

ORIGINAL ARTICLE

“CANDI™”: A MALAYSIAN-TAILORED DIETARY SMARTPHONE APP FOR CANCER PATIENTS AND SURVIVORSNoor Salihah¹, *Pei Lin Lua², Aryati Ahmad² & Mohd. Razif Shahril²¹ School of Food Science and Technology, Universiti Malaysia Terengganu (UMT), Kuala Nerus 21030 Terengganu, Malaysia.² Faculty of Health Sciences, Universiti Sultan Zainal Abidin (UniSZA), Kuala Nerus, 21300 Terengganu, Malaysia.*Corresponding author: peilinlua@unisza.edu.my / peilinlua@hotmail.com**ABSTRACT**

Despite being effective in promoting healthy dietary behaviour, smartphone apps are scarcely available for our local communities and the majority of nutritional-related information is based on western food selections. Our new innovation aims to provide specific educational advice about recommended food intake, types, nutritional qualities and weight issues for cancer patients and survivors who suffer appetite problems and nutritional deficits. The Cancer Dietary (CanDi™) app was developed as a convenient, flexible and attractively engaging smartphone app containing healthy tips which are uniquely tailored to the local food choices, preferences and ingredients. This helps customise users' dietary needs besides permitting constant information up-dating. Features are broadly categorised into Healthy Eating Guide (advice from healthy eating to eating problems, weight loss prevention and increasing proteins and calories intake) and Malaysian Recipes For Cancer Patients (focusing on common Malaysian dishes, ingredients, treatment-based recipes and special diets). An additional Symptom Diary allows user's personal profile to be recorded and stored virtually online. Its feasibility and acceptability were further tested among 30 cancer patients, family caregivers and dieticians recruited from a public hospital in Terengganu, Malaysia. Very good feasibility (> 80%) and excellent acceptability (> 90%) were reported regarding its ease of operation, suitability of language used, attractiveness, knowledge enhancement and perceived usefulness. With this scientific yet creative innovation, routine dietary habits related to cancer conditions could be easily facilitated for both patients/survivors as well as family caregivers for their independent and healthy living.

Keywords: Cancer dietary app, Smartphone app, Malaysian dishes**INTRODUCTION**

Cancer is undeniably one of the most important non-communicable diseases in Malaysia and has contributed to 13.56% of all deaths in the Ministry of Health Hospitals in 2015¹. It was the third most common cause of death following the death caused by diseases of circulatory system (22.77%) and diseases of the respiratory system (18.54%). According to the Malaysian National Cancer Registry Report (MNCR) 2007-2011, a total number of 103,507 new cancer cases were diagnosed in Malaysia during the period of 2007 to 2011, of which 46,794 (45.2%) were reported in males and 56,713 (54.8%) in females¹. The report also stated that the risk of males getting cancer was 1 in 10 and for females was 1 in 9.

The alteration of nutritional status is a common complication observed in cancer patients. The prevalence of nutritional alteration in cancer patients varies between 15% and 80% the localization of the tumour and its extension² depending on several factors such as the malnutrition criteria used and the population studied. Malnutrition is a poor prognostic factor and as such should be prevented, detected and effectively managed, particularly requiring the

involvement of patients in managing and monitoring their health/disease status³. It is therefore crucial for the healthcare provider to encourage and support their patients to self-manage their chronic disease as well as to adopt healthy behaviours. Yet, considering the existing service infrastructures using conventional health education means (i.e. leaflets) the amounts of information, encouragement, and supports that can be conveyed during consultations remain restricted.

Recently, the rapid pace of technological advancement through mobile technologies are making them particularly applicable for providing individual level support to the health intervention delivery due to their popularity, mobility, and technological capabilities⁴. Most of the mobile phones nowadays are addressed as 'smartphone' offering advanced computing power and connectivity hence repositioning them as a "new information medium"⁵. According to data from Hand Phone Users Survey (HPUS) 2014 by the Malaysian Communications And Multimedia Commission (MCMC), one in two Malaysians are statistically smartphone users⁶. Interestingly, half of all smartphone owners use their phones to search for health information, with 60% of all

downloaded health-related apps involving weight loss and exercise⁷. A variety of apps relating to diet, nutrition, and weight control are available from platforms such as iPhone, Android and BlackBerry⁸. To our knowledge, however, no equally identical apps are available for our local communities because the current similar apps in Google PlayStore are found for general cancer-fighting, anti-cancer or cancer prevention foods. Most selections are also non-local and the majority of nutritional-related information is based on western food selections. The aim of this paper is therefore to describe the development and functionality of a new smartphone app, CanDi™ in providing specific nutritional advice for a person with cancer and recommended recipes uniquely tailored to the Malaysian food choices, preferences and ingredients.

METHODOLOGY

Content development

The app was designed by our research team at the Faculty of Health Sciences, Universiti Sultan Zainal Abidin (UniSZA) in Terengganu, Malaysia. The content and format of the app was outlined and consistently reviewed in meetings with the research team consisting of dietitians, nutritionists and behavioural scientists. The app had two key functionality specifications: 1) to record nutritional-related symptoms and food intake (only online virtual storage and functionality) and; 2) to provide nutritional guidelines and healthy Malaysian recipes for cancer patients. To allow for continuous update, the target system was designed to permit upload of recommended recipes by our team. The general principles in cancer food suitability were used for the recipe selection - no red meat, no raw food and no spicy food with less odour and less oil. To maintain appropriate nutritional values, the foods recommended are ideally required to be energy-dense, high protein, not too sweet and also importantly - simple to prepare. In addition to this guide, the recipes chosen are common favourites and represent all regions in Malaysia - North, South, East and West of Peninsular Malaysia as well as East Malaysia, so as to cater for the taste of all strata and ethnicities of the population. The aim was to provide at least 40 different recipes for a start, categorised into breakfast, main dishes, snacks, vegetables and soups nutritionally-suitable for consumption during cancer. For functionality via the *Symptom Diary*, users are initially requested to log in their personal details for customization of their personal records and to prevent duplicate registrations. The time frame for development was approximately four months, with the framework and interface being developed over the first two months (Jan - Feb 2016) and the iterative

development and testing process implemented over the following four months (Mar - Apr 2016).

Technical production

The software and interface development was led by I-Fast Solution Sdn Bhd, Malaysia. The app was initially designed for Android platforms, the most common smartphone platforms in Malaysia⁹. Contents and technical issues were discussed and resolved in regular meetings. The contents were thoroughly vetted by expert dietitians based on the general principles mentioned above, hence ensuring both face and content validity. The finalized product i.e. CanDi™ app was subsequently tested for its feasibility among actual cancer patients, survivors, their family caregivers and also a different group of dietician and nutritional practitioners. This exercise was expected to also function as a needs assessment since the feedbacks would be utilised to further improvise the app so that it will be as informative and as user-friendly as possible.

Feasibility and acceptability testing

Ethical approval

This research has been approved by the Malaysian Ministry of Health Medical Research and Ethics Committee (MREC) with the reference number NMRR-14-1616-23717 (IIR).

Study design and setting

A cross-sectional study was conducted at Hospital Sultanah Nur Zahirah, Kuala Terengganu, Terengganu, Malaysia.

Sampling and sample size

The sample was recruited from the weekly Cancer Clinic and Dietetic Department of Hospital Sultanah Nur Zahirah, Kuala Terengganu, Malaysia. In selecting the respondents, convenience sampling was applied. Samples of 30 respondents were chosen from follow-up cancer patients, family caregivers and dietitians, according to the number postulated for a pilot study which was the nature of our current investigation too¹⁰. The choice of follow-up patients was pertinent to ensure that both patients and their caregivers have had prior experience with dietary changes since being diagnosed with cancer. Since the app also aims to provide a general nutritional guide and advice, patients regardless of cancer type/subtype and treatment types were permitted as respondents - this was also important so that more enriched opinions and perceptions could be gauged from the representative sufferers. The dietitians were recruited from both the hospital and the university - they served as a separate group of experts to validate the feasibility and acceptability of CanDi™, in addition to the content validation conducted by another team during the technical

production phase. Since this app is also intended to be utilized by the dieticians or nutritionists in future, their views are deemed as significant as those of the patients and caregivers - hence their inclusion in the subsequent feasibility and acceptability testing.

Participation was entirely voluntary and the inclusion criteria comprised those who were adults, able to use gadget and comprehend basic English. Although Malay is the local language, our current aim was to run a preliminary test in English to facilitate the app's inclusion in Google Playstore so that wide accessibility can be achieved before the same contents are translated into Malay (next phase). Most non-English-speaking locals could understand English even though they are more comfortable conversing and writing in Malay. Respondents were excluded from the study if they did not own a personal smartphone.

Instruments (a): Personal Information Form

This form consists of several basic details about the respondents' demographic characteristics. Among the demographic characteristics compiled were gender, age, race and occupation.

Instruments (b): Feasibility and Acceptability Questionnaire

The questionnaire used is a 12-item scale that measures the feasibility and acceptability of an app which was adapted from a local study¹¹. It was constructed and therefore administered in two versions: English and Malay to facilitate respondents' preference in the completion process. The score is rated on a 5-point Likert-scale ranging from 1 (strongly disagree) to 5 (strongly agree). The higher the score, the better were the feasibility and acceptability levels. Questions 1 to 4 were meant to assess feasibility of the application while the remaining questions were aimed to evaluate its acceptability, including the ease of operation, suitability of language used, attractiveness, knowledge enhancement and perceived usefulness. The internal consistency reliability as measured by Cronbach's alpha was generally very good (total = 0.821; feasibility = 0.655; acceptability = 0.807).

Data collection method

On the study day, patients and their caregivers were chosen based on the recommendations given by the clinic nurses who were already familiar with them. Potential participants were invited by the research assistant into a private room and briefly explained about CanDi™ app - mainly focusing on its development, special features and key functionality specifications. They were then allowed to explore the application on provided a smartphone for five to ten minutes. Family

caregivers did the same after the patients. Once completed, participants proceeded to complete the *Personal Information Form* and *Feasibility and Acceptability Questionnaire*. Besides that, participants were ensured that their responses would remain confidential and any personal information would not be revealed in any method that could identify them. As for the dieticians, a similar process took place in the hospital as well as in the university's School of Nutrition and Dietetics.

Data analysis

Data were analyzed using the Statistical Package for Social Science (SPSS version 23.0). All socio-demographic data were analysed descriptively and presented as frequencies and percentages. Each item was also analysed descriptively in order to examine the feasibility and acceptability of CanDi™ app among the targeted users. This was carried out by determining the number of respondents who answered in each Likert scale (n) and the corresponding percentage. For the final outcomes, those who chose *Strongly Agree* or *Agree* are collectively considered as agreeing and satisfied with its question. The opposite was true for *Strongly Disagree* or *Disagree* answers.

RESULTS

The results of the development as well as the outcomes of the feasibility and acceptability tests are discussed below.

Functionality overview

A sample of CanDi™ app website screenshot is presented in Figure 1 - the "Download App" button was temporarily placed while it is currently in the process of being included in Google Play (android-based). The copyright application has recently been filled. The four main functionality components of CanDi™ app consist of the Diary, Cancer Diet (CA Diet), Recipes and Frequently-Asked Questions (FAQs). In the Diary section, patients are given the opportunity to record their daily food intake in the last 3-7 days and any nutritional-related symptoms during or after cancer treatment. This allows patients to monitor and exercise control over their regular food consumption and disease progress. The CA Diet section is one of the major anchors of CanDi™ since it functions to provide a comprehensive guideline for healthy eating, managing eating problems, preventing weight loss as well as increasing calories and protein among patients and survivors. Further advantages of CanDi™ are enhanced through the Recipes section whereby pictorial food choices are provided together with its nutritional benefits and ingredients for cooking. Recommended recipes which are treatment-

related are also useful alongside special diets such as neutropenic and low fat diets. Altogether, the app was expected to improve nutritional status of

cancer patients provided they adhere to the suggested recommendations, albeit indirectly. Further details are summarized in Table 1.

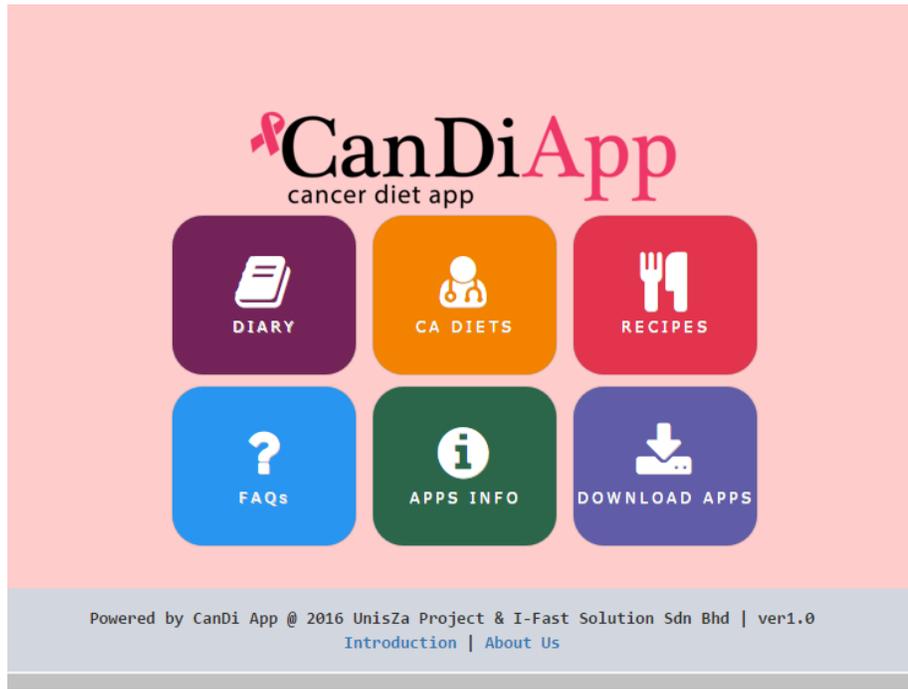


Figure 1: Screenshot of CanDi™ App from the website (inclusion into Google Playstore is in process - hence the “Download Apps” button)

Feasibility and acceptability

Altogether, 30 respondents were recruited from the three categories of intended respondents - 10 cancer patients (majority were on chemotherapy), 10 family caregivers and 10 dietitians. Of this number, 86.7% were female and 13.3% were male. The mean age of the respondents was 35.1 years (± 13.0) ranging from 20 to 58 years old. Majority were employed (53.3%) in various sectors.

An overwhelming majority of the respondents definitely agreed with its ease of operation (96.7%), language used (83.4%), colour attraction (93.4%) and the features (96.7%) of CanDi™ app. In terms of acceptability, all respondents opined that CanDi™ app would help them to increase their knowledge in nutrition and they would recommend it to other people (96.7%). Other than that, most respondents believed that CanDi™ app could improve nutritional status of cancer patients (96.7%) and could attract users' attention (100%). All the respondents contended that they liked CanDi™ and thought that it was a good app. Ninety percent expressed that they were hoping to own this application in the future. Table 2 illustrates the responses regarding the feasibility and acceptability of CanDi™ app.

DISCUSSION

CanDi™ represents a novel smartphone app designed to provide specific educational advice about recommended food intake, types, nutritional qualities and weight issues for cancer patients. To our knowledge, this would be the first research-tested smartphone-based app that provides nutritional advice and local recipes to assist patients in adopting and maintaining healthy nutrition following cancer diagnosis. The CanDi™ app also enables participants to actively record their food intake. This is of particular importance for patients to keep track their food intake as well as for healthcare providers to explore and have better understanding on patients' dietary behaviour after cancer diagnosis. This app would fill a gap in the current array of health education materials based on culturally appropriate, low-cost interventions that can help Malaysian cancer patients maximize their health and quality of life. The application of new technologies using app to provide nutritional advice could empower patients to take control of their own health and routine living. Its attractive features and convenience of usage (in one's own time and recall is repeatable) are highly engaging, hence information retention becomes more effective and practical.

Table 1: The main functionality components of CanDi™ app.

Component	Description
Diary	Two sections are included: .Food record - users are allowed to record their daily food intake within 3-7 days period .Symptom diary - users are allowed to rate the intensity of the nutritional-related symptoms that they may experience during or after cancer treatment.
Cancer diet (CA Diet)	Information in this section focuses on healthy eating guide for cancer patients and survivors based on the Malaysian Medical Nutrition Therapy (MNT) ¹² and Cancer Guidelines and American Cancer Society (ASC) ¹³ . These nutrition guidelines represent guidance related to: l.Practising healthy diet l.Managing eating problems l.Preventing weight loss l.Increasing calories and protein
Recipes	For this early stage of development, approximately 40 common local recipes were selected based on different regions in Malaysia - North, South, West and East regions of Peninsular Malaysia plus the East Malaysia states of Sabah and Sarawak. These include mixtures of Malay, Chinese, and Indian style of cooking. Several recipes were also modified in order to address and cater for cancer diet and are being featured in this app for pilot testing. The current number of selections, which are to be expanded during the next phase of the project, are presented according to four themes: l.Dishes: For example, users are given option to select their favourite recipes based on main meals, breakfast, extra dishes, snack and desserts as well as beverages. l.Ingredients: This informational button includes options to view recipes based on the main ingredient that has been used in the recipes such as chicken, meat, fish, grains, fruits and vegetables. l.Treatment-related: A range of recommended recipes that are suitable to be consumed during or after cancer treatment (i.e. chemotherapy and radiotherapy) are demonstrated here. l.Special diets: Users are also given access to the information related to commonly prescribed special diets for cancer patient complimented by suitable recommended recipes based on their selected diet. Special diets include high energy/ calorie diet, low energy/calorie diet, high protein diet, low fat diet, neutropenic diet, high fibre diet and soft/ band diet.
Frequently asked questions (FAQs)	FAQs are listed questions and answers pertaining to a particular topic which are commonly asked by cancer patients ¹³ . Users can jump to their selected topic that they are most interested in, by simply clicking on one of the topic button display. The topic of interest include antioxidants, fat, fibre, food safety, meat, obesity, organic foods, physical activity, soy products, sugar, vegetables and fruits, vegetarian diets, water and other fluids.

Encouragingly as shown in this pre-test, CanDi seemed to possess an overall excellent feasibility by contending that CanDi™ possessed attractive colour features and was easily operated. As a common medium language in many smartphones, the use of English in the app was also highly agreeable . Since ICT is increasingly becoming part of almost everyone’s routine communication tools for basic tasks such as checking emails, browsing the websites and sending text messages¹⁴, prior familiarisation with smartphone apps would have been the main reason for these positive outcomes .

Similarly its acceptance was clearly evident by the positive feedbacks regarding their knowledge in nutrition and nutritional status which could have

stemmed from the information provided via CA Diet and Recipes sections. Additionally, a previous study has also demonstrated that two-thirds of respondents were interested in accessing their own personal health information electronically while 90% placed importance on the ability to track their symptoms or changes in health online¹⁵. Such reports hence indicated the growing needs to develop devices/apps which are conveniently available and affordable to users to which both these functionalities are offered by CanDi™ through the Diary record. Therefore, at this juncture it can be justified that the use of CanDi™ app was considerably feasible and widely acceptable.

Table 2: Feasibility (items 1-4) and acceptability (items 5-12) of CanDi™ app (n = 30)

Statement	Response, n (%)				
	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree
1. CanDi app is easy to operate.	11 (36.7)	18 (60.0)	1 (3.3)	0	0
2. The language used in CanDi app is simple and easy to understand.	11 (36.7)	14 (46.7)	3 (10.0)	2 (6.7)	0
3. The colour scheme of CanDi app is good and attractive.	11 (36.7)	17 (56.7)	2 (6.7)	0	0
4. The features in CanDi app are catchy.	9 (30.0)	20 (66.7)	1 (3.3)	0	0
5. CanDi app will help to increase nutrition knowledge.	17 (56.7)	13 (43.4)	0	0	0
6. CanDi app will help to improve my nutritional status.	11 (36.7)	18 (60.0)	1 (3.3)	0	0
7. CanDi app will be beneficial to me.	12 (40.0)	17 (56.7)	1 (3.3)	0	0
8. CanDi app attracts my attention.	11 (36.7)	19 (63.3)	0	0	0
9. I would like to own CanDi app in the future.	13 (43.3)	14 (46.7)	3 (10.0)	0	0
10. I like CanDi app.	13 (43.3)	17 (56.7)	0	0	0
11. Overall, I think CanDi app is a good application.	13 (43.3)	17 (56.7)	0	0	0
12. I would recommend CanDi app to other patient/people.	15 (50.0)	14 (46.7)	1 (3.3)	0	0

Nonetheless, the usage and design of CanDi™ app may still possess certain limitations. First, this app will only be released in Android operating system, thus inaccessible to users with other operating system. Because of the large range of smartphone devices available on the market, it was not possible to test compatibility with many Android⁶ was chosen so that we could reach the majority of users in Malaysia. Another pertinent issue is the demographic background of the smartphone users who are mostly younger generation⁶ with higher level of literacy and being in an active internet connection zone - factors which may limit its reach to other population groups.

CONCLUSION

Usage of smartphone apps has been a significant advancement in the field of information dissemination backed by a huge demand in the society for recent health care information on debilitating and fatal illnesses like cancer. CanDi™

app is deemed to fill some of these demands especially when nutrition information linked to the effects of living with cancer is not as widely available for the local scenario. It is also expected to not only facilitate nutrition and dietary counseling delivered by experts but also in assisting family caregivers in food preparation for this cohort.

ACKNOWLEDGEMENT

The authors are greatly indebted to the Centre For Research Innovation and Management (CRIM) of UniSA for the overall financial support (including travelling assistance) in this project through Innovation Grant no. R0001-R288. They are also grateful for the professional dietetics advice from Prof. Dr. Noor Aini Mohd Yusoff and technical assistance from I-Fast Solution Sdn Bhd. as well as parties / individuals who had contributed either directly or indirectly to this study.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

REFERENCES

1. Azizah Ab M, Nor Saleha IT, Noor Hashimah A, et al. 2016. Malaysian National Cancer Registry Report 2007-2011: Malaysia Cancer Statistic Data and Figure. National Cancer Institute, Ministry of Health Malaysia: Putrajaya.
2. Nourissat A, Mille D, Delaroche G, et al. Estimation of the risk for nutritional state degradation in patients with cancer: development of a screening tool based on results from a cross-sectional survey. *Ann Oncol* 2007;18 (September):1882-6.
3. MacDonald N, Easson AM, Mazurak VC, et al. Understanding and managing cancer cachexia. *J Am Coll Surg* 2003; 197(1): 143-61.
4. Free C, Phillips G, Galli L, et al. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. *PLoS Med* 2013; 10(1): e1001362.
5. May H, Hearn G. The mobile phone as media. *Int J Cult Stud* 2005; 8 (2): 195-211.
6. Malaysian Communications and Multimedia Commission. Statistical brief number seventeen: handphone users survey 2014. Cyberjaya, Selangor; 2015.
7. Pew Research Center. Health Fact Sheet (Tracking for Health) [Internet]. [cited 2016 Apr 23]. <http://www.pewinternet.org/fact-sheets/health-fact-sheet/>
8. Kasbo A, McLaughlin R. Mobile Health Applications: 2012 Study. [Internet]. 2012 [cited 2016 Apr 24]. <http://www.webcitation.org/6f9adzkcq>
9. Euromonitor International. Mobile phone in Malaysia. 2014.
10. Lancaster G, Dodd S, Williamson PR. Design and analysis of pilot studies: Recommendations for good practice. *Journal of Evaluation in Clinical Practice*; 10(2): 307-312.
11. Umar II, Lua PL. Feasibility And Acceptability Of My Electronic Personal Health Record Monitor (My-ePHRM). *Int J Pharm Pharm Sci* 2015; 7 (12): 1-5.
12. Chien TP, Lian NG, Mohd Firdaus NS, et al. Medical nutrition therapy guidelines for cancer in adults. Kuala Lumpur: *Ministry of Health Malaysia*; 2012: 1-71 p.
13. American Cancer Society. Nutrition for the person with cancer during treatment: A guide for patients and families. 2014.
14. Kittleson MJ. The future of technology in health education: challenging the traditional delivery dogma. *American Journal of Health Education* 2009: 40(6). http://opensiuc.lib.siu.edu/phe_pubs/1.
15. Markle Foundation. The personal health working group final report. www.providersedge.com/ehdocs/ehr_articles/The_Personal_Health_Working_Group_Final_Report.pdf 2003 (accessed May 2015).