DIGITAL HEALTH

Development and validation of D-PATH website to improve hypertension management among hypertensive patients in Malaysia

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Abstract

Objective: This study aimed at developing and validating a web application on hypertension management called the D-PATH website.

Methods: The website development involved three stages: content analysis, web development, and validation. The model of Internet Intervention was used to guide the development of the website, in addition to other learning and multimedia theories. The content was developed based on literature reviews and clinical guidelines on hypertension. Then, thirteen experts evaluated the website using Fuzzy Delphi Technique.

Results: The website was successfully developed and contains six learning units. Thirteen experts rated the website based on content themes, presentation, interactivity, and instructional strategies. All experts reached a consensus that the web is acceptable to be used for nutrition education intervention.

Conclusion: D-PATH is a valid web-based educational tool ready to be used to help disseminate information on dietary and physical activity to manage hypertension. This web application was suitable for sharing information on dietary and physical activity recommendations for hypertension patients.

Keywords

Hypertension < Disease, dietary management, nutrition education, Physical Activity < Lifestyle, web-application

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Introduction

The Nutrition Research Priorities in Malaysia for the 12th Malaysia Plan (2021–2025) and the World Health Organisation's (WHO) Sustainable Development Goal (SDG) highlight that hypertension is one of the most critical areas for research as hypertension contributes significantly to the increase in disability-adjusted life years (DALYs).[1,2] Hypertension (HTN) has become a worldwide public health concern and the primary cause of morbidity and mortality.[3,4] It poses a considerable risk for dementia, chronic kidney ailments, ischemic heart, cardiovascular ailments, and stroke.5 Besides, the WHO projects that 1.28 billion people aged 30 to 79 suffer from hypertension, with the majority (66%) living in low- and middle-income nations.5 Based on the Malaysia National Health and Morbidity Surveys (NHMS) in 2019, the prevalence of hypertension was reported at 32.6% in 2011, 30.3% in 2015 and 30% in 2019.6 Although the percentage has plateaued, there has been an increase in the number of patients with hypertension due to the growing number of populations. According to the 2019 NHMS report, Malay ethnicity had the highest prevalence of known and unknown hypertension (34.8%), followed by Indians (30.3%) and Chinese (27.6%). Moreover, Malay has the most significant rate of hypertension, estimated at 3 million people. On the other hand, the number of patients with hypertension who received medical treatment increased from 78.9% in 2006 to 83.2% in 2015.6 However, despite the higher proportions of patients receiving treatment, the control of hypertension remained poor, below 40%.7 Comparing blood pressure control between ethnicities, 33.2% of Malays had poor control of hypertension as compared to Chinese (46.8%) and Indians (40.8%). Missed medical appointments, low education level, sedentary lifestyle and poor dietary habits are contributing factors to uncontrolled hypertension.[8,9] For example, excess sodium intake is correlated with hypertension in humans.10 Lifestyle changes are the first line of treatment and are one of the key tactics to reduce hypertension, according to clinical recommendations for its management.[11–16] Lifestyle modifications such as dietary intake adjustment, increased physical activity level and smoking cessation have been proven effective in controlling blood pressure.[13,16]

The digital era has seen extensive adoption and offers individuals several ways to access health-related information. Numerous research works have been done to evaluate patients' information-seeking behaviour (ISB) using interpersonal or online resources.[17–19] Many patients access much information using information, communication and technologies (ICTs) platforms, such as websites, social media or health applications.20 A recent study found that most patients use online health information such as the Internet, social media or online courses, compared to the interpersonal approach.21 The use of health information

on the Internet could play an important role in effectively improving one's self-efficacy and self-management skills. For example, a previous study showed the potential use of online guided self-determination programs to improve diabetes self-management in young adults.22

Various websites used for nutrition intervention show positive results in promoting behavioural changes. For example, many websites were used to improve the clinical outcomes in hypertension management, such as lowering and maintaining blood pressure to normal.[23–26] Websites have become alternative and supporting educational tools for health education. As against in-person delivery, previous study found that Internet-based diet and physical activity instructions resulted in positive and similar nutrition-related improvements and offered the user effective, interactive, and customised content.[27,28] Additionally, wherever physical contact is to be minimised, particularly in clinical settings where the transmission of contagious ailments, especially COVID-19, rises, interventions utilising ICTs should be given priority.29

Given the positive impacts of websites in improving health literacy and patient self-efficacy in controlling hypertension, this study aimed to develop and validate a web-based application for diet and physical activity management to control hypertension for the Malay population, also known as D-PATH (Dietary and Physical Activity Management to Control Hypertension) website. The validation of this website offers valuable insights into experts' assessments of a newly developed platform that seamlessly integrates instructional design with multiple theories, including those related to learning and multimedia. Apart from this, the impact of the COVID-19 pandemic, which prompted patients to access health information through an online platform, justified the importance of creating a hypertension management website. D-PATH will serve as an educational tool for healthcare practitioners in government health institutions, enabling them to educate patients about hypertension management. Patients can independently utilise D-PATH anytime and anywhere, using their preferred devices.

Materials and methods

This study is of a cross-sectional nature, and the development of D-PATH followed the Design and Development Research (DDR) method. DDR research allows researchers to assess theories, models, and frameworks and validate practical applications.30

Development of D-PATH web-based application

D-PATH was created as a free online educational tool for patients with hypertension. The website is maintained by the development team's administrator and is overseen by a registered dietitian. The development of the D-PATH

website involved three stages: (1) content analysis, (2) designing and developing the content and website, and (3) expert validation. The analysis of the literature involved several experts from multidisciplinary areas, such as medical doctor, dietitians, nutritionist, and psychologist. A systemic review of the literature was conducted to identify the preferences and effectiveness of web elements for nutrition education intervention programmes, such as content delivery method, use of notification, and interactivity and was published elsewhere.[21] Additionally, several clinical guidelines were analysed to ensure the content was based on clinical evidence and up to date. Next, the content of the website was modified to suit the ethnicity of the targeted population in this study, which is Malay patients with hypertension aged 18 and above.

After completing the first step, the design and development of the website was done. D-PATH website was based on the Model of Internet Intervention to ensure it meets the objective of the website.[28] This model assists in the development of Internet education or interventions, as well as in promoting behavioural changes. As such, the delivery of the content of the website integrated several multimedia components such as infographics and videos. Table 1 shows the application of the Model of Internet Intervention on the web. Other than that, various models and theories, such as the Unified Theory of Acceptance and Use of Technology (UTAUT)[31] and Flow Theory[32] were adopted to design and develop the website. UTAUT seeks to clarify user intentions regarding the utilisation of an information system and its subsequent usage behaviour.

Table 1. Application of the model of internet intervention in the D-PATH website.

No	Characteristics	Application
1	Appearance	The colour of the website was limited to three colours, which are black (#212121), red (#cc0000), and green (#38761d). The screen size is compatible with desktops or laptops, smartphones and tabs. The font type used for the heading and tab was Nunito. The font size for the main header was 36, the sub-heading was 20 and 14, and the text was 12. Copyright-free images with the premium package from freepik.com were used for the illustration. The red colour was chosen because it reflects safety and excitement.[34] Moreover, the red colour is commonly associated with health care. The green colour was chosen because it is associated with health and freshness. The website's background was white because it provides a clean website and a colour of purity and aspiration.[34] In addition, the use of a white background provides a colour contrast on the web.[35] The font colours vary depending on the headline and text. This helps users to identify the topic of the content easily.
2	Behavioural/ prescriptions	Users have been informed about the user manual on the web's homepage. New users must complete a registration form and agree to follow the guidelines to complete the module. Users are expected to complete the module in four weeks. In addition, users were informed about the profiles of the website administrator.
3	Burdens	The online content was divided into six parts to allow users to browse the content in stages to minimise the burden on users. The materials were presented in the form of videos and infographics.
4	Content	The information was supported by evidence. It was developed using a review of the literature and clinical guidelines. All references were listed on the website.
5	Delivery	The mode of delivery of the content was using videos, infographics, and text.
6	Message	The message was conveyed in layman's words. Medical jargon was avoided in the text, video, and infographics. Instead, the website's text was written in a conversational tone.
7	Participation	In addition to using a conversational tone to encourage users to participate, a chat room and forum have been set up to facilitate interaction between users and the administrator. In addition, the administrator will notify users once a week to ensure they continue using the website. Finally, users must complete the activities at the end of each unit.
8	Assessment	During the online registration process, a personality assessment concentrating on the stages of change was performed. This would allow the administrator to determine the individuals' willingness to change.

This theory posits the existence of four fundamental constructs: (1) performance expectancy, (2) effort expectancy, (3) social influence, and (4) facilitating conditions. Table 2 shows the application of the UTAUT model on the web. Flow theory was used because learners can achieve optimal learning outcomes when engaging in tasks that balance skill and challenge levels, coupled with a person's interest, sense of control, and intense focus. Figure 1 shows the application of Flow theory in the web. Moreover, the website content, such as educational videos, was designed and developed using the Cognitive Theory of Multimedia Learning.[33] The use of fonts, colours, user interface, and content arrangement was done carefully based on the theories and models.

Regarding content development, the transtheoretical model of change (TTM) was used to structure the content on the web, including the pre-contemplation, contemplation, preparation, action, and maintenance stage.[36] TTM was used considering the heterogeneity stage of change among the users, as the web is opened to the public. In addition, the taxonomy of behaviour change techniques (BCT) [37] was also used to identify the specific behavioural change in each learning unit on the web. The web consists of six units: (1) general information about hypertension, (2) management of sodium intake, (3) Dietary Approaches to Stop Hypertension (DASH) diet and recommendation for fruits, vegetables, and whole grains, (4) fat and alcohol, (5) physical activity and exercise, (6) shopping tips. These units were created based on the recommendations from multiple clinical guidelines for the management of hypertension.[14–16,38,39] These topics are important for patients to control their blood pressure. Figure 2 shows the user interface

(UI) of the web. Additionally, activities were provided at the end of every unit to ensure users engaged with the web.

Apart from the behavioural change theories, as mentioned before, the web also integrates Bloom's taxonomy[40] and a revised version of Nine Gagne's Events of Instruction.[41] D-PATH uses the Malay language to ensure the patients can comprehend and apply the information from the web. In addition, Malay was chosen because it is the national language of Malaysia, and every Malaysian can understand it.

Videos have been proven effective in disseminating medical information and promoting behavioural changes.[42,43] Therefore, 48 videos were embedded in the web. 9 videos explain the general information about hypertension, 14 videos on salt and sodium, 5 videos on fruits, vegetables and whole grains, 5 videos on fat and alcohol, 3 videos on physical activity and exercise, and 12 videos on shopping tips. Other than that, infographics were also used in every unit.

Validation of D-PATH web-based application

The last stage in the D-PATH development was the validation. The importance of the validation stage was to ensure the web is valid and ready to be used for nutrition education intervention. A purposive sampling was employed to recruit the experts. Researchers requested authentic feedback to enhance the website and its benefits for patients, emphasising that the review process remains free from any organisational influence. A panel of interdisciplinary health experts with experience in managing hypertension was invited to evaluate the module. The inclusion criteria for the experts were at least five years of experience

Table 2. Application of the UTAUT model in the D-PATH website.

| Predictors	Definition	Applications
Performance expectancy	The degree to which an individual believes that using the system will help them to attain gains in job performance.	Users have been informed that the website contains information to help them better control their disease. The information was broken down into small parts and divided into sections to reduce the user's cognitive load.
Effort expectancy	The degree of ease associated with the use of the system.	Users do not have to log in and can go directly to the homepage and follow the instructions. The navigation bar and buttons are provided on each page.
Social Influence	The degree to which an individual perceives that important others believe they should use the new system.	Users have been informed that the website is accessible to everyone, especially hypertensive patients and their family members. In addition, the website provides a space for group discussion where users can interact and socialise.
Facilitating conditions	The degree to which an individual believes that an organisation's technical infrastructure exists to support the use of the system.	Users have been given a contact number for user support. Support is available 24 h a day.
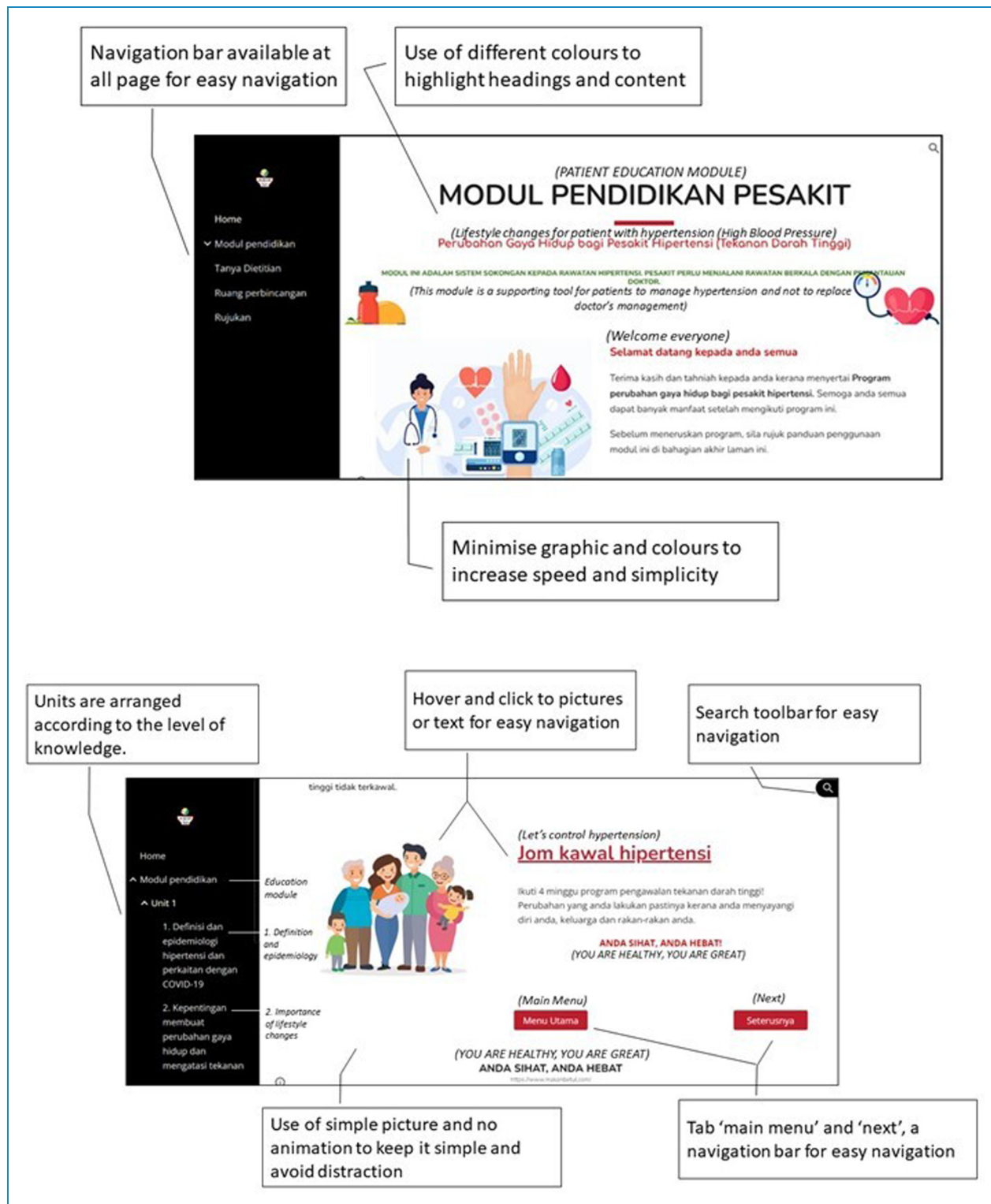
Figure 1. Application of flow theory in the D-PATH website.

in the field44 and high academic qualifications.45 A total of 13 experts, including 1 senior lecturer with a dietetics background, eleven dietitians, one specialist in family medicine and one clinical psychologist, were selected. The recruited number of experts is sufficient since it is more than the recommended number of 10.[46,47] These experts evaluated the web, and the evaluation process was conducted face-to-face. All experts received the web link by email
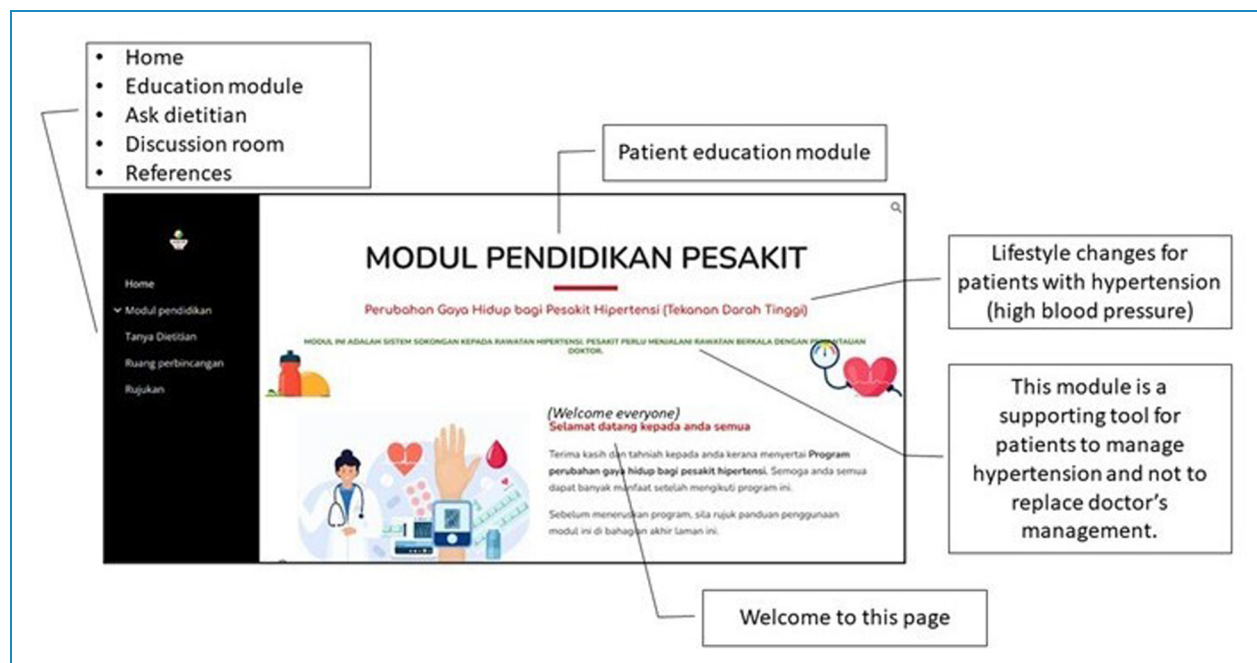
Figure 2. User interface of the D-PATH website.

Table 3. Seven-point-scale for fuzzy Delphi technique.

Characteristics	n (%)	Mean (SD)
1	Extremely strongly disagree	(0.0,0.0,0.1)
2	Strongly disagree	(0.0,0.1,0.3)
3	Disagree	(0.1,0.3,0.5)
4	Moderately agree	(0.3,0.5,0.7)
5	Agree	(0.5,0.7,0.9)
6	Strongly agree	(0.7,0.9,1.0)
7	Extremely strongly agree	(0.9,1.0,1.0)

one week before the evaluation day to ensure sufficient time to go through the web.

Fuzzy Delphi Technique (FDT) was used to assess the website. The FDT presents numerous advantages, such as the capacity to solicit expert opinions, establish consensus and engage with research subjects without constraints related to time and location. The choice of this technique follows the aim of the study to obtain experts' agreement on the content and elements used in the web application. The items in the questionnaire were developed based on the literature review and the researcher's experience.[48,49] The completed questionnaire was given to four experts for face validation. Specifically, the questionnaire utilised

a seven-point scale,[50] as shown in Table 3. The questionnaire was distributed to 13 experts for module evaluation. The questionnaire has four sections: section A: Themes for the content, section B: Presentation interface design, section C: Interactivity interface design and Section D: Instructional Strategies.

Statistical analysis

The data analysis was analysed systematically using Microsoft Excel software.[51] The prerequisites for the Fuzzy Delphi technique are the Triangular Fuzzy Number and the Defuzzification Process. The Triangular Fuzzy Number must meet the two terms: first, the value of Threshold (d) ≤ 0.2, and second, involve a percentage of expert agreement. The expert agreement is attained for the first term when the resulting value is smaller or equal to 0.2.[52] The following formula was used to determine the value:

$$d(\tilde{m}, \tilde{n}) = \sqrt{\frac{1}{3}[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2]}$$

The second term for the Triangular Fuzzy Number involves a percentage of expert agreement. The traditional Delphi technique states that it is acceptable if the expert group agreement exceeds 75%.[53] On the other hand, the Defuzzification Process is the determination of the fuzzy (A) score value based on the α-cut value of 0.5.[54,55] If the fuzzy score value (A) is equal to or greater than 0.5, then the measured item is accepted. Meanwhile, the measured item is rejected if A is less than 0.5. The determination of

fuzzy (A) score value was calculated based on the following formula:

$$A = (1/3) * (m_1 + m_2 + m_3)$$

The triangular fuzzy numbers were established sequentially upon evaluating the collected values of the themes, sub-themes, presentation interface design, interactivity interface design, and instructional strategies.

Results

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, and the experimental conclusions that can be drawn.

Socio-demographic information

Table 4 presents the experts' socio-demographic characteristics. Most experts were females (77%) with degrees (77%). The mean working experience was 12.5 years. The four professions involved in this study were dietitians (77%), a senior lecturer, a family medicine specialist, and a clinical psychologist.

Analysis of the themes for the content

Based on Table 5, all experts accepted the themes for the module's content. All items recorded a threshold (d) value ≤ 0.2. The experts' agreement revealed that all items scored $> 75\%$, and all defuzzification values for items exceeded the value of $\alpha - cut = 0.5$. The items were positioned according to the expert agreement.

Analysis of the presentation interface design

As depicted in Table 6, all experts accepted the presentation interface design of the website. Most items gained 100% consensus from the experts.

Table 4. Socio-demographic characteristics of experts (n = 13).

Characteristics	n (%)	Mean (SD)
Age		36.6 (3.3)
Sex		
• Male	3 (25.1)	
• Female	10 (76.9)	
Education level		
• Degree	10 (76.9)	
• Master	2 (15.4)	
• PhD	1 (7.7)	
Working experience (year)		12.5 (5.6)
Profession		
• Dietitian	10 (76.9)	
• Senior lecturer	1 (7.7)	
• Family Medicine Specialist	1 (7.7)	
• Clinical Psychologist	1 (7.7)	

Table 5. Analysis of the themes for the D-PATH website (n = 13).

		Condition of Triangular Fuzzy Number		Condition of Defuzzification Process	
Item	Name	The threshold value, d	Expert group consensus (%)	Fuzzy score (A)	Expert consensus
1	General information about hypertension	0.040	100.00	0.951	Accepted
2	Management of Sodium Intake	0.065	100.00	0.936	Accepted
3	DASH Diet and recommendation for Fruits, vegetables, and whole grains	0.082	92.30	0.931	Accepted
4	Fat and Alcohol	0.040	100.00	0.951	Accepted
5	Physical Activity and Exercise	0.040	100.00	0.951	Accepted
6	Shopping Tips	0.095	92.31	0.915	Accepted

Table 6. Analysis of the presentation interface design (n = 13).

Item	Name	Condition of Triangular Fuzzy Number		Condition of Defuzzification Process	
		The threshold value, d	Expert group consensus (%)	Fuzzy score (A)	Expert consensus
1	The screen design of the website is simple, attractive and consistent.	0.066	100.00	0.877	Accepted
2	The use of text is straightforward to read.	0.117	100.00	0.859	Accepted
3	The integration of graphics, images, colours and icon buttons is attractive and appropriate.	0.095	100.00	0.836	Accepted
4	The arrangement and structure of the content are organised and engaging.	0.102	100.00	0.844	Accepted
5	The image is realistic to apply the information.	0.072	100.00	0.905	Accepted
6	The graphic elements are used to convey information.	0.076	100.00	0.913	Accepted
7	The video elements are used to convey information.	0.072	100.00	0.928	Accepted
8	The response time on the website is appropriate.	0.076	100.00	0.913	Accepted
9	Has a smooth transition from one display to another.	0.205	84.62	0.833	Accepted
10	The language used is appropriate and easy to understand.	0.164	92.31	0.841	Accepted
11	No technical glitches occurred during the application and presentation.	0.078	100.00	0.885	Accepted
12	The navigation icons are user-friendly.	0.150	92.31	0.844	Accepted
13	The primary menu system is simple and easy to use.	0.105	100.00	0.879	Accepted

Analysis of the interactivity interface design

Based on Table 7, most items accept the website's presentation interface design. Experts rejected items 3 and 10, with the score of 38.5% and 23.8%, respectively. The website did not provide links to other websites or allow users to download all content from the website.

Analysis of the instructional strategies

As highlighted in Table 8, all experts accepted the instructional strategies of the website. Most items gained 100% consensus from the experts.

Discussion

The web was developed in 'Bahasa Malaysia', which is the national language of Malaysia and comprises six units. The content was delivered through notes, infographics, videos and online activities. Numerous behavioural theories can be used to promote behavioural change in the target population. In this study, the transtheoretical model36 and the taxonomy of behaviour change techniques (BCT)37 were used to develop the module. A systematic review suggested using the TTM for digital interventions as it is effective in promoting behaviour change.56 The TTM is appropriate for use in this study because it specifies the mediators to be

Table 7. Analysis of the interactivity interface design (n = 13).

Item	Name	Condition of Triangular Fuzzy Number		Condition of Defuzzification Process	
		The threshold value, d	Expert group consensus (%)	Fuzzy score (A)	Expert consensus
1	Encouraging feedback	0.146	92.30	0.879	Accepted
2	Different forms of feedback (typing answers, clicking options, others.)	0.163	92.30	0.859	Accepted
3	Provide links to other related websites	0.400	38.50	0.708	Rejected
4	Scenarios and activities focus on intended achievement in the learning process.	0.112	92.31	0.877	Accepted
5	Provides a systematic navigation structure to avoid confusion or loss while exploring it	0.249	76.92	0.769	Accepted
6	Provides an easy-to-follow direction for the presentation of information	0.096	92.31	0.908	Accepted
7	Provides more than one form of information access	0.117	100.00	0.895	Accepted
8	Eases the access to information needed	0.105	100.00	0.879	Accepted
9	Provides opportunities to interact through Web 2.0 applications (blog, interactive online wall, interactive whiteboard, forum, WhatsApp group and Facebook)	0.123	92.31	0.892	Accepted
10	Provides facilities to download the material provided	0.403	23.08	0.554	Rejected
11	Provides online evaluation or online reinforcement activities	0.150	92.31	0.844	Accepted
12	Provides user guides to facilitate navigation	0.137	92.31	0.828	Accepted

used at each stage of change. Since the patients in this study are at different stages of readiness for change, the TTM model was the most appropriate. The sequence of the module was set to promote change in the participants from the pre-contemplation stage to the maintenance stage. The taxonomy of behaviour change techniques (BCT) was also used in the development of the module. The BCT specifies the mode of delivery and standardises the intervention protocol in this study. BCT has also been shown to be effective in many studies.[57–59] The use of BCT is beneficial for this study because other researchers can replicate the intervention protocol of the current study. In addition, the content of the module was designed to be suitable for adult learning.[60] Apart from the theories of behaviour change, the instructional design[40,61] was used in the development of the module. The revised version of

Gagne's nine events of instruction was used because it is appropriate for health behaviour change.[41] Bloom's taxonomy was used to ensure that the level of information is arranged from a low to a higher level of difficulty. In addition, the taxonomy indicates the learning objective in each unit of the web.

The website in this study is designed for an educational intervention. This means users are expected to learn, practise, or adjust their behaviour based on the recommendations. Therefore, the model of Internet intervention was used to guide the development of the website.[28] The mode of delivery was selected and coordinated for online usage. For example, the content of the module was delivered using info-graphics, videos and online activities. The cognitive theory of multimedia learning,[62] cognitive load theory,[63] flow theory[32] and the revised version of Nine Gagne's Event of

Table 8. Analysis of the instructional strategies (n = 13).

Item	Name	Condition of Triangular Fuzzy Number		Condition of Defuzzification Process	
		The threshold value, d	Expert group consensus (%)	Fuzzy score (A)	Expert consensus
1	This module uses suitable theories and models to increase knowledge.	0.065	100.00	0.936	Accepted
2	This module uses suitable theories and models to promote behavioural changes.	0.072	100.00	0.928	Accepted
3	This module uses suitable theories and models for website development.	0.076	100.00	0.921	Accepted
4	This module uses suitable learning activities.	0.173	84.62	0.856	Accepted
5	This module clearly specified the objectives of learning.	0.076	100.00	0.921	Accepted
6	This module has an appropriate sequence of learning processes.	0.094	100.00	0.900	Accepted
7	This module uses suitable media elements (graphics, video).	0.072	100.00	0.928	Accepted
8	This module supports learners in recalling prior knowledge.	0.078	100.00	0.885	Accepted
9	This module provides new learning stimuli.	0.076	100.00	0.913	Accepted
10	This module provides guidance.	0.076	100.00	0.921	Accepted
11	This module encourages practice.	0.117	100.00	0.895	Accepted
12	This module allows users and facilitators to provide feedback.	0.095	100.00	0.872	
13	The duration of this module is sufficient.	0.169	92.31	0.831	Accepted

Instruction41 were carefully considered in developing the website, videos and infographics. In addition, the noble concept of edutainment was used in developing the videos.

The web was evaluated using the FDT. This method requires experts to evaluate the content and the website. The FDT method determined the agreement between the content of the module and the website to be used for the educational intervention to control hypertension. FDT is a revised version of the Delphi method to get consensus from experts on specific issues or topics. The Delphi method requires several rounds of discussion among experts to reach an agreement, but the ambiguity and uncertainty of expert opinions persisted.64 Therefore, to overcome the methodological limitations of the Delphi method, Murray introduced the FDT in 1985.65 FDT was used in this study since several rounds of discussion between the researcher and the experts are not required, thus equipped with the capacity to minimise the risk of information loss and avoid any ambiguity in the data. It also allows the experts to express their opinions about the research topic.66 The experts agreed to accept the content of the module based on the FDT analysis. The acceptance of the content could be linked to the selection of the content according to the recommendations of the clinical guidelines for managing hypertension. In terms of the website's presentation interface, user interface interactivity and instructional strategies, all experts agreed on all items except that the website provides links to other related websites and facilities to download the provided material. The website did not include these features to avoid redirecting users to another website. In addition, the materials, especially the

videos, cannot be downloaded as YouTube policies do not allow downloading from the website. However, users can still download the infographics from the websites. Experts commented on the content and the web interface and suggested improvements. All feedback was considered, and measures were taken to improve the website.

The main strength of this study is the novelty of the website development foundation. This website incorporated the Transtheoretical Model theory of behaviour change and the taxonomy of behaviour change techniques for reporting, learning and multimedia theories. The development of the website started by creating a module with digital content such as videos and infographics. Furthermore, the module was structured using Gagne's Events of Instruction and Bloom's taxonomy. Finally, the website was developed based on a specific instructional design for multimedia learning. An internet intervention model was also used to identify important components of the website. In addition, the UTAUT model, cognitive theory of multimedia learning, cognitive load theory and flow theory were employed to develop the website carefully. The use of multiple theories in the development of the website makes it unique and novel compared to other online websites. Secondly, the content of the website is supported by scientific evidence. Experts such as dietitians, a family medicine specialist and a clinical psychologist were involved in validating the website. References are also provided on the website to increase the trustworthiness of the website. Also, the users can read the administrator's profile on the website's home page. Therefore, the users can use the website with confidence. The use of FDT is also one of the strengths of this study because it quantified the experts' consensus of the web application.

The major limitation of the website is the language. The content of the website was developed in Malay, which limits users to those who understand Malay. Apart from this, scientific knowledge may change over time. Therefore, there is a possibility that the content may be outdated. However, the content can be updated from time to time to ensure that it is always relevant. With regard to methodology, the reliability of the questionnaires was not assessed. It is recommended that the reliability of the questionnaire be assessed, and the Cronbach's alpha coefficient be reported for each section. This paper centres its attention on the development of D-PATH, it is suggested that the web shall be further evaluated on its feasibility among hypertension patients. The assessment from patients will shed light on aspects like acceptance, satisfaction, and alterations in knowledge, attitude, and behaviour following their interaction with the D-PATH.

Conclusions

This study showed that D-PATH was valid and ready to be used for nutrition education intervention among patients with hypertension. The web was modified and updated according to the comments from the experts. The use of multiple theories and models make this web distinct and unique from other available online web application. In short, D-PATH is a valid web-based educational tool ready to be used to help disseminate information on dietary and physical activity to manage hypertension. This web application was suitable to share information on dietary and physical activity recommendations for patients with hypertension. However, the web is not to replace medical intervention but can be a helpful tool to complement care for patients with hypertension.

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References

1. Ministry of Health Malaysia. Nutrition Research Priorities in Malaysia for 12th Malaysia Plan (2021-2025). In: *Nutrition*

Division MoHM, 2020, (ed.). Putrajaya: Technical Working Group on Nutrition Research, 2020.

2. World Health Organization. Noncommunicable diseases: Fact Sheet on Sustainable Development Goals (SDGs): Health Targets, https://www.who.int/europe/publications/i/item/WHO-EURO-2017-2381-42136-58046 (2021, accessed 12 December 2022 2021).

3. World Health Organization. Hypertension, https://www.who.int/news-room/fact-sheets/detail/hypertension (2021, accessed 29 October 2022 2022).

4. Brouwers S, Sudano I, Kokubo Y, et al. Arterial hypertension. *Lancet* 2021; 398: 249–261.

5. Zhou B, Perel P, Mensah GA, et al. Global epidemiology, health burden and effective interventions for elevated blood pressure and hypertension. *Nat Rev Cardiol* 2021; 18: 785–802. 20210528.

6. Institute for Public Health. National Health and Morbidity Survey (NHMS) 2019: Vol. I: NCDs – Non-Communicable Diseases: Risk Factors and other Health Problems, https://iptk.moh.gov.my/images/technical_report/2020/4_Infographic_Booklet_NHMS_2019_-_English.pdf (2019, accessed June 6, 2021 2021).

7. Abdul-Razak S, Daher AM, Ramli AS, et al. Prevalence, awareness, treatment, control and socio demographic determinants of hypertension in Malaysian adults. *BMC Public Health* 2016; 16: 351. 2016/04/22.

8. Meelab S, Bunupuradah I, Suttiruang J, et al. Prevalence and associated factors of uncontrolled blood pressure among hypertensive patients in the rural communities in the central areas in Thailand: a cross-sectional study. *PLoS One* 2019; 14: e0212572. 20190219.

9. Khan AU, Falah SF, Shah SAS, et al. The prevalence and associated risk factors of uncontrolled hypertension amongst antihypertensive medicines taking patients. *Pak J Med Health Sci* 2022; 16: 833–835.

10. Baumer-Harrison C, Breza JM, Sumners C, et al. Sodium intake and disease: another relationship to consider. *Nutrients* 2023; 15: 35.

11. World Health Organization. Hypertension, https://www.who.int/news-room/fact-sheets/detail/hypertension (2021, accessed 2 December 2021).

12. Rabi DM, McBrien KA, Sapir-Pichhadze R, et al. Hypertension Canada's 2020 comprehensive guidelines for the prevention, diagnosis, risk assessment, and treatment of hypertension in adults and children. *Can J Cardiol* 2020; 36: 596–624.

13. Umemura S, Arima H, Arima S, et al. The Japanese society of hypertension guidelines for the management of hypertension (JSH 2019). *Hypertens Res* 2019; 42: 1235–1481.

14. Working Group on Hypertension CPG. *Clinical Practice Guideline on Management of Hypertension*, Putrajaya: Ministry of Health, 2018. https://www.moh.gov.my/moh/resources/penerbitan/CPG/MSH%20Hypertension%20CPG%202018%20V3.8%20FA.pdf (2018, accessed August 31, 2019).

15. Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH guidelines for the management of arterial hypertension. *Eur Heart J* 2018;39: 3021–3104. 2018/08/31.

16. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American college of cardiology/American heart association task force on clinical practice guidelines. *J Am Coll Cardiol* 2018; 71: e127–e248. 2017/11/18.

17. Hamid A, Allam FN B, Buhari SB, et al. Health information seeking behaviours during COVID-19 among patients with hypertension in selangor. *Environ Behav Proc J* 2022; 7: 149–155.

18. Dean CA, Geneus CJ, Rice S, et al. Assessing the significance of health information seeking in chronic condition management. *Patient Educ Couns* 2017; 100: 1519–1526. 20170307.

19. Tan SS and Goonawardene N. Internet health information seeking and the patient-physician relationship: a systematic review. *J Med Internet Res* 2017; 19: e9. 20170119.

20. Bitar H and Alismail S. The role of eHealth, telehealth, and telemedicine for chronic disease patients during COVID-19 pandemic: a rapid systematic review. *Digit Health* 2021; 7: 20552076211009396. 2021/05/08.

21. Baderol Allam FN, Ab Hamid MR, Buhari SS, et al. Web-based dietary and physical activity intervention programs for patients with hypertension: scoping review. *J Med Internet Res* 2021; 23: e22465. 2021/03/16.

22. Rasmussen B, Wynter K, Hamblin PS, et al. Feasibility and acceptability of an online guided self-determination program to improve diabetes self-management in young adults. *Digital Health* 2023; 9: 20552076231167008. 20230330.

23. Sillence E, Briggs P, Harris P, et al. Health websites that people can trust – the case of hypertension. *Interact Comput* 2007; 19: 32–42.

24. Muzquiz-Barbera P, Ruiz-Cortes M, Herrero R, et al. The impact of a web-based lifestyle educational program ('living better') reintervention on hypertensive overweight or obese patients. *Nutrients* 2022; 14: 2235.

25. Chen TY, Kao CW, Cheng SM, et al. A web-based self-care program to promote healthy lifestyles and control blood pressure in patients with primary hypertension: a randomized controlled trial. *J Nurs Scholarsh* 2022; 54: 678–691. 20220608.

26. Lokker C, Jezrawi R, Gabizon I, et al. Feasibility of a web-based platform (trial my app) to efficiently conduct randomized controlled trials of mHealth apps for patients with cardiovascular risk factors: protocol for evaluating an mHealth app for hypertension. *JMIR Res Protoc* 2021; 10: e26155. 20210201.

27. Neuenschwander LM, Abbott A and Mobley AR. Comparison of a web-based vs in-person nutrition education program for low-income adults. *J Acad Nutr Diet* 2013; 113: 120–126. 20121023.

28. Ritterband LM, Thorndike FP, Cox DJ, et al. A behavior change model for internet interventions. *Ann Behav Med* 2009; 38: 18–27. 2009/10/06.

29. Cavero-Redondo I, Saz-Lara A, Sequi-Dominguez I, et al. Comparative effect of eHealth interventions on hypertension management-related outcomes: a network meta-analysis. *Int J Nurs Stud* 2021; 124: 104085. 20210905.

30. Richey RC and Klein JD. Developmental research methods: creating knowledge from instruction design and develpment practice. *J Comput Higher Educ* 2005; 16: 23–38.

31. Venkatesh, Morris, Davis, et al. User acceptance of information technology: toward a unified view. *MIS Q* 2003; 27: 25.

32. Csikszentmihalyi M. *Beyond boredom and anxiety.* San Francisco: CA: Jossey-Bass, 1975.

33. Mayer RE. Multimedia learning: are we asking the right questions? *Educ Psychol* 1997; 32: 1–19.

34. Alnasuan A. Color psychology. *Am Res J Humanit Soc Sci* 2016; 1: 1–6.

35. Gu Z and Lou J. Data driven webpage color design. *Comput Aided Des* 2016; 77: 46–59.

36. Prochaska JO and Velicer WF. The transtheoretical model of health behavior change. *Am J Health Promot* 1997; 12: 38–48.

37. Michie S, Richardson M, Johnston M, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Ann Behav Med* 2013; 46: 81–95.

38. NICE. Hypertension in adults: diagnosis and management, www.nice.org.uk/guidance/ng136 (2020, accessed August 31, 2020).

39. Unger T, Borghi C, Charchar F, et al. International society of hypertension global hypertension practice guidelines. *Hypertension* 2020; 75(6): 1334–1357. 2020/05/07.

40. Center for the Advancement of Teaching Excellence (CATE). *Bloom's taxonomy of educational objectives.* Chicago: University of Illinois Chicago, 2003, p. 5.

41. Kinzie MB. Instructional design strategies for health behavior change. *Patient Educ Couns* 2005; 56: 3–15.

42. Ab Hamid MR, Mohd Yusof NDB, Buhari SS, et al. Development and validation of educational video content, endorsing dietary adjustments among patients diagnosed with hypertension. *Int J Health Promot Educ* 2021; 7: 1–12.

43. Hamid MR A, Yusof NDB M and Buhari SS. Understandability, actionability and suitability of educational videos on dietary management for hypertension. *Health Educ J* 2022; 81: 238–247.

44. Berliner DC. Describing the behavior and documenting the accomplishments of expert teachers. *Bull Sci Technol Soc* 2004; 24: 200–212. 20200715.

45. Gambatese JA, Behm M and Rajendran S. Design's role in construction accident causality and prevention: perspectives from an expert panel. *Saf Sci* 2008; 46: 675–691. 20200715.

46. Adler M and Ziglio E. *Gazing Into the Oracle: The Delphi Method and Its Application to Social Policy and Public Health.* London: Jessiva Kingsley Publication, 1996.

47. Jones H and Twiss BL. *Forecasting Technology for Planning Decisions.* New York: Macmillan, 1978.

48. Skulmoski GJ, Hartman FT and Krahn J. The delphi method for graduate research. *J Inf Technol Educ* 2007; 6: 1–21.

49. Okoli C and Pawlowski SD. The Delphi method as a research tool: an example, design considerations and applications. *Inf Manag* 2004; 42: 15–29.

50. Mohamed Yusoff AF, Hashim A, Muhamad N, et al. Application of fuzzy delphi technique towards designing and developing the elements for the e-PBM PI-poli module. *Asian J Univ Educ* 2021; 17: 92.

51. Mohd Jamil MR and Mat Noh N. *Kepelbagaian Metodologi dalam Penyelidikan Reka Bentuk dan Pembangunan.* Bangi: Qaisar Prestige Resources, 2020.

52. Cheng C-H and Lin Y. Evaluating the best main battle tank using fuzzy decision theory with linguistic criteria evaluation. *Eur J Oper Res* 2002; 142: 174–186.

53. Chu HC and Hwang GJ. A delphi-based approach to developing expert systems with the cooperation of multiple experts. *Expert Syst Appl* 2008; 34: 2826–2840. 20070518.

54. Tang C-W and Wu C-T. Obtaining a picture of undergraduate education quality: a voice from inside the university. *High Educ* 2010; 60: 269–286.

55. Bodjanova S. Median alpha-levels of a fuzzy number. *Fuzzy Sets Syst* 2006; 157: 879–891.

56. Hasriani, Sjattar EL and Arafat R. Transtheoretical model on the self-care behavior of hypertension patients: a systematic review. *J Health Res* 2022; 36: 847–858.

57. Michie S, Abraham C, Whittington C, et al. Effective techniques in healthy eating and physical activity interventions: a meta-regression. *Health Psychol* 2009; 28: 690–701.

58. Michie S, Hyder N, Walia A, et al. Development of a taxonomy of behaviour change techniques used in individual behavioural support for smoking cessation. *Addict Behav* 2011; 36: 315–319.

59. West R, Walia A, Hyder N, et al. Behavior change techniques used by the English stop smoking services and their associations with short-term quit outcomes. *Nicotine Tob Res* 2010; 12: 742–747. 20100517.

60. Bryan RL, Kreuter MW and Brownson RC. Integrating adult learning principles into training for public health practice. *Health Promot Pract* 2009; 10: 557–563. 2008/04/04.

61. Gagne RM, Wager WW, Golas KG, et al. Principles of instructional design. *Perform Improv* 2005; 44: 44–46.

62. Fisch SM. Bridging theory and practice: applying cognitive and educational theory to the design of educational Media. *Cognitive development in digital contexts.* Amsterdam, Netherlands: Elsevier Science, 2017, pp. 217–234.

63. Sweller J. Cognitive load theory, learning difficulty, and instructional design. *Learn Instr* 1994; 4: 295–312.

64. Roldán López de Hierro AF, Sánchez M, Puente-Fernández D, et al. A fuzzy delphi consensus methodology based on a fuzzy ranking. *Mathematics* 2021; 9: 2323.

65. Murray TJ, Pipino LL and van Gigch JP. A pilot study of fuzzy set modification of delphi. *Hum Syst Manage* 1985; 5: 76–80.

66. Saffie NAM, Shukor NM and Rasmani KA. Fuzzy delphi method: issues and challenges. In: 2016 International Conference on Logistics, Informatics and Service Sciences (LISS) 24-27 July 2016, 2016, pp.1–7.