

ORIGINAL ARTICLE

Assessing the effectiveness of a 4-week online intervention on food literacy and fruit and vegetable consumption in Australian adults: The online MedDiet challenge

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Abstract

Australians fail to meet the daily recommended two and five serves of fruit and vegetable respectively, which increases mortality risk for non-communicable diseases such as cardiovascular disease and type 2 diabetes. This study aimed to evaluate the effectiveness of an online intervention delivered through social media on food literacy and fruit and vegetable consumption in Australian adults. In a pre-post single group experimental study, 29 participants completed the “online MedDiet challenge”, a four-week intervention delivered via Facebook. Infographics, recipes and informational videos aligned with food literacy concepts related to the Mediterranean Diet were shared with participants. Outcome measures included a validated food literacy questionnaire with two questions from the National Nutrition Survey to record fruit and vegetable consumption. The mean age of participants was 52 years (range: 25–67 years). Post intervention, food literacy improved between 21%–45% across each survey component. Participants also reported an increase in fruit and vegetable consumption by 0.6 and 1.3 serves per day ($p < 0.05$) respectively. Social media holds potential for increasing fruit and vegetable consumption in adults through food literacy. Future research should focus on longer studies and larger cohorts to confirm that food literacy plays a key component to maintain sustainability of such interventions.

KEYWORDS

eHealth, food literacy, Mediterranean diet, mHealth, social media

1 | INTRODUCTION

According to the World Health Organisation (WHO), 41 million people died in 2016 from non-communicable diseases (NCDs), with cardiovascular disease (CVD), dementia, cancer, chronic respiratory disease and diabetes being the top causes of death (WHO, 2016). In the same year, 89% of all Australian deaths were attributed to NCDs,

with cancer and CVD accounting for the top two causes of death at 29% and 28%, respectively (WHO, 2018). The role of modifiable risk factors such as dietary intake, specifically fruit and vegetable intake, has been well established in the development of NCDs (Yip et al., 2019). A systematic review of 64 meta-analyses reported inverse associations between fruit and vegetable intake and over 29 different types of NCDs and their risk factors (Yip et al., 2019).

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Previous research has suggested that poor dietary habits, including low consumption of fruit and vegetables, are partly due to the lack of skills and awareness around planning, selecting, preparing and consuming healthy meals, otherwise referred to as food literacy (Garcia et al., 2016; McGowan et al., 2016; Truman et al., 2017; Vidgen & Gallegos, 2014). The increase in Internet availability and accessibility in recent years has resulted in the development of on-line systems and services that improve public health, including food literacy (Burke et al., 2015). A meta-analysis of 15 intervention studies that examined the effectiveness of online health interventions via mobile and Internet delivery on physical activity and dietary behaviour found significant improvements across both domains in adults (Müller et al., 2016). Although several other reviews that examined the effectiveness of online interventions have reported similar findings, there has been a focus on improving overall dietary behaviour rather than fruit and vegetable consumption and food literacy specifically (Hou et al., 2014; Nour et al., 2016).

To the best of our knowledge, the Food Sensations for Adults program is the only Australian study that has examined the effectiveness of a telehealth intervention on improving food literacy levels and fruit and vegetable consumption in Australian adults (Begley et al., 2019). The program served as a free resource for low to middle income individuals interested to learn about healthy eating and improve their cooking skills (Begley et al., 2019). Evaluation of the Food Sensations for Adults program showed significant improvements in food literacy components, as well as increases in self-reported fruit and vegetable intake in an Australian population (Begley et al., 2019). However, the Food Sensations for Adults program has been designed primarily for face to face delivery with limited videoconferencing components.

Another strategy to improve fruit and vegetable consumption in adults is through the incorporation of the Mediterranean diet (MedDiet) principles, which prioritises regular consumption of plant-based foods, with a focus on fruit and vegetables, wholegrains and olive oil (Davis et al., 2015). Studies that have examined the MedDiet have reported its role in significant improvements for both the primary and secondary prevention of chronic diseases, such as CVD (Grosso et al., 2014; Rosato et al., 2019). Implementation of the MedDiet eating principles within the community to benefit overall health status is multi-factorial (D'Innocenzo et al., 2019) and the use of MedDiet principles as a tool to improve food literacy has not been explored within research yet. Having clear, consistent, accurate and ongoing education around the benefits of adopting MedDiet principles is key for adherence (D'Innocenzo et al., 2019). Therefore, the aim of this study was to develop and trial an online intervention program to improve food literacy and fruit and vegetable intake through the use of MedDiet principles.

2 | METHODS

A pre-post single group experimental design was implemented for the online intervention named the "Online MedDiet Challenge".

What is known about this topic

- Food literacy encompasses knowledge and skills around nutrition and food preparation.
- Fruit and vegetable intake in Australian adults is poor partly due to low food literacy.
- There is a lack of food literacy programs targeting Australian adults in the wider community.

What this paper adds

- Social media is a useful tool for interactive and engaging food literacy programs in adults.
- Incorporating a Mediterranean diet eating pattern can improve fruit and vegetable intake.
- Peer support may contribute to increased sustainability and scalability for future food literacy programs.

Outcome measures were assessed at two time points, at baseline following informed consent, and at conclusion of the 4-week intervention period. Ethics approval was obtained from the La Trobe University Human Ethics Committee (HEC18527).

A sample size calculation showed that a sample of 30 study participants would allow the detection of a 30% increase in fruit and vegetable consumption from baseline to follow up, with a standard deviation of 10%, power of 80% and level of significance of 5%. For their inclusion to the study, participants had to be at least 18 years old; be members or staff of Geelong Medical and Hospital Benefits Association (GMHBA), a not-for-profit, private health insurance provider, residing in Victoria, Australia; able to communicate in English; and have access to the Internet and familiarity with the use of Facebook. Individuals were excluded from the study if they were pregnant or breastfeeding, due to their specific nutritional needs; diagnosed with any of the following medical conditions: diabetes, inflammatory conditions (e.g. rheumatoid arthritis), intestinal disease (e.g. inflammatory bowel disease; irritable bowel syndrome), food intolerances, blood coagulation disorders, any cognitive or mood disorder and any other diagnosed physiological conditions; prescribed any of the following medications: warfarin, anticoagulants, insulin, immunosuppressant agents and hormone replacement therapy; and following a specialised diet for medical reasons (e.g. gluten free diet for coeliac disease).

Participant recruitment took place between May and July 2019. It was advertised by GMHBA to their members and staff through their online magazine, social media platforms, monthly newsletter and website. Once eligibility was confirmed and informed consent was obtained, participants were sent a link to complete the baseline survey online and were invited to join a closed Facebook group, via which the online intervention was delivered.

The main concept of the "Online MedDiet Challenge" was to introduce participants to the MedDiet principles and style of cooking

as a means to improve their food literacy and increase fruit and vegetable consumption. The “Online MedDiet Challenge” was advertised as a 28-day program with pre- and post-surveys administered at baseline and upon completion. Due to the rolling recruitment nature of the study, participants were able to continue within the Facebook group after completing the final survey. Strategies to encourage participants to adopt a Mediterranean style of eating included moderators sharing relevant infographics, how-to videos and recipes within the Facebook group. Infographics were posted on Monday, Wednesday and Friday of each week and were developed to share information about nutrition-related topics such as the benefits of the MedDiet, the nutrition and disease relationship, understanding nutrition labels and interpreting the Australian dietary guidelines. Weekly how-to videos were sourced from YouTube to provide tips and advice on developing nutrition-related skills such as the preparation, buying and cooking of food. Mediterranean style recipes were shared on a weekly basis, in order to encourage participants to incorporate Mediterranean style ingredients in their cooking. Participants were also encouraged to share their own recipes and cooking tips with the group to help generate discussion and motivate each other through peer support. Fortnightly “Question and Answer” sessions were held with nutrition experts for participants to engage with.

Participants received a starter “MedDiet Box”, which contained Mediterranean staple ingredients such as extra virgin olive oil, legumes, and spices along with Mediterranean style recipes and cooking ideas as an added incentive. Participants who completed the final questionnaire were also eligible to win a Mediterranean style cookbook.

Demographic information obtained as part of the baseline questionnaire included participants' country of birth, age, sex, educational level and residential postcode. Participants' residential postcodes were grouped as urban and rural or regional according to Regional Development Victoria classifications (Regional Development Victoria, 2019).

The primary outcome measures for this study were food literacy levels and fruit and vegetable consumption. Food literacy was measured using a modified 11-item food literacy questionnaire based on the Expanded Food and Nutrition Education Program (EFNEP) (National Institute of Food and Agriculture, 2019) and has been validated for use in the Australian population (Begley et al., 2018). The questionnaire was developed to evaluate dietary skills and behaviours, such as how often participants were in charge of the selection and preparation of healthy foods over the last month (Begley et al., 2018). Fruit and vegetable consumption were assessed based on two questions as used in the National Nutrition and Physical Activity Survey (NNPAS) (Begley et al., 2018). The selected questions determined participants' average consumption of fruit and vegetable serves per day to the nearest half serve (Australian Bureau of Statistics, 2014). Examples of what constituted a serve of fruit and vegetable according to the Australian Dietary Guidelines were provided alongside the questions for clarification (National Health and Medical Research Council, 2013).

Data collected for each outcome measure (i.e. food literacy level, fruit and vegetables consumption) were used to categorise participants to those who showed improvement during the intervention period and those who did not. For the food literacy component, improvements were defined as participants who reported an increase in food literacy-related activities (e.g. selection and preparation of healthy foods) compared to baseline (i.e. response improvement from “never” to “sometimes” or from “sometimes” to “most of the time” etc.). Improvement in fruit and vegetable intake was defined as the increase in the daily consumption of serves from each one of the two food groups.

An evaluation survey that consisted of four Likert scale questions and two open-ended questions was sent to participants after the post-intervention survey to obtain feedback and future improvements for the “Online MedDiet Challenge”.

Survey questionnaires were scored using Microsoft Excel for Office 365 (version 1902) and all data were analysed using the statistical software SPSS (version 25.0). The normality of the distribution of continuous variables was examined using the Kolmogorov–Smirnov normality test. Statistical significance of the mean changes observed from baseline to post intervention were assessed with the use of the paired samples *T*-test. All associations between categorical variables were examined via the use of the chi-square test. The level of statistical significance was set at $p < 0.05$, while all reported *p*-values were 2-tailed.

3 | RESULTS

One hundred and thirty individuals expressed interest to participate in the “Online MedDiet Challenge”. Of these, 70 individuals were eligible and 35 provided consent to participate. Thirty-two participants completed the baseline survey and three participants withdrew during the intervention period without providing any reasons. The final sample consisted of 29 participants with full datasets from baseline to post intervention. Figure 1 shows the flow of participants at the different stages of recruitment and study execution.

Table 1 shows the demographic characteristics of participants. Most study participants were female (90%), born in Australia (93%), had a tertiary education (60%), lived in a rural region (72%) and were not living alone (93%).

Overall, improvements were seen across all components of food literacy in participants from baseline to post intervention as shown in Figure 2. More specifically, approximately one fifth (21%) of study participants improved their food literacy by reporting that they “compared prices of foods to find the best prices on healthy foods” and “planned meals ahead of time”. Around one quarter (24%) of participants showed improvements in their food literacy by “changing recipes to make them healthier” or by “trying a new recipe”. In addition, 28% of participants improved their food literacy by reporting that they were “using food labels to make food choices”, by “thinking about healthy choices when deciding what to eat” and by “making a list before going shopping”. Approximately one third (31% or 35% respectively) of participants also improved their food literacy by reporting that they were “feeling more

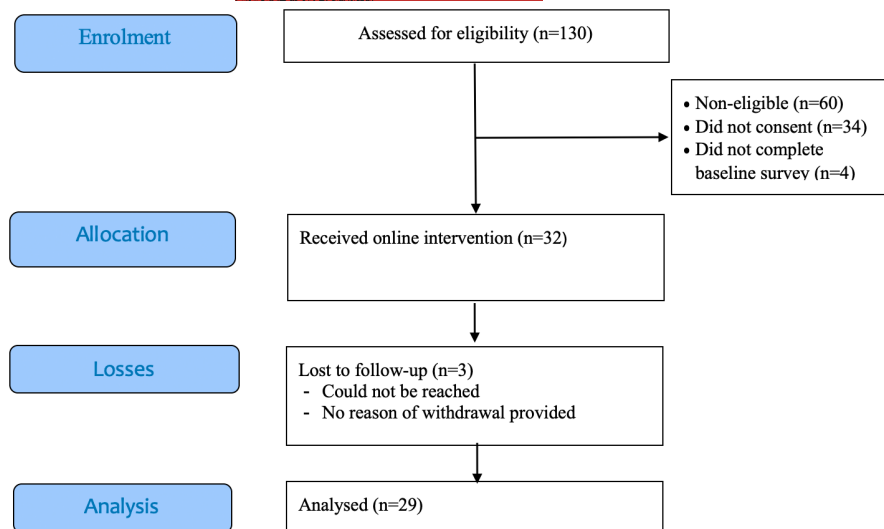


FIGURE 1 CONSORT flow diagram of study participants.

TABLE 1 Demographic characteristics of the study sample (n = 29)

Demographics	Mean (SD)
Age (years)	51.7 (11.1) (Range: 25–67)
	n (%)
Sex	
Male	3 (10)
Female	26 (90)
Living Alone	
Yes	2 (7)
No	27 (93)
Urbanisation	
Urban	8 (28)
Rural/Regional	21 (72)
Country of Birth	
Australia	27 (93)
Other	2 (7)
Education Level	
Tertiary Education	17 (60)
Other	12 (40)

confident about cooking a variety of healthy meals or managing money to buy healthy foods” and by “using nutrition information to make food choices”. Finally, nearly half (45%) of participants showed improvement in their food literacy by reporting that they “plan meals to include all food groups”. In addition to the improvements observed in the food literacy components, the current study also showed statistically significant increases in fruit and vegetable intake as highlighted in Table 2.

Data were then compared between participants who had increased their fruit consumption over the study period and those who did not. Participants who increased fruit consumption showed improvements in food literacy, specifically in response to item 4 of the survey “thinking about healthy choices when deciding what to eat” (84.2%

vs. 15.8%, participants who increased fruit consumption versus those who had not, $p = 0.05$). A similar trend was also seen for item 5 of the food literacy questionnaire on the “use of Nutrition Information Panel to make food choices” for participants who increased their fruit consumption (60.0% vs. 40.0%, participants who increased fruit consumption versus those who had not, $p < 0.05$).

No significant associations between food literacy and vegetable consumption were found when participants were separated into those who had improved vegetable intake over the study period versus those who had not.

Nine participants (31%) completed the evaluation survey with mostly positive feedback regarding the “Online MedDiet Challenge”. All respondents found the “Online MedDiet Challenge” to be helpful or very helpful. On a scale of 1 to 10, with 1 being absolutely would not recommend and 10 being absolutely would recommend, participants scored an average of 8.7 when asked how likely they were to recommend the “Online MedDiet Challenge” to friends and family. On a scale from 1 (very difficult) to 10 (very easy), 56% of participants found it very easy to navigate the Facebook page, with an overall average score of 8.8 (Figure 3).

Seven participants (24%) reported that they intend to make some changes to their health as a result of the “Online MedDiet Challenge”, while two participants (7%) reported that they intend to make significant changes. Five participants (17%) also reported being very confident in applying the skills and knowledge they have learnt from the intervention, while the remaining four (14%) reported being neither confident nor unconfident.

Open-ended feedback provided by participants included suggestions for more recipes, discussion topics, sample meal plans and clinical assessments to gauge their health improvements over the “Online MedDiet Challenge” period.

4 | DISCUSSION

The current study examined the effectiveness of a 4-week online intervention on food literacy and fruit and vegetable consumption,

FIGURE 2 Percentage of study participants showing improvement of food literacy from baseline to post-intervention.

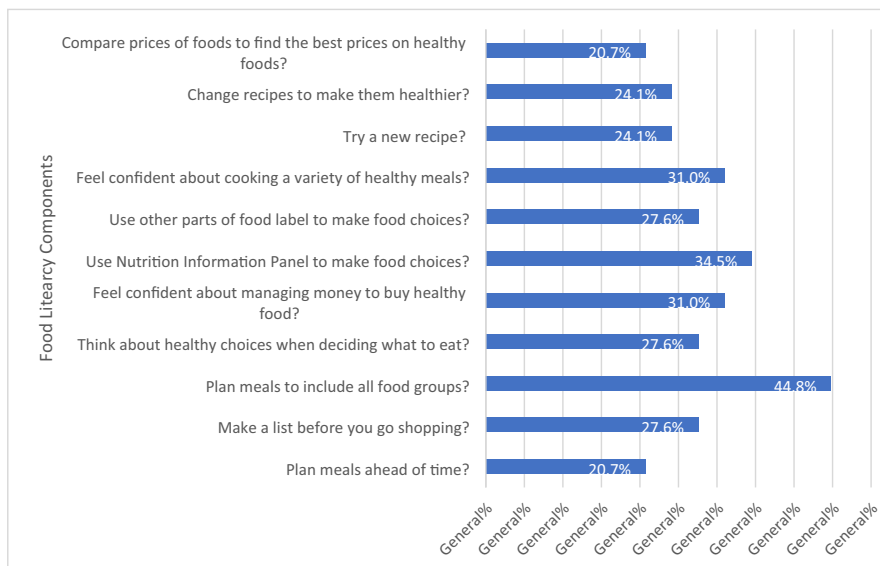


TABLE 2 Changes in fruit and vegetable consumption from pre- to post-intervention.

	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	Change (95% CI)	p-value
Fruit (serves/day)	1.38 (0.49)	1.95 (0.97)	0.57 (0.09–1.05)	0.021
Vegetables (serves/day)	3.19 (1.53)	4.48 (1.40)	1.29 (3.83–5.12)	0.007

Abbreviation: CI, Confidence Interval.

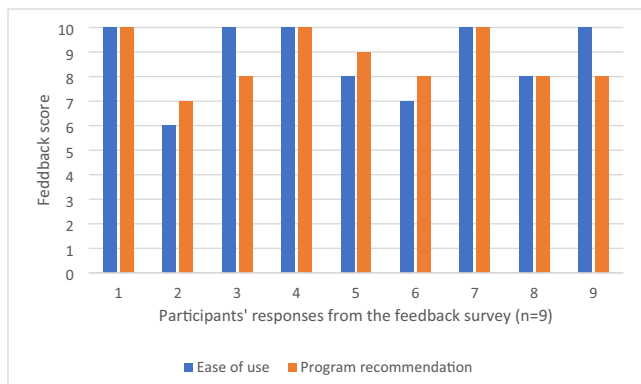


FIGURE 3 Participants' responses from the feedback survey.

using the basic principles of the MedDiet pattern. The study found that the online intervention was effective in improving food literacy and self-reported daily intake of fruit and vegetables.

Improvements in participants' food literacy were observed across all components of the food literacy scale and ranged between 21%–45% at the conclusion of the intervention. Only two other studies to date have examined changes in food literacy using the same questionnaire (Begley et al., 2018; Wrieden et al., 2017). Specifically, the previous Food Sensations for Adults program also found improvements in food selection, planning and preparation of healthy meals, improvements in food literacy as well as

a reduction in food insecurity (Begley et al., 2018). Additionally, a 7-week online intervention in the United Kingdom that aimed to improve cooking skills through food literacy found significant improvements in participants' confidence and cooking skills (Wrieden et al., 2017). These findings are indicative of additional favourable benefits of online interventions that focus on increasing participants' food literacy.

Based on the findings of the current study, fruit and vegetable consumption reported by participants significantly increased by 0.6 and 1.3 serves per day respectively, supporting the use of online interventions such as the "Online MedDiet Challenge". These findings align with a recent meta-analysis of 12 studies that supported the effectiveness of eHealth and mHealth interventions on fruit and vegetable consumption in young adults (Nour et al., 2016). However, each intervention included in the meta-analysis had varying sample sizes and intervention durations and lacked long term follow up, therefore the sustainability of these changes remain unclear. Another meta-analysis that evaluated the effectiveness of online interventions on physical activity and dietary behaviours reported similar favourable findings in changing these behaviours (Hou et al., 2014).

Within the "Online MedDiet Challenge", most of the participants were female (85.7%), which aligned with most of the studies found in meta-analyses mentioned above (Hou et al., 2014; Nour et al., 2016). In general, females are more likely to participate in nutrition interventions (French et al., 1994), including online programs when compared to males (Kodama et al., 2012; Livingstone et al., 2020). While

most online interventions have focused on young adults, few have explored the effectiveness of such programs on older adults. The mean age of participants was 52 years, which contrasts with most previous online interventions that have focused on young adults (Hou et al., 2014; Nour et al., 2016). The high satisfaction and effectiveness reported from the "Online MedDiet Challenge" reinforces the importance of age inclusivity in online programs.

A key strength of the current study was the use of active communication strategies as part of the "Online MedDiet Challenge" through weekly discussion topics and question and answer opportunity with experts. Such active communication strategies have been reported to be the success of other online interventions as reported across two meta-analyses to produce favourable behavioural changes in participants (Hou et al., 2014; Nour et al., 2016). Additionally, online health programs such as the "Online MedDiet Challenge" study further supports the acceptability of an easily accessible public health intervention with the majority of participants (71%) living in a rural or regional area, where health services may be limited (Australian Institute of Health and Welfare, 2019).

The findings of the current study should also be interpreted under the light of its limitations. The recruited sample size was slightly smaller compared to the one dictated by the power calculation (29 vs. 30 participants as per initial sample size calculation). As a result, this may have reduced the probability of observing more significant associations between outcome measures. Most of the participants (60%) had completed some sort of tertiary education, which limits the transferability of the findings to less-educated populations. Furthermore, as all participants included in this study were members and staff of GMHBA private health insurance provider: this might limit the external validity and generalisability of the study findings to those that have private health insurance, who represent just under half (43.8%) of the Australian adult population (Australian Prudential Regulation Authority, 2020). Self-report bias may also be present as participants could have understood the nature of the study through other internal communication channels, which may have influenced their survey responses.

Online interventions delivered through easily accessible platforms on social media, such as the "Online MedDiet Challenge", have the potential to increase food literacy in Australian adults. The current study further confirms that an increase in components of food literacy can also promote fruit and vegetable intake, which is a key modifiable risk factor for non-communicable diseases such as CVD and cancer. Future research in this space should look at continuing to maximise participant engagement with the online food literacy program through personalised content or challenges. Future studies should assess the impact on more sensitive short and long-term health outcome measurements.

AUTHOR CONTRIBUTIONS

A.N., Y.E., J.B. and G.M., conceptualised the research project. Y.E. performed the research. A.N. and Y.E. drafted the manuscript and all authors critically revised the manuscript for intellectual content. All

the authors have seen and approved the final manuscript and have agreed to its submission.

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CONFLICT OF INTEREST

The authors have no conflicts of interest in relation to the research to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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