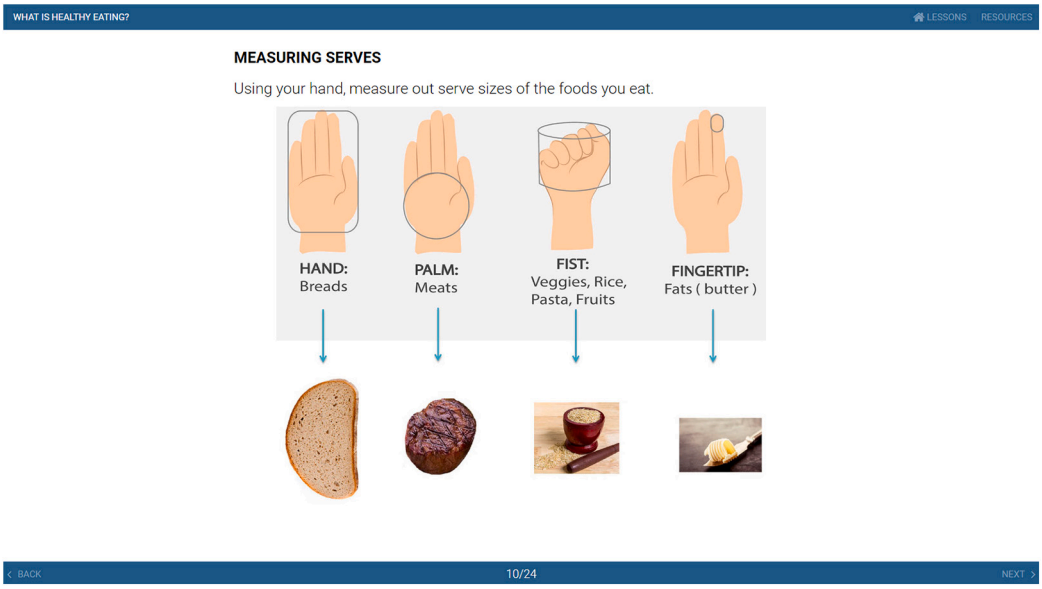
This module introduces the website and overviews topics related to weight gain in pregnancy. Healthy weight gain in pregnancy is described as is determining appropriate gestational weight gain based on the woman's body mass index (BMI). The overall goal of the module is to educate women about the prevention of excessive weight gain in pregnancy through healthy lifestyle adjustments. See example below:

Module 2. What is Healthy Eating?

This module provides advice about what constitutes a healthy diet and the requisite steps to achieve a healthy eating plan. Steps include:

- eating regularly throughout the day,
- eating from a wide variety of the 5 food groups
- following serve sizes and recommendations

This module additionally offers quick easy guides to estimate serve sizes such as using the hand to estimate a portion of bread or meat, for example:

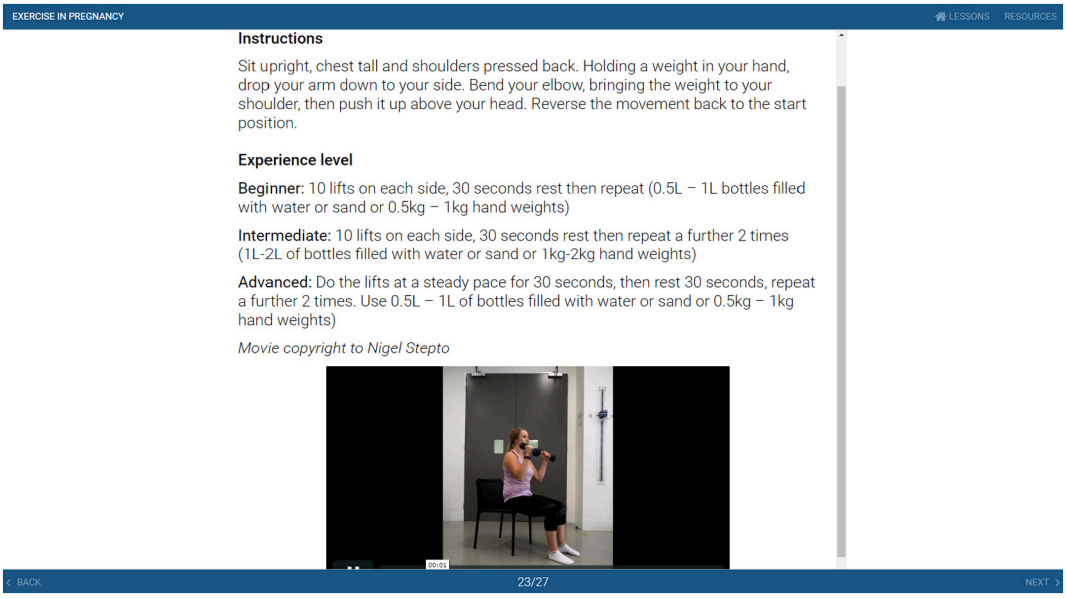


Module 3. Exercise in Pregnancy.

This module was developed based on the most recent best practice guidelines (Hayman et al., 2016; Department of Health Australia, 2014) on physical activity and exercise during pregnancy. It provides information on the benefits of exercise and physical activity, how much (time and intensity) exercise and physical activity is needed, and, types of physical activity and exercise that are appropriate during pregnancy. Practical suggestions for increasing physical activity and a generic exercise program with both strength and aerobic exercises were included and accompanied by clear text and video instructions. See example below:

Module 4. Your Baby's Development.

This module was informed by recommendations for micronutrients in pregnancy (Hermoso et al., 2011; Blumfield et al., 2012; Victoria State Government, 2014) and outlined specific nutrients considered beneficial for fetal development, within each trimester. For example, as shown in the image below, increasing foods that contain vitamin C in the third trimester to promote infant bone development. Module 4 also provides information about foods and substances to be avoided during pregnancy, such as alcohol, smoking and foods which may contain Listeria (such as processed meats and soft cheeses).



2.3. Process evaluation of the website

2.3.1. Ethical considerations

The study was approved by the Hospital ethics committee, Western Health (HREC/11/WH/81). Participants were informed that involvement in the study was voluntary and they could choose to withdraw from the study at any time without penalty. Written informed consent was obtained from each study participant before data collection. All participant details remained confidential.

2.3.2. Assessment measures

The internet evaluation and utility questionnaire (IEUQ) (Ritterband et al., 2008; Thorndike et al., 2008), was used to measure participants' experiences and perceptions of the website. The IEUQ has 15 questions, 13 with 5-point Likert scale responses (0 'not at all' to 4 'very') and 2 open-ended response questions (Table 2). The questionnaire evaluates; user-friendliness, convenience, engagement, visual layout, privacy concerns, satisfaction, acceptability, usefulness, comprehension, trustworthiness, credibility, helpfulness and mode of delivery. The open-ended questions focus on what was 'most helpful' and 'least helpful' about the web intervention. The IEUQ was additionally selected for its ease of use and simplicity. Women were asked to evaluate the website at the hospital clinic. A brief and simple measure, that was easily understood, was critically important for this initial evaluation.

Table 2
IEUQ questionnaire.

1) How easy was the web program to use?
2) How convenient was the web program to use?
3) How much did the web program keep your interest and attention?
4) How much did you like the web program?
5) How much did you like the way the web program looked?
6) How worried were you about your privacy in using this web program?
7) How satisfied were you with the web program?
8) How good a fit was the web program for you?
9) How useful did you find the information in the web program?
10) How easy was the information to understand?
11) How much did you feel you could trust the information in the web program?
[a]12) If you want to learn more about healthy pregnancy in the future, how likely would you be to come back to this web program?
13) How good of a method was the internet for delivering this program?
14) What was the most helpful part of the program?
15) What was the least helpful part of the program?

[a] Minor change of wording to include the term 'healthy pregnancy'.

A study of an earlier and shorter version of the IEUQ showed internal reliability of alpha = 69, (Ritterband et al., 2008). Results of the use of IEUQ with other online health interventions have also been published (Han et al., 2017; Hilgart et al., 2014; Ritterband et al., 2008; Ritterband et al., 2012).

2.4. User testing

Following development, and prior to the evaluation by IEUQ, the intervention was tested by four pregnant women for readability and comprehension. Minor edits to the website occurred as a result of this testing, for example minor changes to wording. Thereafter, a descriptive survey design, was utilized to evaluate the quality of the website. Descriptive surveys aim to establish the range and distribution of some social characteristics, in this instance, user-friendliness and acceptability of the intervention.

2.4.1. Participants and data collection

The website was assessed by pregnant women presenting for care at the study site, a pregnancy clinic at a major metropolitan hospital. Recruitment and data collection took place over a 2 month period. Inclusion criteria were: (1) ability to provide informed consent to

Table 3
Demographic characteristics.

Characteristic	Participants (n = 40)
Age, mean (SD)	30.57 (5.87)
Gestation, mean (SD)	28.36 (7.42)
Parity, n (%)	
Primiparous	18 (45%)
Multiparous	21 (52.5%)
Not specified	1 (2.5%)
Highest level of education obtained, n (%)	
Secondary school	9 (22.5%)
TAFE Certificate	11 (27.5%)
TAFE Diploma	10 (25%)
Undergraduate degree	5 (12.5%)
Postgraduate	4 (10%)
Not specified	1 (2.5%)
Country of birth, n (%)	
Australia	23 (57.5%)
India	4 (10%)
New Zealand	2 (5%)
Chile	2 (5%)
Other	9 (22.5%)

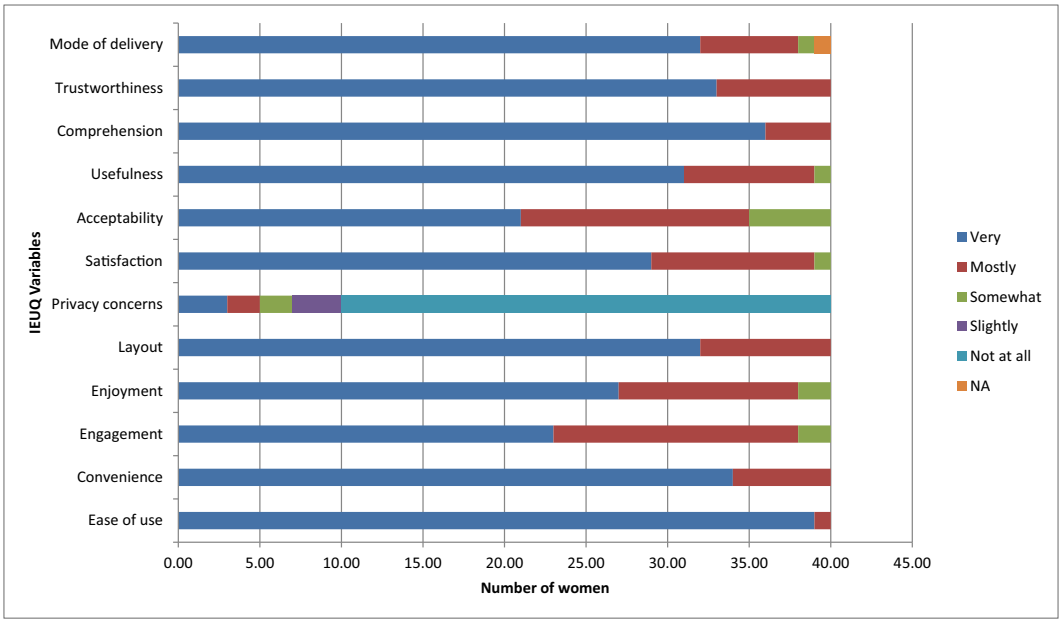


Fig. 1. Internet evaluation and utility questionnaire responses.

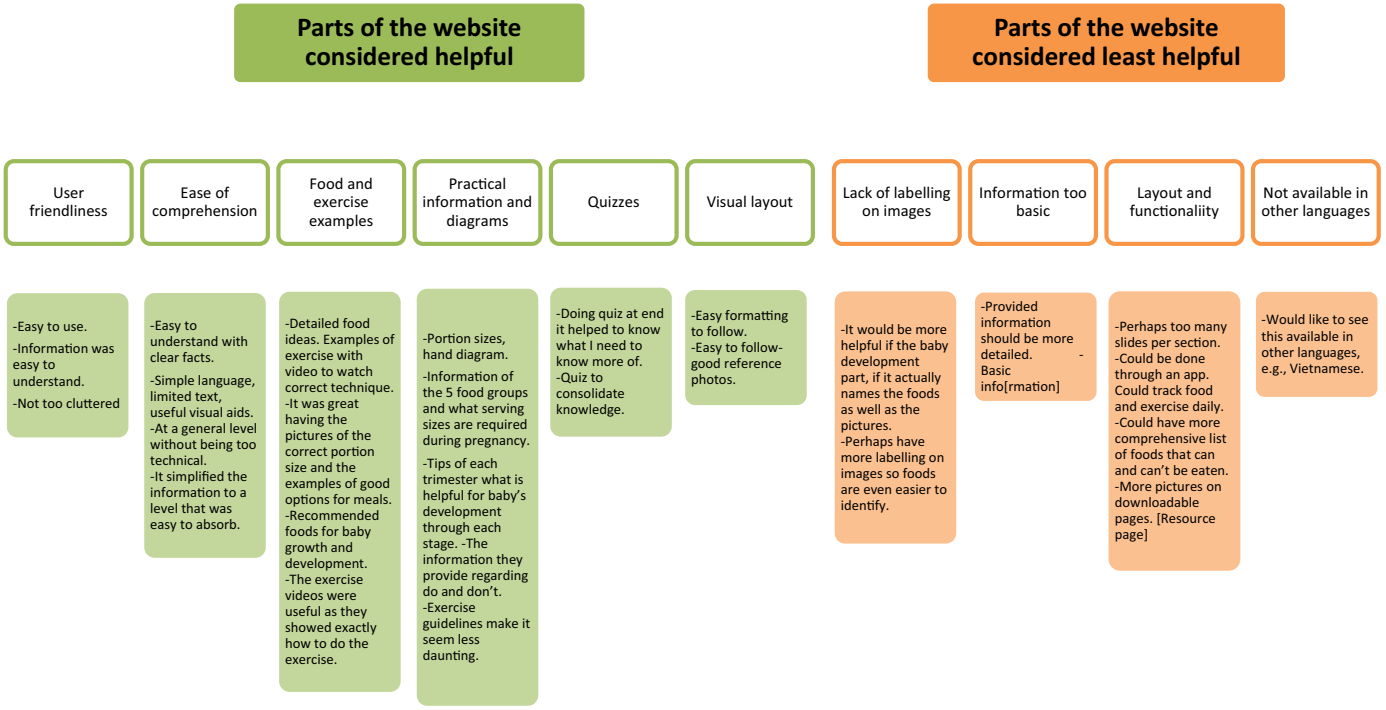


Fig. 2. Internet Evaluation and Utility Questionnaire open ended responses.

participate; (2) Basic English; (3) attending the selected hospital pregnancy clinic; and (4) over the age of 18 years. Women were recruited on a first come basis and fifty-three pregnant women who were waiting for an appointment in pregnancy clinics, on various weekdays, were invited to participate in the evaluation. Participants were compensated with a $25 gift card following their involvement.

Data collection took place in the waiting area of the hospital pregnancy clinic. After providing consent, women were introduced to the website layout and to the modules on an iPad by a member of the research team. Participants were then asked to navigate the website modules independently, and to complete a short demographic questionnaire and the IEUQ. Descriptive statistics were computed for demographic and IEUQ variables using IBM SPSS version 24. Comments provided in the open ended questions were grouped into categories as shown in Fig. 2. This initial testing was intended as a preliminary evaluation and it was expected that it would highlight areas that needed fine tuning, prior to proceeding to a more formal controlled evaluation. Ultimately, when the intervention is ready for release, it is anticipated that women attending the clinic will be provided with the website information by the clinic midwife and they will be able to access the website from home, on home computers or mobile phones.

3. Results

Fifty-three women were invited to participate in the evaluation of the website and 43 provided informed consent. Three women later withdrew when they were called to their appointments. Ten women declined to participate for the following reasons: not interested, minimal understanding of English, less than 18 years of age. A total of 40 women took part.

3.1. Demographic characteristics

Participants were aged between 19 and 44 years and were between 14 and 39 weeks gestation at the time of recruitment (Table 3). There were similar numbers of first time mothers and subsequent mothers in the group. All women had obtained a secondary school education and around 70% had completed some form of additional study such as a Technical and Further Education (TAFE) qualification (generally an apprentice type practical certificate) or University degree. Just over half of the sample was Australian born. The remaining participants were from Oceania, Asia, South America, Europe and Africa, and these proportions are consistent with population data from the Western region (State Government Victoria, 2013). 30% spoke a language other than English at home.

3.2. Internet evaluation and utility questionnaire

A large proportion of participants found the website *very easy* to use (97.5%), *very easy* to understand (90%) and *very convenient* to use (85%). Eighty percent of participants *very much* liked the layout of the website and 82.5% reported that the information on the website was *very trustworthy*. Most participants found the website *very useful* (77.5%) and indicated that the internet was a very good way to deliver diet and exercise information to pregnant women (80%). Most were *very satisfied* with the website (72.5%), and 67.5% *very much* liked using the website. Participants found the website to be *very* (57.5%) and *mostly* (37.5%) engaging. Over half (53%) of the sample indicated that the website was a very good fit and 35% suggested that it was *mostly* a good fit for their needs. Most of the participants had *no* concerns (75%) regarding the privacy of the website, while some were *slightly* (7.5%), *somewhat* (5%), *mostly* (5%) and *very* (7.5%) concerned. Overall, the majority of participants (approximately 90% or more) responded positively (either *very* or *mostly*) to questions on the internet evaluation and utility questionnaire (Fig. 1).

Responses to the open-ended questions were mostly positive (see Fig. 2). There were varying suggestions about what was 'most helpful' about the website. Participants indicated that they found the information useful and easy to understand. They liked the specific examples regarding meal ideas, portion sizes, foods to eat in each trimester and exercise ideas. A few participants mentioned that they liked the quiz at the end of each of the modules. Just 11 participants provided responses about the 'least helpful' aspects of the program. Two women suggested labelling images in the 'your baby's development' module would make the food easier to identify. Other suggested improvements included, reducing numbers of slides, including more pictures on the resources page, adding food and exercise trackers and providing more detailed information. When women completed the end of module 2 knowledge quiz, many incorrectly identified the five food groups. In the module 4 quiz, most women did not correctly answer the question regarding consuming food related to Listeria risk. Most indicated that foods which may contain Listeria bacteria should be avoided completely; however the answer to the question was that these foods can be eaten if cooked to steaming temperatures. After completing the modules, a number of women commented that they were unaware that they were able to consume fish while pregnant. These findings indicate the new information the women were learning while trying out the website. They came to the website with preconceived ideas, for example, that fish was unsafe during pregnancy. After perusing the content, they realised that fish was safe with some restrictions. Inaccurate concerns about listeria risk appear to be common and this will be addressed in the program refinement.

4. Discussion

In summary, this paper describes the development and initial evaluation of a new eHealth intervention to promote healthy diet and exercise in pregnancy. The target group was pregnant women living in a low socio-economic area in the west of Melbourne and attending the hospital clinic for pregnancy care. The aim of the intervention was to provide women with information that was reliable, current and based on best practice. This initial evaluation aimed to examine the user-friendliness, acceptability and usefulness of this website and to identify issues associated with website content.

Participants were positive about the website and found it informative, useful and easy to navigate. These findings are encouraging, as they demonstrate the acceptability of the intervention to inform women about healthy diet and exercise in pregnancy. Some women indicated minor improvements to the layout for example, replacing the word *resources* with *information* and these minor amendments have been made.

Although a small number of digital interventions were previously developed, to promote healthy diet and/or physical activity in pregnancy, most have not particularly targeted a multi ethnic area with low health literacy (Dodd et al., 2018; Hayman et al., 2017; Knight-Agarwal et al., 2015). For example, Hayman et al. (2017), who developed an intervention to promote physical activity among pregnant women, indicated that their study participants were all proficient in English and 72% had private health insurance. Almost 50% had completed a university degree. Similarly, Dodd et al. (2018), reported that 73% of participants in their evaluation study were Caucasian and 75% from more advantaged backgrounds (Dodd et al., 2018). These features suggest educated and motivated cohorts, who are likely to be self-interested in improving pregnancy outcomes.

Of the studies that were concerned with socially disadvantaged populations and/or CALD populations (Dalton et al., 2018; Hughson et al., 2018), uptake of pregnancy information Applications (Apps) varied. Dalton et al. (2018), developed an Android smart App targeting pregnant women in a socially disadvantaged area in Australia, and found difficulties recruiting and retaining women in their study, with just 22% of participants completing the evaluation. Difficulties included financial constraints, such as not having access to an android phone or internet, and reduced rates of technological ability.

Hughson et al. (2018), undertook a literature review the evidence around uptake of pregnancy Apps among women from CALD backgrounds. Despite their broad search strategy, they found only a single study that focussed on pregnant women from CALD backgrounds. That study (Garnweidner-Holme et al., 2015) found, similar to the current study, that health literacy was a concern and that health information must be easily understandable to meet the informational needs of CALD populations.

One of the challenges of developing this intervention was to achieve a level that suited a diverse target group. The main purpose of the intervention was to provide accessible information to all women, regardless of levels of health literacy. However, some of the more educated women reported that the information provided in the modules was too basic, whereas some less well educated women suggested that there was too much information. This suggests that the balance of information included in the resource lies somewhere in the middle, and is likely to meet the information needs of most women in this group. For those women who desire more information, links to other reputable websites providing more detailed advice regarding diet and exercise in pregnancy, were included as additional links (for example, links to Department of Health Dietary guidelines).

Similarly, efforts were made to address the wishes and desires of

pregnant women who participated in interviews in the formative phase of this study, specifically in relation to including sample menus for the most populous ethnic groups (Indian, Vietnamese) and clear information about foods to eat and not to eat in pregnancy. Information on portion sizes, and simple quick recipes were also included. Strategies for increasing physical activity and simple exercise routines that could be integrated into a busy day, were also included. This sort of specific dietary and exercise information is currently not readily available during antenatal care (Duthie et al., 2013; Lindqvist et al., 2014; Lucas et al., 2014).

Participants identified that the internet was a good means of delivering diet and exercise information in pregnancy and this is consistent with the literature (Kennedy et al., 2017a; Sayakhot and Carolan-Olah, 2016). It seems likely that the eHealth intervention developed in this study, will be acceptable to women in the study setting.

The future aim is to fine tune the website based on feedback and comments and to conduct more formal controlled evaluation, such as an RCT. That future evaluation will help identify whether the intervention motivates pregnant women to make improvements in diet and exercise and if the intervention supports women to achieve positive health outcomes such as normal gestational weight gain, normal birth weight and reduction in rates of pregnancy complications such as gestational diabetes.

4.1. Study strengths and limitations

Initial evaluation has been conducted with 40 women and although the sample was recruited on a first come basis, it is reasonably representative of the target population in terms of Australian born and Indian born participants, and socio economic levels. However, it did not contain any South East Asian born populations and this is a limitation that we aim to address in the future.

Although as many as 60% of the population in the study setting, speak a language other than English at home, just 30% of participants in the study spoke another language at home, and this is recognised as a limitation.

The IEUQ questionnaire, used in this study, also has some limiting features. The Cronbach's internal reliability of alpha = 69, (Ritterband et al., 2008) is not ideal due to the different constructs evaluated. Reports by the questionnaire authors indicated that Cronbach's alpha of the subscales ranged from 0.64 to 0.94, however which values link to which constructs have not been reported.

At the time of the study, validated questionnaires to evaluate health based internet interventions were limited. The IEUQ was selected for its relevance and for items of interest to the study. Ease of administration was another important consideration.

Despite the limitations, the information derived from the IEUQ has provided key information about the intervention's acceptability and user friendliness.

5. Conclusion

The findings of this evaluation indicated that pregnant women from this area found the newly developed web resource on diet and exercise acceptable, comprehensible and easy to use. A RCT is planned in the near future and will demonstrate whether the intervention is associated with positive changes in diet and exercise and improved health outcomes in pregnancy. Ultimately, this intervention may serve as an appropriate tool for supporting antenatal care.

Conflict of interest

The authors declare that they have no conflict of interest.

Funding

This study was supported by funding received from the Lord Mayor's Charitable Foundation.

Acknowledgements

We would like to thank the pregnancy clinic staff at Western Health who supported the recruitment phase of the study and the women who participated in the evaluation.

References

ABS: Australian Bureau of Statistics, 2011. 2033.0.55.001 - Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia. Australian Government Press, Canberra.

ABS: Australian Bureau of Statistics, 2019. 2016 Census QuickStats: Brimbank. Australian Government Press, Canberra.

AIFS: Australian Institute of Family Studies, 2013. Using Technology in Service Delivery to Families, Children and Young People (Retrieved from Canberra: Australia Government Press).

Arrish, J., Yeatman, H., Williamson, M., 2014. Midwives and nutrition education during pregnancy: a literature review. Women Birth 27 (1), 2–8. https://doi.org/10.1016/j.wombi.2013.02.003.

Aviram, A., Hod, M., Yogev, Y., 2011. Maternal obesity: Implications for pregnancy outcome and long-term risks-a link to maternal nutrition. Int. J. Gynecol. Obstet. 115 (Suppl. 1), S6–S10.

Bandura, A., 2001. Social cognitive theory: an agentic perspective. Annu. Rev. Psychol. 52, 1–26. https://doi.org/10.1146/annurev.psych.52.1.1.

Barton, J.R., Joy, S.D., Rhea, D.J., Sibai, A.J., Sibai, B.M., 2015. The influence of gestational weight gain on the development of gestational hypertension in obese women. Am. J. Perinatol. 32 (7), 615–620. https://doi.org/10.1055/s-0034-1386634.

Blumfield, M., Hure, A., MacDonald-Wicks, L., Smith, R., Simpson, S., Raubenheimer, D., Collins, C., 2012. The association between the macronutrient content of maternal diet and the adequacy of micronutrients during pregnancy in the Women and Their Childrens Health (WATCH) study. Nutrients 4 (12), 1958–1976. https://doi.org/10.3390/nu4121958.

Brown, S.J., Yelland, J.S., Sutherland, G.A., Baghurst, P.A., Robinson, J.S., 2011. Stressful life events, social health issues and low birthweight in an Australian population-based birth cohort: challenges and opportunities in antenatal care. BMC Public Health 11 (196). https://doi.org/10.1186/1471-2458-1111-1196.

Carolan, M., Steele, C., Margetts, H., 2010. Knowledge of gestational diabetes among a multi-ethnic cohort in Australia. Midwifery 26 (6), 579–588.

Carolan, M., Gill, G., Steele, C., 2012. Women's experiences of factors that facilitate or inhibit gestational diabetes self-management. BMC Pregn. Childbirth 12, 99.

Carolan-Olah, M., Steele, C., Krenzin, G., 2015. Development and initial testing of a GDM information website for multi-ethnic women with GDM. BMC Pregn. Childb. 15 (1) https://doi.org/10.1186/s12884-015-0578-0.

Carolan-Olah, M., Duarte-Gardea, M., Lechuga, J., 2017. A systematic review of interventions for Hispanic women with or at risk of Gestational diabetes mellitus (GDM). Sex. Reprod. Healthc. 13, 14–22.

Costa, D.D., Zelkowitz, P., Bailey, K., Cruz, R., Bernard, J.-C., Dasgupta, K., Khalife, S., 2015. Results of a needs assessment to guide the development of a website to enhance emotional wellness and healthy behaviors during pregnancy. J. Perinat. Educ. 24 (4), 213–224. https://doi.org/10.1891/1058-1243.24.4.213.

Dalton, J.A., Rodger, D., Wilmore, M., Humphreys, S., Skuse, A., Roberts, C.T., Clifton, V. L., 2018. The Health-e Babies App for antenatal education: feasibility for socially disadvantaged women. PLoS ONE 13 (5). https://doi.org/10.1371/journal.pone.0194337.

Department of Health Australia, 2014. Clinical Practice Guidelines: Antenatal Care – Module II Canberra: Commonwealth of Australia. Retrieved from. http://www.health.gov.au/internet/main/publishing.nsf/content/015FBFDD266795DBCA257BF0001A0547/$File/Antenatal-care-module2_Clinical-Practice-Guidelines.pdf.

Dodd, J.M., Louise, J., Cramp, C., Grivell, R.M., Moran, L.J., Deussen, A.R., 2018. Evaluation of a smartphone nutrition and physical activity application to provide lifestyle advice to pregnant women: the SNAPP randomised trial. Matern. Child Nutr. 14 (1) https://doi.org/10.1111/mcn.12502.

Duthie, E.A., Drew, E.M., Flynn, K.E., 2013. Patient-provider communication about gestational weight gain among nulliparous women: a qualitative study of the views of obstetricians and first-time pregnant women. BMC Pregn. Childb. 13 (1), 1–9. https://doi.org/10.1186/1471-2393-13-231.

Ferrara, A., Ehrlich, S.F., 2010. Diabetes prevention interventions for women with a history of GDM. In: Gestational Diabetes During and After Pregnancy, pp. 361–372.

Garnweidner-Holme, L.M., Borgen, I., Garitano, I., Noll, J., Lukasse, M., 2015. Designing and developing a mobile smartphone application for women with gestational diabetes mellitus followed-up at diabetes outpatient clinics in Norway. Healthcare 3 (2). https://doi.org/10.3390/healthcare3020310.

Goldstein, R.F., Abell, S.K., Ranasinha, S., Misso, M., Boyle, J.A., Black, M.H., Teede, H. J., 2017. Association of gestational weight gain with maternal and infant outcomes: a systematic review and meta-analysis. JAMA J. Am. Med. Assoc. 317 (21), 2207–2225. https://doi.org/10.1001/jama.2017.3635.

Goldstein, R.F., Abell, S.K., Ranasinha, S., Misso, M.L., Boyle, J.A., Harrison, C.L., Teede, H.J., 2018. Gestational weight gain across continents and ethnicity: systematic review and meta-analysis of maternal and infant outcomes in more than one million women. BMC Med. 16 (1), 153. https://doi.org/10.1186/s12916-018-1128-1.

Graham, M.L., Strawderman, M.S., Demment, M., Olson, C.M., 2017. Does usage of an ehealth intervention reduce the risk of excessive gestational weight gain? secondary analysis from a randomized controlled trial. J. Med. Internet Res. 19 (1) https://doi.org/10.2196/jmir.6644.

Hackley, B., Kennedy, H.P., Berry, D.C., Melkus, G.D., 2014. A mixed-methods study on factors influencing prenatal weight gain in ethnic-minority women. J. Midwif. Womens Health 59 (4), 388–397. https://doi.org/10.1111/jmwh.12170.

Han, J., Batterham, P.J., Calear, A.L., Wu, Y., Xue, J., van Spijker, B.A.J., 2017. Development and pilot evaluation of an online psychoeducational program for suicide prevention among university students: a randomised controlled trial. Internet Interv. 12, 111–120. https://doi.org/10.1016/j.invent.2017.11.002.

Hayman, M., Brown, W., Ferrar, K., Marchese, R., 2016. Sports Medicine Australia Position Statement: Exercise in Pregnancy and the Postpartum Period. Retrieved from Melbourne: http://sma.org.au/wp-content/uploads/2016/09/SMA-Position-Statement-Exercise-Pregnancy.pdf.

Hayman, M., Reaburn, P., Browne, M., Vandelanotte, C., Alley, S., Short, C.E., 2017. Feasibility, acceptability and efficacy of a web-based computer-tailored physical activity intervention for pregnant women - the Fit4Two randomised controlled trial. BMC Pregn. Childb. 17 (1), 96. https://doi.org/10.1186/s12884-017-1277-9.

Heery, E., McConnon, A., Kelleher, C.C., Wall, P.G., McAuliffe, F.M., 2013. Perspectives on weight gain and lifestyle practices during pregnancy among women with a history of macrosomia: a qualitative study in the Republic of Ireland. BMC Pregn. Childb. 13 https://doi.org/10.1186/1471-2393-13-202.

Hermoso, M., Vollhardt, C., Bergmann, K., Koletzko, B., 2011. Critical micronutrients in pregnancy, lactation, and infancy: considerations on vitamin D, folic acid, and iron, and priorities for future research. Ann. Nutr. Metab. 59 (1), 5–9. https://doi.org/10.1159/000332062.

Hilgart, M., Ritterband, L., Baxter, K., Alfano, A., Ratliff, C., Kinzie, M., Garber, S., 2014. Development and perceived utility and impact of a skin care Internet intervention. Internet Interv. 1 (3), 149–157. https://doi.org/10.1016/j.invent.2014.07.003.

Hughson, J.A.P., Oliver Daly, J., Woodward-Kron, R., Hajek, J., Story, D., 2018. The rise of pregnancy apps and the implications for culturally and linguistically diverse women: narrative review. JMIR mHealth uHealth 6 (11). https://doi.org/10.2196/mhealth.9119.

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 Pregn. Childb. 13 (1), 115. https://doi.org/10.1186/1471-2393-13-115.

Kennedy, R.A.K., Mullaney, L., Reynolds, C.M.E., Cawley, S., McCartney, D.M.A., Turner, M.J., 2017. Preferences of women for web-based nutritional information in pregnancy. Public Health 143, 71–77. https://doi.org/10.1016/j.puhe.2016.10.028.

Knight-Agarwal, C., Davis, D.L., Williams, L., Davey, R., Cox, R., Clarke, A., 2015. Development and pilot testing of the Eating4two mobile phone app to monitor gestational weight gain. JMIR mHealth uHealth 3 (2). https://doi.org/10.2196/mhealth.4071.

Lagan, B.M., Sinclair, M., George Kernohan, W., 2010. Internet use in pregnancy informs women's decision making: a web-based survey. Birth 37 (2), 106–115. https://doi.org/10.1111/j.1523-536X.2010.00390.x.

Lau, Y., Cheng, L.J., Chi, C., Tsai, C., Ong, K.W., Ho-Lim, S.S.T., Tan, K.L., 2018. Development of a healthy lifestyle mobile app for overweight pregnant women: qualitative study. J. Med. Internet Res. 20 (4) https://doi.org/10.2196/mhealth.9718.

Lee, A., Newton, M., Radcliffe, J., Belski, R., 2018. Pregnancy nutrition knowledge and experiences of pregnant women and antenatal care clinicians: a mixed methods approach. Women Birth 31 (4), 269–277. https://doi.org/10.1016/j.wombi.2017.10.010.

Lindqvist, M., Mogren, I., Eurenius, E., Edvardsson, K., Persson, M., 2014. "An on-going individual adjustment": a qualitative study of midwives' experiences counselling pregnant women on physical activity in Sweden. BMC Pregn. Childb. 14 (1)), 1–10. https://doi.org/10.1186/1471-2393-14-343.

Lobo, S., Lucas, C.J., Herbert, J.S., Townsend, M.L., Smith, M., Kunkler, E., Charlton, K. E., 2020. Nutrition information in pregnancy: where do women seek advice and has this changed over time? Nutr. Diet. 77 (3), 382–391. https://doi.org/10.1111/1747-0080.12589.

Lucas, C., Charlton, K.E., Yeatman, H., 2014. Nutrition advice during pregnancy: do women receive it and can health professionals provide it? Matern. Child Health J. 18 (10), 2465–2478. https://doi.org/10.1007/s10995-014-1485-0.

Lupton, D., 2016. The use and value of digital media for information about pregnancy and early motherhood: a focus group study. BMC Pregn. Childb. 16 https://doi.org/10.1186/s12884-016-0971-3.

MacAllister, A.L., Perry, C.L., Parcel, G., 2008. How individuals, environments and health behaviors interact. In: Glanz, B, R.K., Viswanath, V. (Eds.), Health Behavior and Health Education: Theory, Research, and Practice. Jossey Bass, San Francisco, pp. 167–188.

Macdonald-Wallis, C., Tilling, K., Fraser, A., Nelson, S.M., Lawlor, D.A., 2013. Gestational weight gain as a risk factor for hypertensive disorders of pregnancy. Am. J. Obstet. Gynecol. 209 (4) https://doi.org/10.1016/j.ajog.2013.05.042, 327.e321-327.e317.

Mitsutake, S., Shibata, A., Ishii, K., Miyawaki, R., Oka, K., 2020. Associations of ehealth literacy with obtaining knowledge about colorectal cancer among internet users accessing a reputable cancer website: Internet-based survey study. Int. J. Environ. Res. Public Health 17 (9). https://doi.org/10.3390/ijerph17093302.

Negarandeh, R., Mahmoodi, H., Noktehdan, H., Heshmat, R., Shakibazadeh, E., 2013. Teach back and pictorial image educational strategies on knowledge about diabetes and medication/dietary adherence among low health literate patients with type 2 diabetes. Prim. Care Diab. 7, 111–118. https://doi.org/10.1016/j.pcd.2012.11.001.

NHMRC: National Health and Medical Research Council, 2012. The Australian Dietary Guidelines: Healthy Eating for Your Pregnancy. n55h (Vol. www.eatforhealth.gov.au). Australia Government Press.

Nitsos, A., Estrada, R.D., Messias, D.K.H., 2017. Tummy time for Latinos with limited English proficiency: evaluating the feasibility of a cultural and linguistically adapted parent education intervention. J. Pediatr. Nurs. 36, 31–36. https://doi.org/10.1016/j.pedn.2017.04.004.

Phelan, S., Hagobian, T., Brannen, A., Hatley, K.E., Schaffner, A., Muñoz-Christian, K., Tate, D.F., 2017. Effect of an internet-based program on weight loss for low-income postpartum women a randomized clinical trial. JAMA J. Am. Med. Assoc. 317 (23), 2381–2391. https://doi.org/10.1001/jama.2017.7119.

Phelan, S., Hagobian, T.A., Ventura, A., Brannen, A., Erickson-Hatley, K., Schaffner, A., Tate, D.F., 2019. 'Ripple' effect on infant zBMI trajectory of an internet-based weight loss program for low-income postpartum women. Pediatr. Obes. 14 (1) https://doi.org/10.1111/ijpo.12456.

Poth, M., Carolan, M., 2013. Pregnant women's knowledge about the prevention of gestational diabetes mellitus: a qualitative study. Br. J. Midwifery 21 (10), 692–700.

Rhodes, A., Smith, A.D., Chadwick, P., Croker, H., Llewellyn, C.H., 2020. Exclusively digital health interventions targeting diet, physical activity, and weight gain in pregnant women: systematic review and meta-analysis. JMIR mHealth uHealth 8 (7). https://doi.org/10.2196/18255.

Ritterband, L.M., Ardalan, K., Thorndike, F.P., Magee, J.C., Saylor, D.K., Cox, D.J., Borowitz, S.M., 2008. Real world use of an Internet intervention for pediatric encopresis. J. Med. Internet Res. 10 (2), 80–90. https://doi.org/10.2196/jmir.1081.

Ritterband, L.M., Bailey, E.T., Thorndike, F.P., Lord, H.R., Farrell-Carnahan, L., Baum, L. D., 2012. Initial evaluation of an Internet intervention to improve the sleep of cancer survivors with insomnia. Psycho-Oncology 21 (7), 695–705. https://doi.org/10.1002/pon.1969.

Sayakhot, P., Carolan-Olah, M., 2016. Internet use by pregnant women seeking pregnancy-related information: a systematic review. BMC Pregn. Childb. 16 (1) https://doi.org/10.1186/s12884-016-0856-5.

Schneider, L.H., Hadjistavropoulos, H.D., Dear, B.F., Titov, N., 2020. Efficacy of internet-delivered cognitive behavioural therapy following an acute coronary event: a randomized controlled trial. Internet Interv. 21. https://doi.org/10.1016/j.invent.2020.100324.

State Government Victoria, 2013. Victoria's Diverse Population 2011 Census. State Government Victoria, Melbourne. Retrieved from. http://www.multicultural.vic.gov.au/images/stories/documents/2013/pop_diversity_vic_brochure_2013_web.pdf.

Storr, T., Maher, J., Swanepoel, E., 2017. Online nutrition information for pregnant women: a content analysis. Matern. Child Nutr. 13 https://doi.org/10.1111/mcn.12315.

Thorndike, F.P., Saylor, D.K., Bailey, E.T., Gonder-Frederick, L., Morin, C.M., Ritterband, L.M., 2008. Development and perceived utility and impact of an Internet intervention for insomnia. E-J. Appl. Psychol. 4 (2), 32–42. https://doi.org/10.7790/ejap.v4i2.133.

Victoria State Government, 2014. Better health channel: pregnancy and diet. Retrieved from. https://www.betterhealth.vic.gov.au/health/healthyliving/pregnancy-and-diet.

Walker, R., Bennett, C., Blumfield, M., Gwini, S., Ma, J., Wang, F., Truby, H., 2018. Attenuating pregnancy weight gain—what works and why: a systematic review and meta-analysis. Nutrients 10 (7). https://doi.org/10.3390/nu10070944.

Waring, M.E., Moore Simas, T.A., Xiao, R.S., Lombardini, L.M., Allison, J.J., Rosal, M.C., Pagoto, S.L., 2014. Pregnant women's interest in a website or mobile application for healthy gestational weight gain. Sexual Reprod. Healthc. 5 (4), 182–184. https://doi.org/10.1016/j.srhc.2014.05.002.

Wilkinson, S.A., Donaldson, E., McCray, S.J., 2018. Re-evaluating the nutritional awareness, knowledge and eating behaviours of women attending a tertiary maternity hospital following iterative service redesign. Nutr. Diet. 75 (4), 372–380. https://doi.org/10.1111/1747-0080.12475.

Women's Health West, 2015. Women and diabetes in the west. Retrieved from Melbourne. http://whwest.org.au/wp-content/uploads/2015/10/Brimbank_PRINT.pdf.