

Original Research



Exploring dietitians' views on digital nutrition educational tools in Malaysia: a qualitative study

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ABSTRACT

BACKGROUND/OBJECTIVES: Dietitians frequently use nutrition education tools to facilitate dietary counselling sessions. Nevertheless, these tools may require adaptation to keep pace with technological advancements. This study had a 2-fold purpose: first, to identify the types of nutrition education tools currently in use, identify their limitations, and explore dietitians' perspectives on the importance of these tools; second, to investigate the features that dietitians prefer in digital nutrition education tools.

SUBJECTS/METHODS: A semi-structured face-to-face interview was conducted among 15 dietitians from selected public hospitals, primary care clinics, and teaching hospitals in Malaysia. Inductive thematic analysis of the responses was conducted using NVivo version 12 software.

RESULTS: Most dietitians used physical education tools including the healthy plate model, pamphlets, food models, and flip charts. These tools were perceived as important as they facilitate the nutrition assessment process, deliver nutrition intervention, and are time efficient. However, dietitians described the current educational tools as impersonal, outdated, limited in availability due to financial constraints, unhandy, and difficult to visualise. Alternatively, they strongly favoured digital education tools that provided instant feedback, utilised an automated system, included a local food database, were user-friendly, developed by experts in the field, and seamlessly integrated into the healthcare system.

CONCLUSION: Presently, although dietitians have a preference for digital educational tools, they heavily rely on physical nutrition education tools due to their availability despite the perception that these tools are outdated, impersonal, and inconvenient. Transitioning to digital dietary education tools could potentially address these issues.

Keywords: Digital health; mobile applications; information technology; diet; dietitians

INTRODUCTION

Dietary education is a component of the “Nutrition Care Process,” an integral standard process in dietetic services [1]. Effective dietary education reduces the risk of diseases by making nutrition knowledge accessible and practical in everyday situations [2]. Utilising

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Conflict of Interest

The authors declare no potential conflicts of interests.

Author Contributions

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educational tools for nutrition instruction during counselling, particularly with patients who receive individualised counselling, has been demonstrated to improve adherence to dietary recommendations [3-5]. In addition, it also helps patients understand dietary advice better [6-8]. Having adequate nutrition knowledge and understanding are necessary components for preventing and managing non-communicable diseases that are linked to unhealthy diets, such as obesity [9].

The effectiveness of nutritional counselling depends on various factors, such as offering personalised dietary advice, receiving feedback and support from dietitians and using educational tools during counselling sessions [10]. Nonetheless, a local study indicated that healthcare professionals were facing obstacles in providing effective dietary education due to unappealing and unlocalised pamphlets, and limited nutrition education materials at the primary healthcare clinic [11]. To accommodate the literacy level of the target population, nutrition education tools need to be adjusted accordingly. A study that employed a visual educational tool among individuals with lower literacy individuals demonstrated that they could formulate healthier eating plans with a higher Healthy Eating Index compared to another group taught using a standard system [12].

It has been reported that the public frequently misinterprets specific terms found in nutritional guidelines, such as “serving size” [13]. Consequently, it is important to provide educational tools that can help patients accurately estimate food portions [14,15]. Traditionally, dietitians have used physical-based nutrition education tools during counselling sessions, such as pamphlets, flip charts, healthy plate models, food pyramids, food models, and meal planning sheets. However, these tools may lose their effectiveness as technology advances. Dietitians who fail to embrace or understand the digital dietary landscape are at risk of falling behind [16]. There is a lack of local research on how dietitians utilise nutrition educational tools in their practice. Therefore, this study aimed to investigate the existing types and limitations of the nutrition education tools that are being used and to seek dietitians’ perspectives on digital nutrition educational tools. Data from this study can be utilised to create nutrition educational tools that accommodate dietitians’ preferences and patients’ needs.

SUBJECTS AND METHODS

Study design and population

Fifteen dietitians were recruited using a convenience sampling method from selected healthcare facilities in central Malaysia, i.e., the Klang Valley, including 7 public hospitals, 5 teaching hospitals, and 3 primary care clinics. In this study, “health clinics” refer to government facilities that provide fundamental healthcare services such as preventive care and treatment for common illnesses. “Public hospitals” are tertiary hospitals with specialised medical facilities managed by the government. Finally, “university hospitals” are institutions affiliated with universities or medical schools that provide medical care to patients while also serving as training grounds for healthcare professionals.

The subjects were invited to participate in this study through social media such as WhatsApp Messenger and email. Klang Valley is the most populated city in Malaysia with the greatest number of public hospitals and experienced servicing dietitians [17]. Only dietitians with a minimum of 5 years of experience in both outpatient and inpatient settings were eligible for

the study. Those who worked in the food service department were excluded as they usually do not provide dietary counselling to patients.

A research dietitian with initial training in qualitative study methods used semi-structured face-to-face interviews to conduct this qualitative study. The study was conducted following the ethical standards of the Medical Research Ethics Committee of Universiti Kebangsaan Malaysia (reference code: UKM PPI/111/8/JEP-2020-219). All participants were briefed on the purpose and procedures of the study, and they signed a written informed consent form before participating in this study.

The Interviews

To gain a comprehensive understanding of the subject matter, this study utilised a qualitative approach that allowed for an in-depth analysis of the interviewees' responses [18]. The interview guide was developed using research questions and The Design and Development Research Model [19]. A pilot study was conducted among 5 dietitians to pre-test the questions, leading to necessary amendments before the actual interviews. The participants of this study were dietitians from 5 selected public hospitals and primary care clinics in the Klang Valley, all of whom met the study criteria. The participants were asked 4 key questions: (i) the nutrition education tools they used during dietary counselling sessions, (ii) the importance of using nutrition education tools during dietary counselling sessions, (iii) the limitations of existing educational tools, and (iv) their preferences for nutrition education tools during dietary counselling. Individual interviews were carried out at the participants' workplaces between January and February 2020, using a Xiaomi Redmi Note 4 mobile phone to record the sessions. On average, each interview session lasted 30 min. The interview questions are listed below:

1. What nutrition education tool do you currently use in your dietary counselling?
2. In your opinion, what is the importance of using nutrition education tools during dietary counselling?
3. Are there any limitations in the current nutrition education tools you use?
4. What is your preference for nutrition education tools to be used during dietary counselling?

Data coding and analysis

The interview data was transcribed verbatim and input into the NVIVO 12 Plus software program for qualitative analysis. An inductive thematic analysis of the data was used, whereby the data was coded through an open coding process based on the research questions. Subsequently, 2 other researchers conducted a second round of coding to consolidate codes and identify the main themes relevant to the research questions. This was further reviewed and independently checked by another researcher.

Trustworthiness

Several methods were used to ensure the reliability and quality of the data in this investigation. To begin with, the participants' trust and rapport were maintained throughout the research process, beginning with the initial contact to the completion of the interviews. Secondly, after performing 5 preliminary interviews, the primary researcher engaged in discussions with pertinent supervisors to consider the potential modifications to probing and interview questions. The transcripts texts and audio recordings were re-examined to fully understand the interactions. The final step involved ongoing peer debriefing among co-researchers to ensure consensus in data interpretation and data analysis.

RESULTS

Study participants' general characteristics

In this study, data saturation was attained following the interviews of 15 participants. These participants were based on the concept of data saturation, which is the point at which no additional pertinent information surfaced during the interviews [20]. **Table 1** shows the socio-demographic profiles of participants in this study. Most of the participants were women (87%) and held at least a bachelor's degree qualification. Their ages ranged between 32 and 44 yrs, and they had an average of 11 yrs of experience working in an outpatient dietetic clinic.

Nutrition educational tools currently used in dietary counselling

Table 2 shows descriptions of several types of nutrition education tools, as well as their uses and representativeness. Among the study participants, the Malaysian Healthy Plate model and pamphlets were the most widely used nutrition education tools (100%), followed by household measurement tools (67%), flip charts (60%), menu planning sheets (47%), and food models (33%). The least used resources were digital tools (20%). All the participants believed that the Malaysian Health Plate Model can improve awareness of food portion size, making it the most frequently used nutrition education tool.

The participants in this study indicated that practical nutrition education tools, such as household measurement tools, were important since they could help patients comprehend food portions better if they also used the same tool at home. Furthermore, pamphlets were frequently used because they are typically given out to patients at dietetic clinics and customised to specific medical diagnoses such as diabetes. Flip charts were used by more than half of the participants as they found it helped to stage the flow of dietary counselling and increase patients' concentration and memory retention of information gained from the sessions. Participants also mentioned that it helped deliver dietary interventions to patients who had language barriers. Menu planning sheets were reported as another tool that is frequently utilised and provided to patients as reference materials after the counselling session. As for food models, participants described that they assist patients in visualising actual food portion sizes.

Findings from this study indicate that digital tools are the least used nutrition education tools by the participants. However, one of the participants said that she preferred to use digital flip charts because they are more portable than physical flip charts. Another participant described the convenience of using digital nutrition apps to track patients' progress. However, according to one of the participants, she doubted the invalidated existing nutrition smartphone application content.

"A lot of apps were not developed by dietitians, so I doubt the food database." (D4/Public Hospital)

Table 1. Participants' characteristics

Characteristics	Mean \pm SD or No. (%)
Age (yrs)	34.53 \pm 3.04
Working experience (yrs)	11.53 \pm 3.04
Sex	
Men	2 (13.3)
Women	13 (86.7)
Outpatient dietetics clinic	
Health clinic	3 (20.0)
Public hospital	7 (46.7)
University hospital	5 (33.3)

Table 2. Types of nutrition education tools and participants' quotes illustrating their use of these tools

Types	No. (%)	Reason of use	Participant quotations
<p>The Malaysian Healthy Plate model</p> 	15 (100)	To explain food portions and facilitate patients' understanding	<i>The Healthy Plate Model is a good thing for me to show to the patient. I like to use it because it can help patients understand about half-half-quarters concept (food portion). If we just talk about the food portion, patients will probably be unable to understand it. But once they see the plate, it becomes easier for them to understand. (D8/Public Hospital)</i>
<p>Pamphlet</p> 	15 (100)	<p>Commonly available in clinic</p> <p>As additional information</p> <p>As a reference for specific disease</p>	<p><i>I use pamphlets because it is the most common tool that is usually available in clinics. (D2/Primary Care Clinic)</i></p> <p><i>We have a pamphlet for reference so that when they (patients) go home, they can refer to it as the counselling session is short. The one-hour dietary counselling session is not enough. They have a lot of things to ask and want additional information. We just give them the pamphlets to refer to at home. (D10/Public Hospital)</i></p> <p><i>We give pamphlets to patients according to the patient's diagnosis. For example, diabetic patients use diabetic pamphlets. (D15/Teaching Hospital)</i></p>
<p>Household measurement tool</p> 	10 (67)	To show food portion size	<i>It is quite practical for me, especially if we choose the household measurement because we can show it to the patient and ask them to choose the household measurement size, they usually use at home. For example, the patient always uses a rice scoop to take rice. So, we kind of talk about the same thing, and we refer to the same thing and that thing is in front of their eyes during counselling, so they can understand better. (D13/Teaching Hospital)</i>
<p>Flip charts</p> 	9 (60)	<p>To facilitate steps in the dietary counselling process</p> <p>Help patients to focus</p> <p>Help patients remember counselling input</p> <p>Help people with hearing problems and language limitation</p>	<p><i>I like it if there is a complete flipchart so we can tell one story, step-by-step. We can show it to the patient then the patient can see. (D8/Public Hospital)</i></p> <p><i>Patients seem to be more focused and alert when dietitians show them a flip chart that contains pictures. (D1/University Hospital)</i></p> <p><i>Flip charts in the clinic perhaps can help patients at least remember the information given to them and share it with other people when they go home. (D6/Public Hospital)</i></p> <p><i>Flip charts help during counselling especially for those who are deaf and patients who are less fluent in the Malay language because usually flip charts have pictures and are available in the English language as well. (D1/Teaching Hospital)</i></p>
<p>Menu planning sheet</p> 	7 (47)	As reference and reading material for patients	<i>(The menu planning sheet) is for diabetic patients who are using insulin, so you must counsel them on that first because that is the main issue for the patient. We don't have enough time to counsel our patients in depth about nutrition and food portions. We just give the menu planning sheet for the patients to refer to during their first visit. (D15/Teaching Hospital)</i>
<p>Food models</p> 	5 (33)	Assist in visualisation	<i>The food model can help a patient to visualise the actual form of food. (D13/Teaching Hospital)</i>
<p>Digital tools: smartphone apps, digital notes, and digital flip charts</p> 	3 (20)	<p>No need to bring physical tools</p> <p>Faster to assess patient's progress</p>	<p><i>Sometimes I use digital flip charts. It's easier than bringing the physical pamphlet. (D2/Primary Care Clinic)</i></p> <p><i>I like to use digital apps because it is faster. Just go, I glance through, and I can see the patient's record for the past weeks, or months. That's (apps) easier because we can see the trend in how they eat. (D4/Public Hospital)</i></p>

Importance of nutrition education tools during dietary counselling

Table 3 shows the input from participants that supports the sub-themes that emerged regarding the importance of nutrition education tools. The first sub-theme identified is timesaving in which participants expressed that the shortage of dietitians especially in primary care health clinics resulted in time constraints in giving full dietary advice to the patient. Furthermore, one primary health care clinic dietitian is reported to oversee many clinics in each district thus, strengthening the need for using nutrition education tools that can expedite the dietary counselling process and help save time.

Another sub-theme that emerged from the analysis was nutrition education tools facilitating nutrition assessment and intervention during dietary counselling. Participants described that nutrition education tools are essential for collecting information to evaluate patients' nutritional status. Participants also felt that the usage of the tools is crucial in dietary counselling as they increase patients' attentiveness as well as understanding.

Limitations of the existing nutrition educational tools

Five sub-themes were found within the existing nutrition education tools theme (**Table 4**). The first sub-theme highlighted is the difficulty in visualisation of portion size. According to the participants, the Malaysian Healthy Plate Model that emphasises the concept of quarter-quarter-half serving is unclear for some patients. For example, patients feel unsure of the

Table 3. Illustrative participants' quotes regarding their perceptions of the importance of nutrition education tools

Sub-themes	Participant quotations
Timesaving	<i>Sometimes dietitians have time constraints. Another thing, there are a limited number of dietitians in primary healthcare clinics. We usually must cover 4 to 5 clinics in one district. One session for a new case takes about 30 to 40 minutes. We had to skip some information because there was just not enough time... Nutrition education tools can help in so many ways. (D12/Primary Care Clinic)</i>
Facilitate the nutrition assessment process	<i>If there are tools, I don't think there is much of a problem. Usually, if there is no such thing (educational tool), it is difficult to get information from the patient. (D14/Teaching Hospital)</i>
Assist in the nutrition intervention process	<i>Most of the diet interventions that I give to patients are mostly just talking. When I talk, I'm not sure patients will remember, understand, and, and remember it... Good types of patients will take notes in front of me, but some come in only to hear it. The tendency to misunderstand and not remember the advice given is there. The educational tool can help them to focus and understand better. (D1/Teaching Hospital)</i>

Table 4. Illustrative participants' quotes regarding their experience with the limitation of existing nutrition education tools

Types	Sub-themes	Participant quotations
Physical tools	Unhandy	<i>It's a bit difficult for me to bring along all these nutrition education tools especially when I have to go to other clinics. (D5/Public Hospital)</i>
Malaysian Healthy Plate model	Difficult to visualise	<i>Sometimes patients make mistakes, they think the carbohydrate section in the healthy plate model is just for rice. (D14/Teaching Hospital)</i>
Pamphlet	Not personalised	<i>Not all pamphlets suit the patients. For example, the pamphlets that are given to diabetic patients are very rigid like the menu planning fixed at 1,200 or 1,500 calories. (D7/Teaching Hospital)</i>
	Difficult to visualise	<i>Sometimes dietitians use printed images. It's a real image, not an animation image. However, patients are still confused and unable to estimate the food portion, perhaps because of low printing quality and the picture sizes that are not the same as real food sizes. (D1/Teaching Hospital)</i>
	Budget constraint	<i>We only had black and white pamphlets; it was so boring. Although the original copy was in a colour version, due to tight budget, we are only able to make the educational material printed in black and white. (D6/Public Hospital)</i>
Household measurement tool	Difficult to visualise	<i>During dietary assessments, dietitians use bowls to show their patients, that they can't describe how many bowls of rice they had eaten because they did not use a bowl at home. The same goes for other household measurement tools like spoons and cups, patients said they did not use those kinds of tools at home. So, it's a bit difficult to estimate how many servings they ate. I was afraid that there would be a mistake, which they (the patients) meant differently, and that the dietitians understood them differently. (D1/Teaching Hospital)</i>
Flip charts	Outdated	<i>Nutrition education tool like flip charts is old school using old pictures and are too wordy. (D13/Teaching Hospital)</i>
Food models	Budget constraint	<i>In the place where I work, there are very few types of food models. We can't afford to buy more because it's expensive. (D9/Public Hospital)</i>

actual food portion to fill in a quarter-quarter-half space as it is commonly assumed that one portion is only for one type of food such as rice. This is despite that the first quarter section portion is also applied to all cereals and starchy vegetables. In addition, participants cited that some patients were unable to estimate the portion of food as the printed food photos on the Malaysian Healthy Plate Model did not represent the actual size of the food. Moreover, the size of the Malaysian Healthy Plate Model used by dietitians was different from the size of the plate patients used at home. Thus, it is difficult for patients to visualise the message delivered by dietitians during dietary counselling sessions. In the Malaysian Healthy Plate Model, “quarter-quarter half” represents a recommended division of a meal plate, where one-quarter is allocated to protein sources, another quarter to carbohydrates or grains, and half the plate to fruits and vegetables, promoting a balanced and healthy diet [21].

The second sub-theme is the cost of educational tools currently used in dietetic clinics. Participants in this study stated that the types of food models available in dietetics clinics are limited because food models are generally expensive, and most clinics have limited budgets. The same situation applies to pamphlets, which were first produced in colour and distributed in dietetics clinics. However, due to financial limitations, they were only printed in black and white. Consequently, participants felt that it would make the pamphlets less attractive to their patients.

The next sub-theme identified in this study is that participants reported it was challenging to use physical nutrition education tools during numerous trips to health clinics. They acknowledged that even though the pamphlet was customized to various medical diagnoses, it can be unsuitable for some patients as it is not personalised based on their actual energy needs. On the contrary, the menu planning pamphlet is prepared based on a general range of calorie needs (i.e., 1,200 kcal, 1,500 kcal and 1,800 kcal).

Additionally, participants cited that the existing flip charts in their clinics were outdated as they were based on old pictures and references. Moreover, it was felt that the existing materials were wordy and that their patients would not be interested to read them.

Preferred nutrition education tools during dietary counselling

All participants stated that they preferred digital tools and suggested that more digital tools should be developed in Malaysia. Smartphone apps were described not only to simplify dietitians' tasks but also to ease the overall experience for patients.

“Nowadays everyone uses a smartphone. Many people like to snap food pictures before eating. Meaning that we (dietitians) can ask the patient to log in their daily food intake in the apps. When they come to see us, they don't need to recall anything, we can review directly from the apps.” (D1/Teaching Hospital)

Another participant recommended using a digital flip chart, perceiving that it would make dietary counselling sessions more engaging and enjoyable compared to using old-fashioned flip charts.

“Flip charts can be converted to the digital format. It is very interesting and fun to listen to and to see.” (D13/Teaching Hospital)

Features of digital nutrition education tools desired by study participants

Six sub-themes were identified in the discussion on the features that should be included in a digital tool for nutrition education (**Table 5**). Firstly, the participants described that digital tools could serve to provide instant monitoring and feedback from dietitians to patients. It is believed that the delivery of current dietary interventions should be more prompt rather than delayed until a physical clinic appointment.

The second suggested digital feature was an automated calculator that could obtain important nutritional information. Participants expressed that mobile apps should have the capability to automatically calculate patients' body mass index (BMI) and energy requirements, thereby allowing more time for dietitians to focus on giving counselling to the patient. In addition, the participants prompted that digital nutrition education tools be embedded with the local food database.

The next sub-theme involves the development of digital nutrition education tools by experts in the field such as dietitians and nutritionists. Participants claimed that available apps in the market are often misleading, and this might be due to the lack of legitimate experts included in the development process.

Finally, participants added that the ability of a nutrition education tool to be able to integrate with healthcare databases was crucial. Dietitians have already started to use digital apps to determine patient's energy requirements. However, they need to manually document the information retrieved from the apps into their respective hospital databases which can be time-consuming. Thus, participants would prefer that future apps be connected to hospital databases.

Advantages of digital nutrition education tools

Table 6 summarises the perceived advantages of digital nutrition education tools mentioned by the participants. It has been perceived that the functions of digital nutrition education

Table 5. Illustrative participants' quotes regarding their preferred feature of the digital nutrition education tool

Sub-themes	Participant quotations
Instant feedback	<i>We (dietitians) want to counsel whenever possible. For example, if the patient has already consumed an excess of calories, we can respond through smartphone apps. It doesn't have to happen in the counselling room. Meaning we can counsel the patient anytime and anywhere. (D11/Primary Care Clinic)</i>
Automated system	<i>When dietitians key in patients' data like weight, height and age, smartphone apps should be able to automatically calculate their BMI and energy needs. On top of that, it's good if the apps can also calculate a patient's diet intake. For example, when patients have reached their calorie needs, a function as a signal can be made to remind and help them to limit further food consumption. (D5/Public Hospital)</i> <i>Auto calculation features can help speed up the process. For now, we have taken 20 minutes just to calculate everything manually, so we have limited time for the counselling session and our engagement with the patient becomes less. (D7/Teaching Hospital)</i>
Local food database	<i>Maybe it's good to have a complete Malaysian food database including calories and nutrients. I know this is a burdensome job, but it would be very good if we put our local food database in digital nutrition education tools. (D5/Public Hospital)</i>
Developed by experts	<i>There are plenty of available apps in the market but I'm not sure about where the food database is from. (D6/Public Hospital)</i> <i>I believe a lot of apps nowadays are not accurate. So maybe the thing that we can improve is to get involvement from experts like dietitians during the development phase of the apps. (D10/Public Hospital)</i> <i>The apps are not developed by dietitians. We do not know the background of the developer. (D14/Teaching Hospital)</i>
User friendly	<i>I wish to have a user-friendly digital education tool. It means one makes it easier for us not to become more complicated. (D2/Primary Care Clinic)</i>
Digital nutrition educational tools integrate into systems in health facilities	<i>For example, we (dietitians) have calculated patients' calorie intake in apps, but we cannot enter them into the system (official hospital system) because it's not integrated. To me, it's still a problem for us who have time constraints and need to complete such documentation. If there is something that can be integrated with the existing systems, that thing is very good, and I like it. (D8/Teaching Hospital)</i>

Table 6. Illustrative participants' quotes regarding their perceptions of the advantages of digital nutrition educational tools

Sub-themes	Participant quotations
Facilitate dietitians	<i>We (dietitians) would be happy if food pictures were all put into apps. No need to print many times. (D11/Primary Care Clinic)</i> <i>If the patient has keyed in all the info into the apps, at least we can get the info before the patient comes in. When the patient comes in, we just have to assess back on certain things that are not clear and then we can prescribe things that they are not doing correctly. So, we do not have to go from A to Z. So, it can shorten the time and we can see more patients with more quality care. (D3/Public Hospital)</i>
Improving communication between dietitians and patients	<i>If we have apps where patients and dietitians can communicate, perhaps can directly discuss, for example, about the patient's food intake. Dietitians can also send the healthy menu and recipes through the apps. So, it means that the patient can see what menu is right for them. (D7/Teaching Hospital)</i>
Timesaving	<i>If there are apps, whenever patients eat, they can write and snap the picture, and upload it into the apps. So, when they come to see the dietitian perhaps can shorten the time. (D1/Teaching Hospital)</i> <i>Now everyone uses mobile phones. So maybe we can develop apps that dietitians can access before the counselling session, so we do not have to wait for the patients to enter the clinic to assess their food diary. (D3/Public Hospital)</i> <i>In terms of time, apps are faster. If I can just glance through, I can see the patient's record for the past weeks, or months. That way is easier because we can see the trend in how they eat. (D4/Public Hospital)</i>
Cost saving	<i>So, if we can make the flipchart in digital form, it's even easier... It can save money on printing, save paper and it's even easier. (D2/Primary Care Clinic)</i>
Digital devices are not easily damaged	<i>If the thing is in a soft copy form, we can open it using a smartphone. Everywhere we go we can bring that thing so can open it when we are free, and it will not damage. (D10/Public Hospital)</i>

tools available in mobile apps help dietitians obtain initial information about their patients before the dietary counselling session begins. Secondly, participants cited that the availability of digital nutrition education tools may improve communication between dietitians and patients. Thirdly, digital nutrition education tools are believed to be able to accelerate the dietary counselling process and simultaneously save time. Furthermore, patients can complete food diaries via digital apps to meet their dietitian and thus, expedite the nutrition assessment process.

Concomitantly, participants narrated that digital nutrition education tools would be more cost-effective by reducing paper and printing costs that were previously used to develop flip charts and other education tools. Lastly, digital nutrition education tools are believed to be easily accessible and not vulnerable to damage as compared to physical nutrition education tools.

DISCUSSION

This qualitative study provides a comprehensive exploration of dietitians' perspectives on nutrition education tools, considering the types of tools that they use as well as their importance and limitations. In addition, we explored in depth the participants' recommended features in digital nutrition education tools.

Most of our participants favoured printed pamphlets as they perceived it was the most convenient option and was readily available at their clinics. Moreover, the pamphlet was given to patients as take-home messages. Similarly, another qualitative study among multidisciplinary clinicians on challenges in implementing Mediterranean dietary patterns found that participants also agreed that handouts could be supporting materials, especially during short consultation sessions due to time and resource constraints [22]. Thus, printed education materials can benefit healthcare providers by expediting the consultation process as well as allowing them to review the information at their convenience and improve their understanding.

In this study, the participants believed that The Healthy Plate Model, household measurements, food models, pictorial pamphlets, and flip charts to be able to increase

patients' concentration during dietary counselling sessions. The inclusion of visual elements in teaching aids is encouraged because it can increase audience engagement, attract attention, and simplify complex knowledge [23]. Furthermore, it was demonstrated that colourful education pamphlets reduced patients' absenteeism rates for dietary intervention [24]. The Kiel Obesity Prevention Study that was conducted in Germany found that pictorial foods and visual food models used in dietary counselling sessions had improved the nutrition knowledge of their study participants [25]. Pictorial-type education tools can serve as a guide to patients in determining the appropriate food portion and the type of diet to comply with [26-28].

Our study participants revealed their uncertainty about the available apps in the market. Issues related to their accuracy, reliability, and trustworthiness become the main concern. It was reported that app users preferred expert-developed apps as they believed it could affect the accuracy and reliability of nutrition advice provided [29]. The healthcare professional mentioned that the important criteria for selecting an app were ease of use, apps being free of charge and validation [30]. Significant barriers to using the nutrition apps reported in the previous study include inaccurate database nutrition output and a lack of local food composition database [31]. In addition, our study found that the digital nutrition education tool needs to be user-friendly for dietitians to utilise and to conduct their work more efficiently compared to the traditional method. It was reported that perceived accessibility, usefulness, price value, and trust affect the adoption of the app in dietetic practice [32]. Findings from our study suggest that it is crucial to involve dietitians during the development process of apps as well as test their usability with local end users including both dietitians and patients.

In this study, although most of the participants had not initiated the use of digital nutrition education tools in their dietary counselling sessions, they highly recommended the development of these tools for future use. Text messaging programs delivered by dietitians have been reported to be effective in improving eating behaviours among people with cardiovascular diseases [33,34], and web-based nutritional interventions have helped in improving eating behaviours in patients with obesity [35] and type 2 diabetes mellitus [36]. Moreover, dietary interventions using community-based technologies such as mHealth and eHealth have shown the ability to improve nutritional behaviours among people with type 2 diabetes mellitus [37], hypertension [38], and chronic kidney disease [39]. A quasi-experimental study examining the effectiveness between graphic persuasive games and non-graphic persuasive games towards changes in healthy food choice attitudes among second-year students found that the treatment group scores were significantly higher than the control group [40]. A randomised controlled trial among older adults found that web-based health education tools are more cost-effective compared to pamphlets [41].

In this study, participants thought that the audio and visual features of digital communication used in digital nutrition education tools could improve communication between dietitians and patients. A study assessing an automated and interactive telephone program developed by dietitians to enhance dietary compliance with the Dietary Approach to Stop Hypertension among American patients with hypertension demonstrated notable enhancements in dietary quality, increased fibre intake, reduced daily energy consumption, improved medication adherence, and a decrease in blood pressure [42].

Our participants also thought that digital education tools could provide instant intervention feedback to patients rather than delaying it until a physical clinic appointment. The

innovation of natural language processing, artificial intelligence, and machine learning have led to the increased use of information technology in healthcare such as chatbots which can provide lifestyle and medical advice through real-time feedback [43]. For instance, the Academy of Nutrition and Dietetics Health Informatics Infrastructure is an electronic web-based tool that allows dietitians to monitor and evaluate nutritional care outcomes remotely [44]. Digital nutrition education tools also have the advantage of being time-efficient, which may save time during dietary counselling sessions [45]. Time efficiency was reported as one of the key user requirements during the development of the TreC-Lifestyle mobile app nutrition education [46].

In this study, the participants felt that the current local population is prepared for digital nutrition education tools due to the increasing use of mobile phones. The Malaysian Communication and Multimedia Commission 2021 report shows that nearly all Malaysians use smartphones (94.8%) [47]. A study in Malaysia shows that 53.6% of smartphone users have downloaded health-related apps for lifestyle management [48].

This study is subject to a limitation in participant selection. Specifically, participants were exclusively recruited from government hospitals, teaching hospitals, and health clinics within the main city of the country. As a result, our findings only reflect the perspectives of dietitians from these settings which may limit our insights into the experiences of dietitians working in rural areas. This limitation highlights the necessity for further investigation among dietitians in rural settings, where internet access and usage are likely to be less prevalent. Nevertheless, the findings of our study on the perspectives of dietitians regarding digital nutrition educational tools in Malaysia present significant implications for dietitians in diverse geographical regions. These implications encompass cross-cultural insights, the adaptation of educational tools, professional development, and policymaking. Through comparative analysis of their local contexts, dietitians can identify common challenges or opportunities in implementing similar tools.

In conclusion, dietitians in this study believed that nutrition education tools are crucial in assisting dietary counselling, facilitating the nutrition assessment process, and saving time. Most dietitians in this study are using physical nutrition education tools due to their availability and ease of use. Nonetheless, some of the physical nutrition education tools were perceived as immobile, impersonalised, outdated, and modified to lower quality due to budget constraints which could limit the efficacy in delivering the nutrition care process. Dietitians in this study thought that digital nutrition educational tools could overcome these limitations. To ensure the trustworthiness of these digital applications, dietitians perceived that the digital nutrition education tools must involve the end users in the development process which includes dietitians and patients. The findings of the current study serve as a reference for the development of up-to-date nutrition education tools for dietitians in Malaysia. Furthermore, these findings can serve as a valuable resource for dietitians worldwide seeking to enhance their practice with the latest educational tools and methodologies.

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