

ORIGINAL ARTICLE

Development and Evaluation of Animated Videos Promoting Healthy Diet During Pregnancy and Exclusive Breastfeeding for Healthy Child Growth

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ABSTRACT

Introduction: Healthy and adequate maternal nutrition during pregnancy and exclusive breastfeeding are helpful for preventing child stunting, yet educational tools to promote this, particularly on digital platforms, are still lacking. Thus, this study aimed to develop and evaluate a series of animated videos for nutrition educational purpose. **Methods:** A design and developmental research method consisting of content analysis, video design and development, and video evaluation phases was utilised in this study. The video storyboards and scripts were created based on a review of literature and guidelines and evaluated by six field experts. The videos were created using Powtoon software and evaluated by multimedia experts to ensure technical quality. Fifty reproductive-aged women assessed the understandability, actionability, and suitability of the videos using the PEMAT-AV and SAM tools. **Results:** Four short, animated videos were developed regarding the recommended intakes of total calories, macronutrients, and micronutrients for pregnant and exclusively breastfeeding mothers. The storyboards and scripts were approved by content experts in terms of objectives, structure, presentation, and relevance. The videos also received favourable responses from the target viewers, with scores ranging from 96% to 100% for understandability, 95% to 99% for actionability, and 94% to 99% for suitability. **Conclusion:** The newly developed animated video series on healthy maternal nutrition during pregnancy and exclusive breastfeeding was approved by content and multimedia experts. They were also found to have desirable levels of suitability, understandability, and actionability. These indicate its acceptability as a nutrition education tool for promoting healthy child growth through maternal nutrition.

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INTRODUCTION

The nutritional status of mothers during pregnancy and breastfeeding periods determines the long-term outcomes of child health and development. Poor nutritional status of mothers such as low body mass index (BMI <18.5 kg/m²), as well as inadequate energy and nutrient intake before or during pregnancy can lead to intrauterine growth retardation, low birth weight, and subsequently, child stunting (1, 2). According

to the conceptual framework of malnutrition by the United Nations International Children's Emergency Fund (UNICEF), dietary intake (in the first 1000 days) and childhood diseases are important determinants of nutrient intake, nutrient needs, and utilisation among the paediatric population (3). Inadequate nutrient intake not only affects linear growth but also other processes such as the development of the brain and the immune system. As the foetus depends on the mother for its nutrition, maternal diet and nutritional status during pregnancy followed by exclusive breastfeeding in the postnatal period are vital for the child's health and development (3).

Child stunting has been linked to increased morbidity and

mortality, delayed mental development, poor learning performance, reduced cognitive ability, and barriers to participation in communities (4, 5). Furthermore, stunting is also related to an increased risk of non-communicable diseases (NCDs) such as diabetes, obesity, and cardiovascular disease later in life (4). According to the Joint Malnutrition Estimates (JME) 2023, the prevalence of stunting among children under the age of five years has increased from 17.6% in 2012 to 21.9% in 2022 (5). In Malaysia, the National Health and Morbidity Survey found that 20.7% of children in Malaysia suffered from stunted growth (6). Although there are many factors that contribute to childhood growth failure, foetal growth restriction may have a significant role in stunting among children (7). According to a recent systematic review and meta-analysis conducted in our neighbouring country, Indonesia, low birth weight is indicated as a risk factor for stunting (8). Indeed, low birth weight was associated with >2-fold increased risk of childhood stunting among the 0-5 years age group with a moderately higher risk being detected in Asia as compared to Africa (9). This suggests the importance of maternal nutritional status, particularly during pregnancy, for healthy foetal growth and development.

Patient education plays an essential role in improving patient's health literacy, empowerment, and participation in disease management (10). Thus, in the latest WHO global strategy on digital health, strategic and innovative use of digital information and communications (ICT) has been widely acknowledged as an essential enabling factor towards the rapid improvement of health (11). Furthermore, ICT-mediated media, with the Internet at the forefront, are increasingly adopted for health communication, especially in view of its flexibility and accessibility (12).

In recent years, with the advent of mass media, especially online media, public health disease prevention, and community health management strategies have become more attainable (13). Common media used to communicate health information to the community include the Internet (social media, websites, podcasts, and videos) (14). These formats have been shown as more effective than conventional media such as radio and television in improving health knowledge, user satisfaction, self-efficacy, and health behaviour. Specifically, video-based educational methods were reported as effective in promoting behavioural changes (15, 16). It also conferred additional advantages over other media, such as it can be watched by different people at different times, information can be standardised and used to explain certain concepts that are difficult to be communicated in printed media. Among the different types of video-based educational formats, the animated video format appears to be more popular as it does not require actors or camera equipment. As a result, its content can be updated in a convenient and flexible manner (17).

While the important role of maternal nutrition during the first 1,000 days of life is widely acknowledged, very limited nutrition education tools in digital format are available to deliver important nutrition information for stunting prevention. The gap is especially notable in Malaysia despite the worrying prevalence of stunting. In view of this, this study aimed to develop a nutritional education module in the form of an animated video series to advocate healthy maternal nutrition during pregnancy and exclusive breastfeeding periods for the prevention of child stunting. In addition, the video series will be evaluated in terms of understandability, actionability, and suitability to ascertain its feasibility in the delivery of useful information that is easily understood and engaging for the targeted viewers.

MATERIALS AND METHODS

A design and developmental research (DDR) methodology consisting of three stages: (I) content analysis, (II) design and development, and (III) evaluation (pilot study) was utilised to develop the animated nutritional education videos. This systematic process ensured that the educational animated videos were developed and validated for their intended purpose.

Stage I: Content Analysis

The content analysis was conducted to gather relevant information before deciding on to content to be included in the video. In the current study, the aim was to identify factors related to maternal dietary intake during periods of pregnancy and exclusive breastfeeding that contributed to stunting in children. This analysis was conducted using two approaches, i.e. a systematic review of the literature and a review of all the identified evidence-based practice guidelines.

Literature Review

A systematic literature review of the relationship between maternal dietary intake and childhood stunting was conducted on four databases: Web of Science, Scopus, PubMed, and Google Scholar. The PICOS search tools, which encompass population, intervention, outcome, and research type, served as the basis for the keywords utilised to find similar studies. Maternal, "pregnant women," "nurturing," "gestation," "reproductive age," "retard growth," "low birth weight," "low height for age," "stunting," "pregnancy diet intake," "maternal nutrition," "nutrients deficit," "macronutrients deficits," and "micronutrients deficits" were the search terms used based on these. Other details of the review methodology are presented elsewhere (18).

Evidence-based Practice Guidelines Review

In addition, a review was also conducted on all currently available practice guidelines that matched the sociocultural values of the study population. Some of the common guidelines used in Malaysia

included Recommended Nutrition Intakes for Malaysia (RNI) (19) and documents from the Family Health Development Division, Ministry of Health Malaysia. The recommendations retrieved from the guidelines included the requirement of macronutrients and micronutrients for both pregnant ladies and mothers who are exclusively breastfeeding.

Stage II: Video Design and Development Storyboard and Script Construction

A storyboard containing the learning objectives, learning approaches, and subtopics was developed for each video. The content of the videos was designed following Bloom's taxonomy (20). It includes 'remembering' (C1) and 'understanding' (C2) all the cognitive domain levels. Health Belief Model and Cognitive Load Theory were also used to emphasise nutrition knowledge and practices in the storyboard (21, 22). During the composition of the storyboard, the team paid special attention to ensure the video would be suitable for the target population, the intended time and setting of implementations, the time allocated, as well as effective in improving the knowledge, attitude, and practice of individuals. Following the development of the storyboard, the script for the videos was constructed in Malay, the national language of Malaysia.

The content for each video was guided by the review of the literature and the local practice guidelines in the previous stage. The proposed topics to be covered in the videos included: (i) Total energy and macronutrient requirements for pregnant mothers towards the prevention of child stunting, (ii) Total energy and macronutrient requirements for exclusively breastfeeding mothers towards the prevention of child stunting, (iii) Vitamin requirements for pregnant and exclusively breastfeeding mothers, and lastly (iv) Mineral requirements for pregnant and exclusively breastfeeding mothers.

Content Validity Assessment

The storyboard and video scripts were evaluated by content experts to ensure accuracy and relevance using the Content Validity Index (CVI). At least 6-10 experts should be recruited based on the literature recommendation (23). Therefore, six experts in the field of nutrition and dietetics with a minimum of five years of working experience were invited via email to assess the video scripts. They were asked to rate the animated videos using the Educational Content Validation Instrument in Health on a Likert scale ranging from 0 = disagree, 1 = partially agree, to 2 = totally agree (24). This tool is commonly used to validate educational content in videos, games, websites, and software. In this study, 14 items from three domains (objective, structure/presentation, and relevance) were assessed. A comment section was provided for each item to allow the experts to explain their rating choices and provide recommendations for further improvement. The CVI

of each item (I-CVIs) was first obtained by dividing the number of experts who rated scores 1 or 2 with the total number of experts. The CVI of relevancy can be calculated on both item level (I-CVIs) and scale level (S-CVI). Items rated as 1 and 2 would be combined and labelled as 'Relevant' while items with value 0 would be labelled as 'Not Relevant'. For the average item level CVIs (S-CVI/Ave) approach, the total of I-CVIs must be divided by the total number of items, and a threshold of 80% agreement is needed to confirm the relevance of the instrument items (24).

Based on the feedback of the content experts, improvement was made to the storyboard and scripts of the video. The revised storyboard and scripts were sent back to the experts for a second-round review before final approval. The final script was also sent to a language expert to be translated into English subtitles.

Video Design and Development

Next, the video design and development were performed using an iterative production and multimedia review process. Based on the approved storyboard and scripts by the content experts, four animated video series were developed using Powtoon (Powtoon Ltd., London, UK), a video-making software. The videos were enhanced with images and graphics obtained from the Freepik image bank website (Freepik Company, Malaga, Spain). A Malay voice-over was used for video narration and English subtitles were included. The final video iterative was evaluated by two research team members with vast experience in video production and a specialist in multimedia production to ensure technical quality.

Stage III: Video Evaluation

In the final step of video production, representatives of the target audience were invited to review the acceptability and adequacy of the videos. A total of 50 women of childbearing age (15 to 49 years) were conveniently sampled to participate in a pilot study aimed at evaluating the understandability, actionability, and suitability of the videos. The inclusion criteria were Malaysian women of childbearing age (between 18 and 49 years) based on the World Health Organization (WHO)'s definition of women in their reproductive years (25) who understand Malay or English language. There is no recommended sample size for the evaluation of health educational videos, but similar research in the past included between 22 and 50 participants (26-28). Since the evaluation was conducted during the COVID-19 pandemic (April to October 2021), all communications with the participants were done online via emails and WhatsApp. To recruit the study participants, a brief study description and an online invitation with a clickable link were disseminated via public Facebook groups for pregnancy support (Malaysia) and breastfeeding support (Pahang). In addition, to get more participation, the invitation was also circulated among WhatsApp groups for staff and postgraduate students at the university

where the study was conducted. An instruction page containing a link to the animated videos posted on YouTube and the questionnaires were shared with the participants who volunteered to take part in the study.

Evaluation of Understandability and Actionability

Each video was evaluated using the Patient Education Materials Assessment Tool for Audio-Visual Material (PEMAT-AV) (29). Both the original English version and the translated Malay version were attached to the email to the participants. It comprises 13 items to measure understandability and 4 items to measure actionability (30). Understandability means that the video can be processed by its audience and the key messages can be comprehended by people from various backgrounds and health literacy levels. Actionability refers to the consumers' ability to determine what actions need to be taken based on the information offered in the education video. The response to each question can be either "Agree" (one point) or "Disagree" (zero point). The understandability scores were summed, divided by the total maximum scores (22), and converted into percentages. The same method of calculation was used for actionability. The videos were considered understandable and actionable with a total score of more than 70% (29).

Evaluation of Suitability

The suitability of the educational videos was assessed using the Suitability Assessment of Materials (SAM) tool (31). The tool consists of 15 items in six areas: i) Content, ii) Literacy demand, iii) Graphics and illustrations, iv) Layout and typography, v) Learning stimulation and motivation, as well as vi) Cultural appropriateness. Each question can be rated as Superior (2 points), Adequate (1 point), or Not Suitable (0 points). To obtain the final percentage, the obtained points would be divided by the total maximum points. The suitability of the education materials is determined based on 0-39% (not suitable), 40-69% (adequate), and 70-100% (superior) (31).

Ethical Approval

This study obtained ethical clearance from the International Islamic University Malaysia (IIUM) Research and Ethics Committee (IIUM/504/14/11/2/ IREC2021-062). An informed consent description was also attached to the online questionnaire. The respondents were duly informed that answering the questionnaire would indicate their agreement for voluntary participation in the study.

RESULTS

Content Analysis

A systematic literature review was conducted to determine the association between maternal dietary intake and childhood stunting (18). The findings

indicated that pregnant women need to eat a diverse diet with the inclusion of at least five food groups to fulfil the nutritional requirement. A protein intake between 0.8 and 1.1 g/kg body weight daily is recommended for positive birth weight and height outcomes. Supplementation of vitamin A, vitamin C, iron, zinc, vitamin D, and calcium, was also shown to improve pregnancy outcomes.

In addition, based on a review of available practice guidelines, the RNI (19) and Perinatal Care Manual (32) suggest different energy intakes for each trimester of pregnancy to maintain a healthy foetus. Carbohydrate intake should reach 50% to 65% of the total energy requirement daily, while an additional 0.5 g, 8 g, 25 g, and 19 g of protein is required during the first, second, and third trimesters and exclusive breastfeeding, respectively, to achieve the daily protein requirement (19). Fat intake should be 25% to 30%, with different values for each trimester (19, 32). Post-delivery, mothers should aim for a higher fat content of 66 to 79 g/day to achieve sufficient fat intake during lactation. Pregnant and lactating mothers also need vitamins A, B complex, C, and D, as well as essential minerals such as iron, calcium, and iodine (32).

Video Design and Development

Content Validity

The storyboard and script for each topic were evaluated by experts in nutrition and dietetics (N=6). These included two dietitians, a nutritionist, two dietetics lecturers, and one nutrition lecturer with working experience between five and twelve years.

Table I shows the results of the content expert evaluation. For the domain of 'Objectives' that comprises of purpose, goals, or target, two out of four items (Items 1 and 2) achieved an I-CVI value of 1, indicating that all experts agreed the videos fulfilled the proposed theme and were appropriate for the teaching-learning process. In contrast, both Item 3 ('Clarifies doubts on the addressed theme') and Item 4 ('Provides reflection on the theme') obtained a 5 out of 6. However, the achieved S-CVI/Ave value of 0.92 exceeded the agreement score of 0.80. Thus, the 'Objectives' domain was deemed acceptable by the content experts. In addition, all seven items in the 'Structure/Presentation: Organisation, structure, strategy, consistency and sufficiency' domain achieved I-CVI values of 1.0, indicating universal experts' agreement. Therefore, the designed contents are considered to have interactive language, objective information, and a reasonable sequence of thoughts. Similarly, the domain 'Relevance: Significance, impact, motivation, and interest' also received universal experts' agreement with a S-CVI/Ave score of 1.0. All experts agreed that the video content can encourage learning, contribute to knowledge in the area, and arouse interest in the theme.

Table I: Ratings of the domains of objectives, structure/presentation, and relevance by experts (N=6)

Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert in agreement	I-CVI	UA
Objectives: Purpose, goals, or target									
1. Contemplates the proposed theme	1	1	1	1	1	1	6	1	1
2. Suits the teaching-learning process	1	1	1	1	1	1	6	1	1
3. Clarifies doubts on the addressed theme	1	1	0	1	1	1	5	0.83	0
4. Provides a reflection on the theme	1	1	1	0	1	1	5	0.83	0
							S-CVI/Ave	0.92	
Proportion Relevance	1	1	0.75	0.75	1	1	S-CVI/UA		0.5
The average proportion of items judged as relevant across six experts 0.92									
Structure/Presentation: Organisation, structure, strategy, consistency, and sufficiency									
5. Language appropriate to the target audience	1	1	1	1	1	1	6	1	1
6. Interactive language, enabling active involvement in the educational process	1	1	1	1	1	1	6	1	1
7. Correct information	1	1	1	1	1	1	6	1	1
8. Objective information	1	1	1	1	1	1	6	1	1
9. Enlightening information	1	1	1	1	1	1	6	1	1
10. Necessary information	1	1	1	1	1	1	6	1	1
11. Logical sequence of ideas	1	1	1	1	1	1	6	1	1
							S-CVI/Ave	1	
Proportion Relevance	1	1	1	1	1	1	S-CVI/UA		1
The average proportion of items judged as relevant across six experts 1									
Relevance: Significance, impact, motivation, and interest									
12. Encourages learning	1	1	1	1	1	1	6	1	1
13. Contributes to knowledge in the area	1	1	1	1	1	1	6	1	1
14. Arouses interest in the theme	1	1	1	1	1	1	6	1	1
							S-CVI/Ave	1	
Proportion Relevance	1	1	1	1	1	1	S-CVI/UA		1
Average proportion of items judged as relevant across six experts 1									

Video Development

Four animated videos of four to five minutes duration were developed. Each video starts with an introduction and concludes with a take-home message. Terms and languages that are easy to understand, attractive and colourful graphics, captioned pictures, and illustrations of food examples appropriate for the local populations were used in the videos. The requirements for total calories, macronutrients, and micronutrients were shown in numbers while the examples of foods were displayed as images. All fonts were standardised across the videos, and not more than three font types were used to improve readability.

Multimedia Review

Most of the comments received from the review of the video iterative revolved around the areas of visual

enhancement, content organisation, and presentation. In terms of visual enhancement, reviewers suggested the removal of the white background in some images as well as using pictures with larger pixels for better resolution. Additionally, they also commented that motion and animation should be used carefully even though they are powerful tools in video. For instance, some experts advised against using motions that were not directly relevant to the video content as excessive movements could distract the viewers and affect the information delivery. Irrelevant animations should also be removed so that they will not interfere with the focus of the video. Regarding content organisation and presentation, the experts felt that subtitles should be presented in a single line to improve readability. In addition, transitions should be added between the subtopics to alert the viewers. An outline of all the contents can be added at the beginning

of each video to provide systematic guidance for the viewers. In short, the experts emphasised using clear, simple, and focused presentations to effectively convey the intended message and information.

Video Evaluation

The understandability, actionability, and suitability of the videos were evaluated by 50 participants (Table II). These comprised Malay women with ages ranging from 18 to 46, with a mean age of 25.4. The majority of them completed tertiary education, while 20.0% (n=10) graduated from secondary schools. About one-third of the participants were married (34.0%).

Table II: Sociodemographic characteristics of study participants (N=50)

Demographics	N	%	Mean $\pm$ SD
Age (18 – 46 years)			25.4 $\pm$ 6.5
Education level			
Secondary	10	20.0	
Pre-university	3	6.0	
Diploma	2	4.0	
Bachelor's degree	29	58.0	
Master's degree/ Ph.D.	6	12.0	
Marital status			
Single	33	66.0	
Married	17	34.0	
Number of children (0 – 4 children)			0.5 $\pm$ 1.0
None	36	72.0	
1 to 2	11	22.0	
3 to 4	3	6.0	

Evaluation of Understandability and Actionability

All four videos were given scores of more than 70%, signifying that they were understandable and actionable (Table III). With a score from 96% to 100% for understandability and from 95% to 99% for actionability, the videos were considered meaningful, informative, and easily understood. The fourth video entitled "Mineral requirements during pregnancy and exclusive breastfeeding" scored 100% on the understandability test, indicating that all participants agreed that the video was completely understandable.

Table III: Mean (SD) score percentage for understandability, actionability, and suitability of the video (N=50)

Video topic	Understandability	Actionability	Suitability
1. Total energy and macronutrient requirements during pregnancy	96 (5.9)%	95 (9.8)%	94 (5.9)%
2. Total energy and macronutrient requirements during exclusive breastfeeding	98 (6.0)%	99 (3.9)%	97 (7.5)%
3. Vitamin requirements during pregnancy and exclusive breastfeeding	99 (2.5)%	99 (3.9)%	98 (3.7)%
4. Mineral requirements during pregnancy and exclusive breastfeeding	100%	99 (4.0)%	99 (3.1)%

SD: Standard deviation

Additionally, almost all the target viewers (99.5%) agreed that the purpose of all four videos was clear and evident (Table IV). For the first video, 76% percent of the participants agreed that the video did not include any information or content that could distract the viewers from its intended purpose. Most of the study participants also agreed that common layman language (99%) and active voice (99.5%) were used in all the videos. At least 86% of the respondents agreed that the videos applied medical terms only when they needed the viewers to be familiarised with the concept. They were satisfied with the use of active voice and the division of information into short sections. More importantly, all of them agreed that the numbers shown in the videos were easy to comprehend.

Table IV: Assessment of understandability and actionability by target viewers (N=50).

		N (%)			
Understandability		Video 1	Video 2	Video 3	Video 4
Content					
This video makes its purpose completely evident					
-	Agree	50 (100%)	49 (98%)	50 (100%)	50 (100%)
-	Disagree	0 (0%)	1 (2%)	0 (0%)	0 (0%)
The material does not include information or content that distracts from its purpose					
-	Agree				
-	Disagree	38 (76%)	46 (92%)	47 (94%)	48 (96%)
		12 (24%)	4 (8%)	3 (6%)	2 (4%)
Word choice & styles					
This video uses common, everyday language					
-	Agree	48 (96%)	50 (100%)	50 (100%)	50 (100%)
-	Disagree	2 (4%)	0 (0%)	0 (0%)	0 (0%)
Medical terms are used only to familiarise the audience with the terms. When used, medical terms are defined					
-	Agree	43 (86%)	47 (94%)	49 (98%)	50 (100%)
-	Disagree	7 (14%)	3 (6%)	1 (2%)	0 (0%)
This video uses the active voice					
-	Agree	49 (98%)	50 (100%)	50 (100%)	50 (100%)
-	Disagree	1 (2%)	0 (0%)	0 (0%)	0 (0%)
Use of numbers					
Numbers appearing in the material are clear and easy to understand					
-	Agree				
-	Disagree	50 (100%)	50 (100%)	50 (100%)	50 (100%)
		0 (0%)	0 (0%)	0 (0%)	0 (0%)
The material does not expect the user to perform calculations					
-	Agree				
-	Disagree	43 (86%)	46 (92%)	49 (98%)	50 (100%)
		7 (14%)	4 (8%)	1 (2%)	0 (0%)
Organisation					
This video's sections have informative headers					
-	Agree	49 (98%)	48 (96%)	50 (100%)	50 (100%)
-	Disagree	1 (2%)	2 (4%)	0 (0%)	0 (0%)
This video presents information in a logical sequence					
-	Agree	50 (100%)	49 (98%)	50 (100%)	50 (100%)
-	Disagree	0 (0%)	1 (2%)	0 (0%)	0 (0%)
This video provides a summary					
-	Agree	43 (86%)	49 (98%)	50 (100%)	50 (100%)
-	Disagree	7 (14%)	1 (2%)	0 (0%)	0 (0%)
Layout and design					
This video uses visual cues (e.g., arrows, boxes, bullets, bolds, larger font, highlighting) to draw attention to key points					
-	Agree				
-	Disagree	49 (98%)	49 (98%)	49 (98%)	50 (100%)
		1 (2%)	1 (2%)	1 (2%)	0 (0%)
The text on the screen is easy to read					
-	Agree	49 (98%)	50 (100%)	50 (100%)	49 (98%)
-	Disagree	1 (2%)	0 (0%)	0 (0%)	1 (2%)
This video allows the user to hear the words clearly (e.g., not too fast, not garbled)					
-	Agree				
-	Disagree	49 (98%)	50 (100%)	50 (100%)	50 (100%)
		1 (2%)	0 (0%)	0 (0%)	0 (0%)
Use of visual aids					
The material uses visual aids whenever they can make content more easily understood (e.g. illustration of healthy portion)					
-	Agree				
-	Disagree	50 (100%)	49 (98%)	50 (100%)	50 (100%)
		0 (0%)	1 (2%)	0 (0%)	0 (0%)
The material's visual aids reinforce rather than distract from the content					
-	Agree				
-	Disagree	50 (100%)	50 (100%)	50 (100%)	50 (100%)
		0 (0%)	0 (0%)	0 (0%)	0 (0%)

CONTINUE

Table IV: Assessment of understandability and actionability by target viewers (N=50). (CONT.)

		N (%)			
Understandability		Video 1	Video 2	Video 3	Video 4
Content					
Use of visual aids					
The material's visual aids have clear titles or captions					
-	Agree	49 (98%)	49 (98%)	49 (98%)	50 (100%)
-	Disagree	1 (2%)	1 (2%)	1 (2%)	0 (0%)
This video uses illustrations and photographs that are clear and uncluttered.					
-	Agree	50 (100%)	49 (98%)	50 (100%)	50 (100%)
-	Disagree	0 (0%)	1 (2%)	0 (0%)	0 (0%)
The material uses simple tables with short and clear row and column heading					
-	Agree	49 (98%)	49 (98%)	49 (98%)	50 (100%)
-	Disagree	1 (2%)	1 (2%)	1 (2%)	0 (0%)
Actionability					
This video clearly identifies at least one action the user can take					
-	Agree	50 (100%)	50 (100%)	50 (100%)	50 (100%)
-	Disagree	0 (0%)	0 (0%)	0 (0%)	0 (0%)
This video addresses the user directly when describing actions					
-	Agree	49 (98%)	50 (100%)	50 (100%)	50 (100%)
-	Disagree	1 (2%)	0 (0%)	0 (0%)	0 (0%)
This video breaks down any action into manageable, explicit steps					
-	Agree	47 (94%)	49 (98%)	49 (98%)	50 (100%)
-	Disagree	3 (6%)	1 (2%)	1 (2%)	0 (0%)
The material provides a tangible tool (e.g., menu planners, checklist) whenever it could help the user take action					
-	Agree	49 (98%)	50 (100%)	50 (100%)	50 (100%)
-	Disagree	1 (2%)	0 (0%)	0 (0%)	0 (0%)
The material provides simple instructions or examples of how to perform calculations					
-	Agree	44 (88%)	50 (100%)	49 (98%)	50 (100%)
-	Disagree	6 (12%)	0 (0%)	1 (2%)	0 (0%)
The material explains how to use charts, graphs, tables, or diagrams to take actions					
-	Agree	45 (90%)	49 (98%)	48 (96%)	50 (100%)
-	Disagree	5 (10%)	1 (2%)	2 (4%)	0 (0%)
The materials use visual aids whenever they can make it easier to act on the instructions					
-	Agree	50 (100%)	49 (98%)	50 (100%)	50 (100%)
-	Disagree	0 (0%)	1 (2%)	0 (0%)	0 (0%)

Furthermore, almost all the participants agreed that the video sections had informative headers, and that information was presented in a logical sequence. However, slightly fewer of them (89.5%) agreed that videos provide a good summary of their overall purpose. A large proportion agreed that all the videos optimised good visual cues to draw the audience's attention, besides using easy-to-read texts and audible words in the audio. In addition, most of the respondents agreed that the use of visual aids improved the understandability of the video content. Moreover, a clear title, relevant illustrations, and simple tables with short and clear headings successfully enhanced the video without distracting the viewers from the intended objectives. In terms of actionability, all the participants identified at least one action that the users can take after watching the video. Almost all of them (97.5%) agreed that all the videos taught them how to break down the necessary actions into explicit manageable steps while at least 88% of them agreed that the simple instruction and visual aids in the videos served as tangible tools for viewers to take the necessary actions after watching the videos.

Evaluation of Suitability

Based on the SAM scores of more than 70%, all videos were indicated as superior. Furthermore, the suitability scores of the videos ranged between 94% and 99%, thus they were considered highly readable and comprehensible (Table 3).

DISCUSSION

Animated videos have been increasingly recognised as an effective tool for nutrition education and health promotion. In the literature, animated videos are effective in improving knowledge, promoting behavioural changes, and delivering various health messages across diverse populations. In particular, short and animated story-based videos can effectively deliver health messages (33). In a study, educational videos are more effective in improving nutritional awareness among the elderly compared to traditional teaching methods (34). Video health education has also been reported to be more effective in promoting health behavioural changes compared with other methods (35). Furthermore, videos were also shown to be effective as they resembled a live demonstration in the education process. Hence, there is a big potential for video-based education in the promotion of child growth and development (36). In the context of nutrition education, video-mediated educational interventions have been linked with improved nutrition knowledge levels among adolescents (37).

The present study successfully developed four animated videos for nutrition education on the recommended intakes of total energy, macronutrients, vitamins, and minerals to ensure healthy maternal nutrition for pregnant and exclusively breastfeeding mothers. The main aim of the educational videos was to encourage

mothers to look after their nutritional intake, as this can subsequently become one of the risk factors for the prevalence of stunting among their children. This is especially vital with the increasing prevalence of child stunting in Malaysia, especially in view of the scarcity of similar education tools. In the current study, the development and evaluation of the animated videos were conducted systematically in several steps. The video content was carefully developed by incorporating evidence-based nutrition information retrieved from a review of relevant literature and practice guidelines before being reviewed to ensure that all content would be informative for the viewers. All videos were narrated in Malay, the national language, with English subtitles included to reach more viewers.

Stunting is a multifactorial condition influenced by a combination of biological, environmental, and socio-economic factors, with early childhood nutritional status playing an important role. Inadequate maternal nutrition during pregnancy, suboptimal breastfeeding and complementary feeding practices, and micronutrient deficiencies contribute significantly to impaired growth and development (7). Foetal growth restriction is one of the primary factors of child stunting and accounts for 32% of its prevalence in 137 developing countries (38). On the other hand, the likelihood for low birth weight, a condition that is also a risk factor for stunting, is increased in mothers with poor nutritional status, such as being underweight and anaemic. Moreover, the condition can be aggravated by insufficient gestational weight gain, suggesting the impact of maternal caloric and protein intake before and during pregnancy on child growth and development in utero (38). With an emphasis on the importance of the first 1,000 days of a child's life, a systematic review of the connection between maternal food intake and child stunting indicates that sufficient daily protein intake during pregnancy is important for healthy birth weight and height outcomes. Supplementation of vitamin A, vitamin C, iron, zinc, vitamin D, and calcium was also associated with better pregnancy outcomes (18). This is in line with the key messages delivered by the Maternal Dietary Guidelines for Malaysia 2023 to support the health and nutrition of women during their reproductive years, particularly throughout pregnancy and lactation (39). Among others, these include the recommendations of meeting energy requirements during pregnancy and breastfeeding by consuming a variety of foods, prioritising micronutrient-dense foods rich in essential vitamins and minerals such as iron, folate, calcium, and iodine, and maintaining an optimal weight before and during pregnancy.

In addition to the content quality, the presentation of the education videos was also important in ensuring that they would be visually appealing and easy to understand. The videos should be interactive, objective, relevant, and clear to effectively convey the intended nutritional knowledge (40). The videos developed in

this study also underwent a review by experts with knowledge and experience in the multimedia field. A few aspects of the video presentation were improved for better visual quality and more effective content delivery following expert review. Visual aids such as images of food and its nutrient content can significantly improve the understanding of the viewers. Better display of the food item and nutrient labelling enhances the clarity of visual aid and the overall learning experience (41). Emphasis should also be given to the use of image transitions and animated fonts to highlight the important points in line with the video narration. However, the use of irrelevant graphics and motions must be minimised to prevent viewer distraction (42). Besides, voiceovers also play a pivotal role in conveying information. To engage viewers effectively, voice-over intonation should be used to emphasise critical points to enhance long-term information retention among the viewers (43). This can be achieved by using different intonation patterns and volume levels, as well as strategically incorporating brief pauses of two to three seconds in between the narration. These techniques not only enhance comprehension but also enable a more engaging and memorable educational experience for viewers.

In this study, PEMAT-A/V and SAM were used to evaluate the videos. PEMAT-A/V is a systematic tool that assesses two essential domains: understandability and actionability, with scores of 70% indicating poor understandability and actionability (29). On the other hand, SAM rated materials on factors that affect readability and comprehension. A score between 70% and 100% was deemed superior (31). Overall, all the newly developed videos were found to be highly understandable, actionable, and suitable for use as educational tools, hence indicating positive acceptance of the videos among the target viewers. The good understandability scores also indicated that the videos comprised clear and comprehensible content that were easy to understand. Language barriers are minimised by narrating the videos in Malay and including an English subtitle to enable clear communication and effective information delivery (44). The videos also included appropriate visual cues and tables to enable viewers to focus on the important message about the recommended nutrient intake. Meanwhile, the actionability scores inferred that the study participants obtained clear ideas regarding the appropriate actions to be taken after watching the videos. Regarding suitability, the videos were rated as superior by the respondents, suggesting that the videos were well-received by the target population.

The development and evaluation of educational animated videos offer valuable insights into effective strategies for health promotion in maternal and child health. These findings have implications for the design and implementation of future interventions aimed at reducing child stunting and improving maternal and child nutrition outcomes on a global scale. To the

best of our knowledge, this was the first Malaysian study to produce animated educational videos on the recommended maternal nutritional intake for pregnant and exclusively breastfeeding mothers with the aim of stunting prevention. The development and evaluation of the videos were performed systematically. All videos were evaluated by experts in terms of content and multimedia presentation. In addition, a sample of the target viewers assessed the understandability, actionability, and suitability of the videos using established tools, i.e. PEMAT-A/V and SAM.

The current study is not without its limitations. The study population of the evaluation part consisted of childbearing-aged women, rather than the intended population of women who are pregnant or exclusively breastfeeding. This was attributed to the fact that the study was conducted during the COVID-19 pandemic movement control period. Therefore, certain adjustments had to be made to the study population to ensure the completion of data collection due to time constraints. However, care was taken to ensure that the number of study participants was equally represented according to different age groups, e.g., 18 to 25 years, 26 to 35 years, and 36 to 45 years. In view of this limitation, future research should assess the impact of the videos on knowledge levels among pregnant and exclusively breastfeeding mothers. Pre-test/post-test designs can be used to measure the effectiveness of the videos in improving their knowledge levels. Additionally, the integration of these videos into broader nutrition intervention programs, including mobile health (mHealth) applications and community-based outreach programs, can also be explored. As such, future interventions can be optimised using digital technologies to ensure greater accessibility and effectiveness in promoting healthy maternal and child nutrition.

CONCLUSION

This study developed four videos on healthy maternal nutrition for pregnant and exclusively breastfeeding mothers for the prevention of child stunting. The videos were subjected to rigorous content validation and multimedia review processes. They were also found to be highly understandable, actionable, and suitable to be used as educational tools, as evidenced by the positive acceptance of the videos among the target viewers. This indicates that the animated videos are acceptable for use as a tool to promote optimal child growth through healthy maternal nutrition in Malaysia.

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