A Web-based Dietary Intervention for People with Type 2 Diabetes: Development, Implementation and Evaluation

Amutha Ramadas[1], Carina Ka Yee Chan [1, 4], Brian Oldenburg[2], Zanariah Hussien[3] and Kia Fatt Quek[1]

[1]*Jeffrey Cheah School of Medicine and Health Sciences, Monash University, Malaysia.*

[2]*Department of Epidemiology and Preventive Medicine, Monash University, Australia.*

[3]*Department of Medicine, Hospital Putrajaya, Malaysia.*

[4]*Australian Catholic University, Australia*

Amutha Ramadas: amutha.ramadas@monash.edu

Carina Chan: carina.chan@acu.edu.au

Brian Oldenburg: brian.oldenburg@monash.edu

Zanariah Hussein: ppzana@hpj.gov.my

Kia Fatt Quek: quek.kia.fatt@monash.edu

Corresponding author:
Amutha Ramadas, PhD
Clinical School Johor Bahru,
Jeffrey Cheah School of Medicine and Health Sciences,
Monash University Malaysia,
No 8, Jalan Masjid Abu Bakar,
80100 Johor, Malaysia.
e-mail: amutha.ramadas@monash.edu
phone: +607-2190638
fax: +607-2190601

ABSTRACT

Purpose: Although e-health is an emerging theme, only a few successful web-based studies on diabetes self-management have been reported. We describe the development, implementation and process evaluation of an Internet-delivered dietary intervention program (*my*DIDeA) for diabetic patients in a developing country. **Methods:** Specific dietary components to be included in the intervention module were first identified through a comprehensive review of literature and guidelines. The lesson plans and the study website were then developed based on the evidence, Transtheoretical Model's Stages of Change and user-centered design approach. Finally, the effectiveness of the website was tested through a randomized-controlled trial to promote dietary change in patients with type 2 diabetes. The participants in the intervention group (n = 66) were given access to *my*DIDeA for 6 months. Process evaluation in form of intervention adherence and program reception were conducted at post-intervention. **Results:** The response rate for the process evaluation was 89%. On average, each participant logged in at least once for each lesson plan and spent almost 12 minutes on the site. The participants' content satisfaction, acceptability and usability scores were satisfactory. The primary outcome of the trial, Dietary Knowledge, Attitude and Behavior score was strongly correlated with content satisfaction (r=0.826, $p<0.001$), acceptability (r=0.793, $p<0.001$) and usability of the website (r=0.724,$p<0.001$), and moderately correlated with frequency of log-in (r=0.501, $p<0.05$) and duration spent in the website (r=0.399, $p<0.05$). **Conclusion:** The process evaluation of *my*DIDeA demonstrates its feasibility and future studies should identify the possibility of extending the use of Internet-based intervention programs to other health behaviors and issues related to self-management of chronic conditions. In addition, interactivity, peer-support via social media and other means to stimulate the interest of participants can be explored.

Trial registration: Clinicaltrials.gov NCT01246687

INTRODUCTION

Diabetes has recently become one of the most prevalent non-communicable diseases globally. The health, societal and economic burden associated with diabetes are particularly serious in low- and middle-income countries which now account for more than 80% of the global burden of diabetes [1]. Specifically, diabetes is becoming a very important health issue in rapidly developing countries like Malaysia. Malaysia is experiencing rapid development under the influence of Westernization, urbanization and modernization. The accelerated changes in lifestyle have resulted in changes in dietary habits that are known to be associated with non-communicable diseases including diabetes [2]. The prevalence of T2DM in Malaysians above 30 years old was reported to be 15.2% in the year 2011, and it is predicted to increase further in the coming years [3]. The huge burden of morbidity and mortality caused by T2DM is evident among Malaysians, as more than 4% of people with diabetes already have diabetes-related complications [4]. Related to these complications, blood glucose control is a major challenge as less than one quarter of patients with diabetes achieved the targeted HbA1c of 6.5% or below [3]. There is now emerging evidence that socio-behavioral interventions can be effective in preventing and managing chronic conditions like diabetes [5]. Hence, developing evidence-based interventions that can assist with the modification of diet and lifestyle behaviors related to diabetes has become a growing priority.

Diabetes education is important in empowering the patients to self-manage their disease and it is recommended for all patients with T2DM in Malaysia [6]. There is an urgent need to improve overall diabetes self-management education especially in areas of dietary and lifestyle behaviors, and diabetes complications [7]. However, very few studies with an exclusive focus on dietary self-management among people with T2DM have been reported [8, 9]. The traditional health system in Malaysia may not best address behavioural changes critical to NCD management [10]. Hence we need to look at other strategies to more effectively target health behaviours and in particular dietary change. In addition, the current hospital-based dietary counseling model is unable to cater for the

growing number of diabetic patients. This has led to the need to explore the use of communication technology such as the Internet to assist the current diabetes management system.

While other internet-based interventions on health behavior change in people with diabetes have been reported, most are based in developed countries [11] and none has yet emphasized diet. The current study is, therefore, unique in considering the culturally and ethnically diverse background of the Malaysian population and tailoring the content of dietary change based on individual motivation readiness. This paper describes the development of a web-based dietary intervention program for people with T2DM (*my*DIDeA), its implementation in a group of urban patients, and an evaluation of its acceptability and feasibility.

METHODS

A detailed description of the study design has been published elsewhere [12]. In brief, this was a behavioral intervention aimed at patients with T2DM undergoing follow-up treatment at the outpatient medical clinics of three public hospitals in Klang Valley, Malaysia. Klang Valley refers to Kuala Lumpur, the capital of Malaysia and the surrounding sub-urban; the core of Malaysia's industry and commerce.

The one-year RCT was designed according to the recommendations of the CONSORT statement for randomized trials of non-pharmacologic treatment [13]. Ethical clearance was obtained from the Malaysian Ethics Research (NMRR-09-303-3416) and the University's Human Research Ethics Committee (CF09/1583 – 2009000877) to conduct the trial. The eligibility screening, recruitment of study participants and data collections were conducted in the outpatient medical clinic of the hospitals. If a potential patient was identified by the diabetes nurse, he/she was screened according to the eligibility criteria and recruited with written informed consent. The intervention was delivered via a personalized website that was developed for a randomized-controlled trial (RCT), *my*DIDeA.

Development of the intervention program

We reviewed the literature [14, 15] and existing dietary guidelines for patients with T2DM [6, 16-18] to determine the important dietary factors to be addressed in the management of T2DM. The selected guidelines were then translated into more defined lesson plans with specific objectives. The research panel comprising a nutritionist, a behavioral psychologist, a public health specialist, an endocrinologist and an epidemiologist reviewed these guidelines to identify suitable content for the intervention. The content was studied for its relevance to the local community and tailored to suit the local context. We developed a set of general recommendations and constructed two to three intervention objectives for each lesson plan.

The Transtheoretical Model (TTM)'s Stages of Change (SOC) [19] was found to be the most suitable behavioral model for tailoring the web intervention materials. Twelve dietary lesson plans in the intervention package were personalized according to the patients' Dietary Stages of Change (DSOC) and were expected to improve their Dietary Knowledge, Attitude and Behavior (DKAB) and to assist them to progress in their respective DSOC. The improvement in DKAB and progress in DSOC were expected to be reflected in the patients' dietary practices. Changes in anthropometric measurements and biomarkers were considered as indicators of adopting healthy dietary practices.

Lesson plans were developed and translated to the local language, *Bahasa Malaysia* and back-translated to English by a qualified translator. Care was taken at this stage to ensure that the lesson plans were developed in a manner that was as non-technical as possible. A sample lesson plan (carbohydrate intake) was pilot-tested in a group of patients with T2DM (n=30) to assess the acceptability and user-friendliness of the intervention.

The prototype design process

The website was developed using the user-centered web design approach [20, 21], taking into consideration the usability, level of knowledge and demography of the patients. A paper prototype was first created using the input from the expert research panel, after which a mock prototype website was designed and alpha testing was conducted by the webmaster. In this stage, the idea on

web usage details such as fonts, colors, use of graphics and navigation bars were conceived. Technical issues such as bandwidth, latency and document-caching capabilities were also taken into account. The website was made compatible with Web 2.0.

A pilot (beta) test was then conducted to assess the acceptability and user-friendliness of the intervention structure and web design. For this purpose, the web design expert developed a prototype website consisting of a standard homepage, two sample lesson plans (carbohydrate intake, and fruit & vegetable intake), factsheets on diabetes and the patient's personal profile. A group of patients with T2DM (n=30) was requested to go through the factsheets and personal profile, and answer the stage of dietary change questions to be directed to the corresponding recommendation page. The patients were then requested to provide their feedback on the user-friendliness of the website in terms of navigation, loading time, overall outlook and layout, font size, color combinations and language used. Changes were made according to the feedback received.

The intervention website

The final website consisted of 9 sections that resulted in 70 unique web pages. The website was updated throughout the 6-month intervention program. The layout and navigation was kept simple, with hyperlinks to new pages made to open in a new window. The snapshots of the website are available as appendices.

The landing page provided a general overview of the website and invited the participants to login to the website. Photographs depicting a healthy diet and lifestyle were shown in intervals. Access to the web content was made secured and only participants from the intervention group could access the website using unique username and password assigned to them. Participants were asked not to share their username and password with anyone. The contact e-mail address of the first author was provided at the landing page to which participants could send their queries and for password resets (if necessary).

Upon logging-in, participants were greeted with their first name and taken to a standard homepage, which had the details of the study, available information and instructions on how to navigate the site. “My Profile” was a feature that provides the participants with their data on primary and secondary outcomes taken at baseline. The data were updated at post intervention and post follow-up to illustrate the changes in the outcomes. The side bar contained various static factsheets and information on diabetes, as well as links to existing diabetes resources.

Program implementation

The dietary module was arranged and uploaded according to the lesson plans. The lesson plans were based on stage-tailored recommendations aimed to address any barriers and motivate the participants to change accordingly. Twelve lesson plans were made available to the patients one after another over the intervention period, with updates every fortnight.

Each lesson plan was made available in simple understandable form in *Bahasa Malaysia* and English. The program was tailored according to each participant’s SOC [22]. Upon entry to a website, they were given a set of five previously validated SOC questions for each lesson plan. The score was automatically calculated based on the algorithm and patients were directed to a recommendation page that corresponds to the score.

Relevant photographs and illustrations were added to enhance the understanding of the lesson plans. The responses were automatically sent to the server, converted and stored in the form of a Microsoft Excel spreadsheet and only the researchers and webmaster had access to it. Login reminders were sent via e-mail each time *my*DIDeA is updated with new lesson plans. The participants were also encouraged to send their queries to the study nutritionist via the website.

Measures

Process evaluation was conducted to determine the feasibility and acceptability of the program among the intervention patients. The program reception was recorded in a self-administered

questionnaire at post-intervention, assessing the participants' content satisfaction, acceptability of the intervention and usability of the website (Table 1). The content satisfaction explored three factors (performance expectancy, effort expectancy and patient-centered factors) that were associated with the participants' fulfillment of using the website. Four factors were used to determine the acceptability of the website: attitude towards technology, anxiety, self-efficacy and behavioral intention. The usability of the website was measured based on facilitating conditions and user-friendliness. The responses were recorded using a Likert scale with score ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).. Responses were scored in an inverse order for negative statements. Scores for each domain ranged from 5 to 20 as indicated in Table 1. Adherence to the intervention was assessed by the number of logins and duration spent in minutes on the website.

Data on diabetes-related DKAB were collected using Dietary Knowledge, Attitude and Behavior Questionnaire (DKAB-Q) [22], while data on fasting blood glucose (FBG) and glycosylated hemoglobin (HbA1c) were obtained from the participants' medical record. The socio-demographic characteristics (age, gender, ethnicity, education level, occupation, personal income) and diabetes status (disease duration, type of treatment) of the participants were recorded in the study questionnaire.

Analyses

The study sample, intervention adherence and program reception were described using descriptive statistics (frequency, mean and percentage). The continuous data were checked for normality. Independent *t*-test was used to determine the mean differences of process evaluation measures. Partial correlations and multiple linear regressions were performed to determine the associations between process evaluation measures and outcomes. All statistical analyses were performed with IBM® SPSS® Statistics 20.0, with p =.05.

RESULTS

Study participants

Fifty nine participants in the intervention group responded to the process evaluation (response rate = 89%). The average age of the participants was 49 years old with majority of them from the Malay community (88%), had tertiary education (61%) and currently employed (61%). The average diabetes duration was slightly more than 8 years and mean income of the respondents were MYR4,628 (SD=2,534). Majority of the participants were in drug therapy (49%), followed by a combination of drug and insulin therapy (34%).

Evaluation of feasibility and acceptability of *my*DIDeA

The study website was evaluated in terms of intervention adherence and program reception (Table 2). The acceptability of the program scored lowest at 62%, while usability was scored the highest (72%). On average, the participant logged-in at least once and spent almost 12 minutes on a lesson plan. There were no differences in evaluation measures between gender, age, ethnicity, education status and occupation. However, we observed a decrease in the login frequency and minutes spent at the website as time progressed (Figure 1).

Association between process evaluation measures and study outcomes

High correlations were seen between the program reception measures (*r's* ranging from 0.755 to 0.802), and within the intervention adherence measures (r=0.610, $p<0.05$) (Table 3). Program reception measures were moderately correlated with the intervention adherence measures. We found strong positive correlations between the change in DKAB score (pre – post score) with content satisfaction (r=0.826, $p<0.001$), acceptability (r=0.793, $p<0.001$) and usability (r=0.724, $p<0.001$) of the website, and moderate positive correlation with frequency of log-in (r=0.501, $p<0.05$) and duration spent in the website (r=0.399, $p<0.05$). The change in FBG showed moderate inverse correlations only with acceptability (r=-0.343, $p<0.05$) and usability (r=-0.365, $p<0.05$), while the

change in HbA1c showed moderate inverse correlations with all program reception measures (*r* ranging from -0.343 to -0.516) and duration spent in the website (*r*=-0.393, p<0.05).

We conducted multiple linear regression analyses to explore the relationship between the primary outcome of the trial, DKAB score and the process evaluation measures (Table 4). Content satisfaction, acceptability and frequency of logins significantly predicted the change in DKAB score. The program reception measures explained 78.2% variance while the intervention adherence measures explained 35.5% variance in the changes in DKAB score.

DISCUSSION

On average, each participant logged in the website once per module and spent about 12 minutes surfing the content. However, the login frequency and the time spent per visit declined over time. The program reception measures strongly supported the utility of the *my*DIDeA to improve users' DKAB score, but had only moderate correlation with glycemic control of the participants. Intervention adherence measures (duration spent at the website and frequency of log-in) were moderately correlated with the study outcomes. The content satisfaction was the best predictor, explaining 68% variance in DKAB score. We postulated this due to the nature of the intervention program itself, which was focused on improving dietary behavior of the participants.

We used the SOC model to assist the translation of existing empirical evidence and guidelines to user-friendly and personalized dietary lesson plans. The Internet has made it more convenient to implement the intervention tailored to the patients' SOC. While the use of the Internet to educate patients is a relatively new area of clinical and research interest in Malaysia, there is a lot of possibilities for such an education program to be incorporated into the existing healthcare system. A previously published web-based intervention has shown positive effects on patient empowerment [24]. The use of web-based interventions compared to non-web-based interventions has demonstrated improvement in achieving the specified knowledge and/or behavior change for the studied outcome variables, which included an increase in nutritional knowledge and diabetes control.

It is important to note that the current sample of patients might have come from a higher social-economic position and hence they are likely to be more competent in using the computer and accessing information from the website. Conducting similar e-health interventions with less computer literate populations may require training to bridge the communication inequalities before actually implementing such intervention [25].

Published articles on the process evaluation of web-based interventions are scant. An example of similar process evaluation has been conducted for the Australian Physical Activity Network (AusPAnet) [26]. The process evaluation of the communication web portal was conducted by monitoring the e-mails and by evaluating self-reported perception, satisfaction and usefulness of the web portal. Over time, the portal experienced attrition and this could be captured by the evaluation.

There were other process evaluations performed on dietary and lifestyle web-intervention, though it was not confined to people with T2DM [27, 28]. Process evaluation of a healthy eating website promoting the Mediterranean diet also used the same measures of adherence and program evaluation, but added another feature of focus group interview to obtain qualitative feedback on the program [27]. Similar focus group discussion was used by Steele et al. [28] besides the evaluation of satisfaction and usability of a physical activity website. Although the process evaluation data on web-delivered interventions are limited, the available evidence supported the process evaluation and program reception measures that were taken in this study.

In *my*DIDeA, we found the login frequency and duration spent per visit declined over time and this is probably the greatest barrier to the overall success of a web-based intervention program. This is understandable as the participants were inclined to read only the lesson plans as they progressed through the 6-month intervention, as other pages were static. A similar decline in frequency of login and the average time spent on the website per visit has been shown in a previous web-based intervention [29]. Nevertheless, we could not conclude that the website was inefficient due to the decrease in login frequency, as participants could always login after sometime and obtained all the previous lesson plans that they have missed.

The success of an Internet-based intervention relies heavily on the login rates, usability, and personalization [11]. The process evaluation of the intervention program was able to capture the details of web usage and program satisfaction. High rating of the usability of the website and satisfactory rating of content satisfaction and acceptability supported the use of *my*DIDeA in disseminating dietary information and encouraging the dietary behavior changes.

Future web interventions should record more detailed statistics providing information on the website sections visited, pages saved and printed that will be helpful in determining the website usage pattern. Regular reinforcement by using the e-mail as a reminder service to encourage the subjects to log-on to a nutrition education website has been successful in increasing the login rates. Content development in the local language may improve the usability of the Internet among the locals who might be seeking health information.

Strengths and limitations

The participants were recruited from urban tertiary hospitals in Malaysia. While the patients were predominantly urban, the study population also consisted of those residing away from the city as the recruitment hospitals were major referral centers. Involvement of clinicians and attending nurses in the recruitment process was a helpful method to reach out to the patients of various backgrounds.

The program was based extensively on adapting existing guidelines and recommendations, with priority given to local evidence. Adaptation was based on our observation of local patients' need in public hospital setting and suitability for a web-based education program.

Another major strength of this study is that the material and method delivery can potentially be scaled up for broader uptake in the population. This is because the intervention package can be disseminated through CD-ROM and smart phone-delivered interventions. The culturally adapted content in the website can also be useful for similar interventions in the South-east Asian regions. Future research should explore the possibility of adopting and investigating the feasibility of the intervention package being delivered in different intervention mediums and target populations.

Future studies should also look at enhancing the website by making it more interactive with a platform for the participants to discuss their obstacles and success stories, share ideas and motivate each other in following the dietary advice. This could also stimulate the participants' interest to login more frequently and stay longer in the website.

The follow-up to the 6-months intervention has only been conducted once at the 12^{th} month. However, longer term impact, maintenance and sustainability of such a program are important and we plan to address this in a follow-up 'real world' implementation trial.

The study participants were representation of the current distribution of ethnic groups in Malaysian public hospitals. Despite restricting the study to those with Internet access, we did not come across difficulties during recruitment process. Government's initiative of introducing free WIFI in certain parts of the country including rural areas alongside the rising popularity of high speed-broadband and web-enabled smart phones are expected to result in an Internet boom within next few years. Hence, we can postulate the study findings to be generalizable to a larger segment of Malaysian population soon.

In the long run, the findings are expected to assist the promotion of a healthy diet and lifestyle to high-risk groups as well as the Malaysian public in line with technological development. Moreover, the output from this study may serve as a recommendation to the Ministry of Health and other related NGOs on effective dietary intervention strategies for the management of T2DM and its complications.

The program can be first implemented in urbanized setting, where newer hospitals and health facilities have gone paperless and all patients' related data are already available in the existing system. The intervention can be linked to the hospital system for the benefit of patients and for ease of monitoring from the healthcare provider's point of view. As diabetes is multifactorial and requires care from a multidisciplinary team, the intervention can be expanded to include components from other healthcare professionals to provide complete and best follow-up care to the patients. As implementation of this intervention in hospital setting would require the integration or adaptation of

behavior change communication in the existing system, this new approach may require some level of training and cognitive change from health professionals. There will be some cost involved to set-up the program but the longer term benefit of keeping diabetic patients in check will be an encouraging factor for MOH to consider.

Lack of manpower will be a major challenge for any interactive intervention programs such as *my*DIDeA to be implemented in Malaysian hospital setting. Staff members who handle the intervention program would require training both prior to the commencement of the intervention and on an on-going basis. Building capabilities of existing staff members would mean adding an extra task on these already overworked healthcare professionals for them to be trained and updated. The professionals will also need to allocate dedicated time to answer queries online and to monitor the progress of the patients, and this could be a huge task when dealing with hundreds of thousands of patients out there. A checklist may be a simpler way to monitor patients and an automated query response maybe able to cope with the queries. In addition, a dedicated HelpDesk can be stationed at MOH or at each hospital for staffs to have quick check on the program whenever required or as problem arises. All these imply a gradual healthcare reform is needed for the new intervention strategies to be implemented.

A nationwide implementation would require the intervention to be adapted to different languages and this can be tricky in a multicultural society like Malaysia. While Bahasa Malaysia is widely used, some patients may be more well-versed in English or their own mother tongue eg Mandarin, Tamil and others. Hence, precise translation of the intervention program to other languages is required and this can add another layer of complication when we want to expand the intervention to include medical practitioners, pharmacists and nurses. Another method to enhance understanding will be through improvement of the program with pre-recorded audio and videos that could enhance the acceptability of the program and patients' understanding than just text and illustrations alone.

As implementation of this intervention in a real world setting may face greater challenges in the form of capacity building. Involvement of various government (e.g., policy-makers) and non-government (e.g., communities) sectors in the program planning is vital.

CONCLUSION

Malaysia is a rapidly developing middle-income country in face of alarming rise of non-communicable diseases (NCD). Unfortunately, the current one-off counseling session offered in most public hospital setting is not sufficient to address issues faced by people with NCDs such as diabetes as it requires life-long dietary and lifestyle changes. The study describes the development, implementation and evaluation of a tailored website to deliver a dietary education program for people with T2DM in a multiethnic country to complement the existing dietary and lifestyle counseling method. While process evaluation supported the use of web-based dietary intervention in this group, the limitations and issues identified during process evaluation should be addressed before such program is marketed to a larger population. Future studies can be designed to be implemented in the real world setting, experimenting different modes of program delivery and making a comparison in terms of cost effectiveness of various modes of interventions.

ACKNOWLEDGEMENTS

The author (AR) of this publication was supported by the ASCEND Program (www.med.monash.edu.au/ascend) funded by the Fogarty International Centre, National Institutes of Health, under Award Number: D43TW008332. The contents of this publication is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the ASCEND Program. The authors would also like to thank the Director of Health Malaysia for permission to publish this paper.

FUNDING

This study was supported by Seed Grant (MED2009-CM(SG)-004-QKF) funded by Monash University Malaysia.

CONFLICT OF INTEREST

The authors- Amutha Ramadas, Quek Kia Fatt, Brian Oldenburg, Zanariah Hussein and Carina Ka Yee Chan declare that they have no conflict of interest.

HUMAN RIGHTS STATEMENT

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 and 2008.

REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas, 6th edn. Brussels, Belgium: International Diabetes Federation, 2013.
2. Ismail N. The nutrition and health transition in Malaysia. Public Health Nutrition. 2002;5(1A):191-5.
3. NHMS IV. The Future of Diabetes in Malaysia. Keynote address. . Malaysian Diabetes Educators Society Seminar2012.
4. NHMS III. The Third National Health and Morbidity Survey (NHMS III) 2006. Kuala Lumpur: Institute for Public Health, 2008.
5. Oldenburg B, Absetz P, Chan CKY. Behavioral interventions for prevention and management of chronic disease. . In: Steptoe K, Freedland JR, Jenning M, Lllabre S, Manuck, Susman E, editors. Handbook of Behavioral Medicine: Methods and Applications. New York: Springer; 2010. p. 969-88.
6. Ministry of Health and Academy of Medicine of Malaysia. Malaysian Clinical Practice Guidelines: Management of Type 2 Diabetes Mellitus (4th Edition) 2009. Available from: http://www.acadmed.org.my/view_file.cfm?fileid=292.
7. Azimah MN, Radzniwan R, Zuhra H, Khairani O. Have we done enough with diabetic education? A pilot study. Mal Fam Physician. 2010;5(1):24 - 30.
8. Swinburn BA, Metcalf PA, Ley SJ. Long-term (5-year) effects of a reduced-fat diet intervention in individuals with glucose intolerance. Diabetes Care. 2001;24(4):619-24.
9. Watanabe M, Yamaoka K, Yokotsuka M, Tango T. Randomized controlled trial of a new dietary education program to prevent type 2 diabetes in a high-risk group of Japanese male workers. Diabetes Care. 2003;26(12):3209-14.
10. Yasin, S., Chan, CKY, Reidpath, D, Allotey, P. Contextualising chronicity: a perspective from Malaysia. Globalization and Health. 2012; 8: 4-9.
11. Ramadas A, Quek KF, Chan CKY, Oldenburg B. Web-based interventions for the management of type 2 diabetes mellitus: A systematic review of recent evidence. Int J Med Inform. 2011;80(6):389-405.

12. Ramadas A, Quek KF, Chan CKY, Oldenburg B, H. Z. Randomised-controlled trial of a web-based dietary intervention for patients with type 2 diabetes mellitus: Study protocol of myDIDeA. BMC Public Health. 2011;11(359).
13. Boutron I, Moher D, Altman DG, Schulz KF, Ravaud P, Group ftC. Extending the CONSORT Statement to randomized trials of nonpharmacologic treatment: explanation and elaboration. Ann Intern Med. 2008;148(4):295-309.
14. Nield L, Moore HJ, Hooper L, Cruickshank JK, Vyas A, Whittaker V, et al. Dietary advice for treatment of type 2 diabetes mellitus in adults. Cochrane Database Syst Rev. 2007;18(3):CD004097.
15. Davi G, Santilli F, Patrono C. Nutraceuticals in diabetes and metabolic syndrome. Cardiovasc Ther. 2010;28(4):216 - 26.
16. National Diabetes Institute. Dietary Management. 2003 [April 7, 2011]; Available from: http://www.nadidiabetes.com.my/nadimgr20da.html?xsection=complications&xdate=20020617&xname=article2.
17. Malaysian Dietitians' Association, Ministry of Health. Malaysian Medical Nutrition Therapy for Type 2 Diabetes. Malaysian Dietitians' Association., 2005.
18. American Diabetes Association. Nutrition recommendations and interventions for diabetes: A position statement of the American Diabetes Association. Diabetes Care. 2008;31(Supplement 1):S61 - 78.
19. Prochaska JO, DiClemente CC. Stages and processes of self-change of smoking: toward an integrative model of change. J Consult Clin Psychol. 1983;51(3):390 - 5.
20. Davis F. Perceived usefulness, perceived ease of use and user acceptance of information technology. MIS Quart. 1989;13(3):319 - 40.
21. Lazar J. User-centered web development. Massachusetts: Jones & Bartlett Publishers; 2001.
22. Kendra C. Stages of Change - How to Keep a Resolution. 2010 [14 April 2010]; Available from: http://psychology.about.com/od/behavioralpsychology/ss/behaviorchange.htm.
23. Ramadas A, Chan CKY, Quek KF, Zanariah H, Oldenburg B. Validation of a knowledge, attitude, and behavior questionnaire for dietary education in Malaysian diabetic patients. International Journal of Behavioral Medicine. 2010;17(Suppl 1).
24. Samoocha D, Snels IA, Bruinvels DJ, Anema JR, Kowalczyk W, van der Beek AJ. Process evaluation of a web-based intervention aimed at empowerment of disability benefit claimants. BMC Med Inform Decis Mak. 2011;11.
25. Wantland JD, Portillo JC, Holzemer LW, Slaughter R, McGhee ME. The effectiveness of Web-based vs. non-Web-based interventions: a meta-analysis of behavioral change outcomes. J Med Internet Res. 2004;6(4):e40.
26. Macniven R OB, Shilton T, Bauman A. The initial development and process evaluation of AusPAnet: the Australian Physical Activity Network. Health Promot J Austr. 2008;19:36 - 9.
27. Papadaki A, Scott JA. Process evaluation of an innovative healthy eating website promoting the Mediterranean diet. Health Educ Res. 2006;21(2):206-18.
28. Steele R, Mummery KW, Dwyer T. Development and process evaluation of an Internet-based physical activity behaviour change program. Patient Educ Couns. 2007;67(1-2):127 - 36.
29. McConnon Á, Kirk SFL, Ransley JK. Process Evaluation of an Internet-based Resource for Weight Control: Use and Views of an Obese Sample. J Nutr Educ Behav. 2009;41(4):261-7.

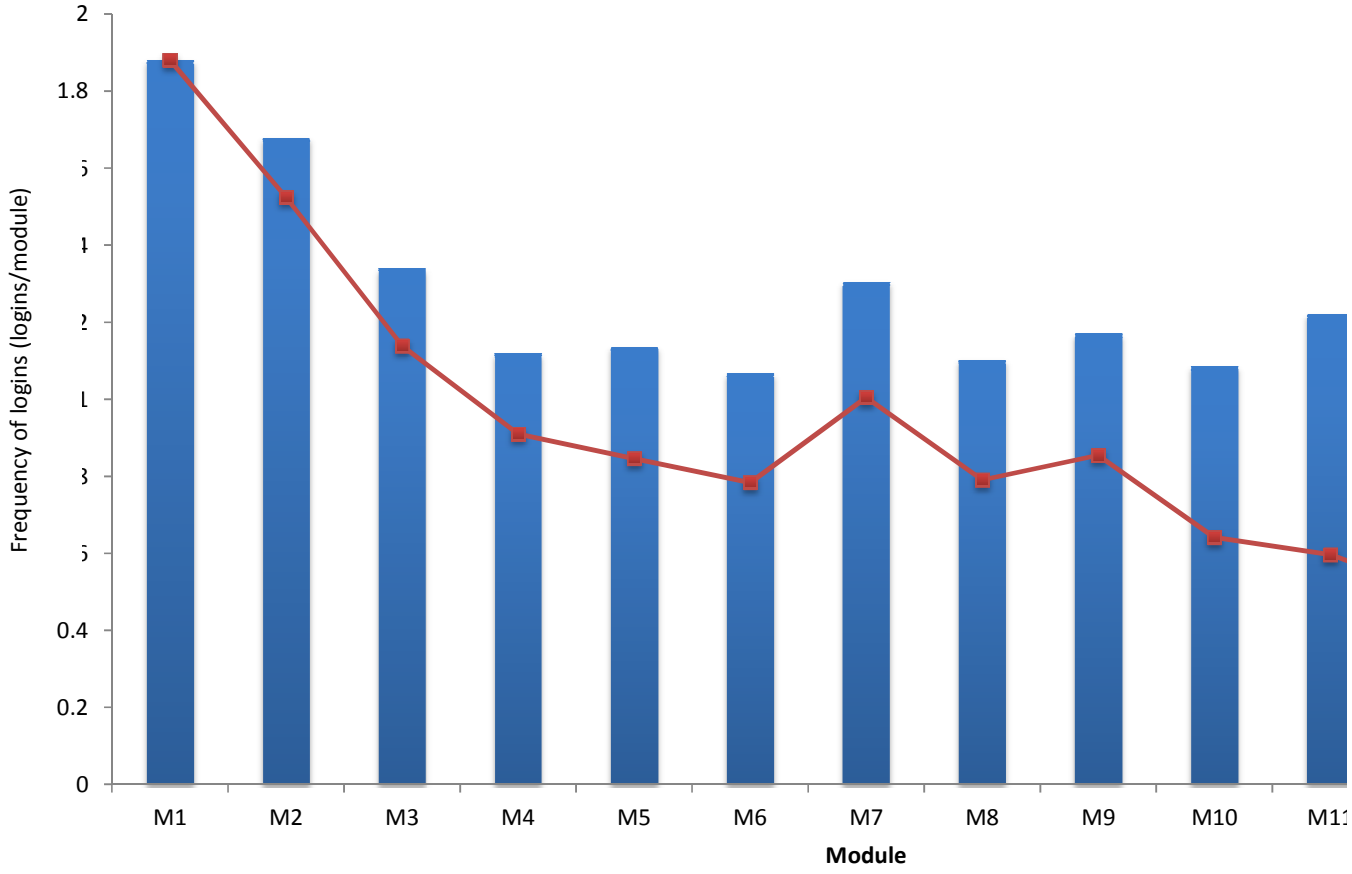

Figure 1: Frequency of logins and duration spent at the website

Table 1: Program reception measures

Program reception	Cronbach's Alpha		Number of items	Maximum score	Sample question
Content satisfaction	0.818	Performance expectancy	4	20	I found *my*DIDeA to be useful in the management of my diet.
		Effort expectancy	4	20	I found answering questions for each lesson plan frustrating.
		Patient centred factors	4	20	I am inspired to do better with my diet and lifestyle management now.
Acceptability	0.809	Attitude towards technology	2	10	*my*DIDeA is a good idea to educate diabetic patients on diet.
		Anxiety	2	10	It scared me to think that I could give the wrong answer to the questions.
		Self-efficacy	1	5	I feel confident using *my*DIDeA.
		Behavioural intention	2	10	I intend to use *my*DIDeA if it becomes publicly available in the future.
Usability	0.834	Facilitating conditions	2	10	The guideline given at the homepage was sufficient for me to use *my*DIDeA.
		User-friendliness	4	20	I was able to find my way around the website.

Table 2: Process evaluation measures of the study website

		Mean(SD)		*p*	Total
		Male (n=30)	Female (n=29)		
Intervention adherence	**Frequency of log-in (times/lesson plan)**	1.27 (0.18)	1.25 (0.14)	0.695	1.26 (0.16)
	Duration spent (mins/lesson plan)	12.11 (2.87)	11.74 (2.96)	0.633	11.93 (2.90)
Program reception	**Content satisfaction (%)**	63.44 (19.28)	64.54 (20.62)	0.834	63.98 (19.78)
	Acceptability (%)	60.19 (16.32)	63.25 (17.64)	0.492	61.69 (16.90)
	Usability (%)	72.67 (24.04)	71.03 (24.95)	0.799	71.86 (24.29)

Table 3: Partial correlation table between process evaluation measures and study outcomes

		Program reception			Intervention adherence		Mean changes in outcomes		
		Content	Acceptability	Usability	Duration spent	Frequency of log-in	DKAB score	FBG	HbA1c
Program reception	**Content satisfaction**	1.000							
	Acceptability	0.755**	1.000						
	Usability	0.789**	0.802**	1.000					
Intervention adherence	**Duration spent**	0.472**	0.375*	0.583**	1.000				
	Frequency of log-in	0.479*	0.318	0.483*	0.610*	1.000			
Mean changes in outcomes	**DKAB score**	0.826**	0.793**	0.724**	0.399*	0.501*	1.000		
	FBG	-0.246	-0.343*	-0.365*	-0.116	-0.078	-0.140	1.000	
	HbA1c	-0.343*	-0.414**	-0.516*	-0.393*	-0.058	-0.261	0.594**	1.000

Note: adjusted for age, gender, ethnicity, personal income and duration since diagnosis; *significant at p<0.05; ** significant at p<0.001

Table 4: Multiple linear regression analyses between process evaluation measures and changes in DKAB score

		Beta	t	p	95% CI
Program reception	**Content satisfaction**	0.380	3.555	0.001*	0.162 – 0.599
	Acceptability	0.559	2.653	0.013*	0.129 – 0.990
	Usability	-0.079	-0.409	0.685	-0.472 – 0.315
	*Adjusted R^2 =0.724 , R^2 =0.782 , F = 13.433, p <0.001***				
Intervention adherence	**Duration spent**	0.408	0.764	0.450	-0.680 – 1.496
	Frequency of log-in	19.257	2.114	0.043*	0.683 – 37.830
	*Adjusted R^2 =0.210 , R^2 =0.355 , F = 2.442, p =0.041**				

Note: adjusted for age, gender, ethnicity, personal income and duration since diagnosis; *significant at p<0.05; ** significant at p<0.001

Author/s:
Ramadas, A; Chan, CKY; Oldenburg, B; Hussien, Z; Quek, KF

Title:
A Web-Based Dietary Intervention for People with Type 2 Diabetes: Development, Implementation, and Evaluation

Date:
2015-06-01

Citation:
Ramadas, A., Chan, C. K. Y., Oldenburg, B., Hussien, Z. & Quek, K. F. (2015). A Web-Based Dietary Intervention for People with Type 2 Diabetes: Development, Implementation, and Evaluation. INTERNATIONAL JOURNAL OF BEHAVIORAL MEDICINE, 22 (3), pp.365-373. https://doi.org/10.1007/s12529-014-9445-z.