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ORIGINAL ARTICLE

Development and validation of a nutrition education module on free sugar for individuals with metabolic syndrome: My 3S (Smart Sugar Study)

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ABSTRACT

Introduction: Metabolic syndrome (MetS) is a measure of an individual's risk of developing cardiovascular disease. This paper describes the development and validation of a nutrition education module, The My 3S (Smart Sugar Study) that focused on free sugar. **Methodology**: The My 3S have three phases: Phase 1 Needs assessment, Phase 2 Development and validation of nutrition education module, and Phase 3 Feasibility study. Phase 1 Needs assessment, which is a cross-sectional study was conducted using surveys on dietary free sugar of general population (n=209) and individuals with MetS (n=39), and clinical observation of dietetic consultation (n=20). The inclusion criteria included Malaysian; 30-65 years old; able to communicate in Malay or English; presence with MetS. The module development involved five experts in nutrition, dietetics, and medicine. The content validity was conducted using a content validity index (CVI) among five expert panels who were health care experts. And the face validity involved 32 target audiences and five expert panels. **Result**: The free sugar of individuals with MetS was 18.6 (9.09) % of total energy intake and the dietetic consultation did not include daily free sugar allowance. The developed module showed good content validity (CVI = 1.0) and face validity (average score of 78.3% to 91.7% from the expert panels and 96.9% to 100.0% from the target audiences). **Conclusion**: Individuals with MetS consumed high free sugar and there is lack of nutrition education module on free sugar for them. The newly developed nutrition education module can be used to educate individuals with MetS and high free sugar.

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1. INTRODUCTION

Metabolic syndrome (MetS) is a measure of an individual's risk of developing diseases such as type 2 diabetes (T2DM) and cardiovascular disease [1,2]. The prevalence of MetS in the Asia-Pacific region is 12 to 37% [3]. In Malaysia, the prevalence of MetS is between 38 to 49% among the adult population, which is one of the highest in the Asia-Pacific region [4].

The dietary factors are responsible for more than 40% of the most common cardiometabolic-related deaths in the U.S. [5]. Studies showed that high sugar intake is among the contributing factors to the development of cardiometabolic risk (CMR) [6–10]. The free sugar is quickly absorbed and may lead to significant high blood glucose levels, leading to increased insulinemia. This in long term will result in glucose intolerance and insulin resistance, leading to increased CMR [11]. The World Health Organisation (WHO) issued dietary guidelines which recommend limiting free sugar intake to less than 10% of daily energy intake [12]. Malaysian population consumed high dietary sugar (85 g/day) [13]. And the availability of sugar (kg per capita per year) in Malaysia has risen by 91%, from 22.5 kg in 1963 to 42.9 kg in 2013 [14]. This rise in dietary sugar is in parallel with the increased prevalence of MetS in Malaysia.

Systematic review and meta-analyses of randomised controlled trials have been conducted to investigate the effect of lifestyle intervention focusing on dietary modification in individuals with CMR [15,16]. However, the positive impact of the nutrition education focusing on lifestyle modification was not sustained over time [17]. This may be because the participants become demotivated and discouraged from following a healthy diet. Incorporating a theoretical framework in the individualised nutrition care may improve the success of the lifestyle modification. This was supported by the U.K. Medical Research Council where it recommends using a theory to develop interventions [18].

The standard theoretical framework incorporated in the nutrition intervention include Health Belief Model (HBM), Social Cognitive Theory, Theory of Planned Behaviour, Self-determination Theory and others. The HBM is one of the theories used to study individuals' responses to symptoms and their responses to a diagnosed disease [19,20]. Its constructs include perceived susceptibility, perceived seriousness, perceived benefits, perceived barriers, self-efficacy, and cues to action [19,20]. The rationale of the HBM is that individuals with MetS will be more likely to follow the dietary advice if they believe that they are susceptible to CMR, serious consequence to them, and following the advice would lower the CMR [19,20]. A scoping review reported that integrating HBM in nutrition education positively impacted the outcome measures in individuals with MetS, particularly in improving dietary habits [21]. Hence, incorporating HBM in the nutrition education intervention would improve the sustainability of the outcomes of the intervention.

In Malaysia, there is a lack of nutrition education module focusing on dietary free sugar that incorporates a theoretical framework, tailored for individuals with MetS. Hence, the present study aimed to develop and validate a nutrition education module focusing on dietary free sugar for individuals with MetS. Dietitians are the key healthcare professionals to provide medical nutrition therapy and nutrition care plan to individuals with MetS in the outpatient healthcare setting. The objective of The My 3S (Smart Sugar Study) is to determine the feasibility of the nutrition education module focusing on free sugar among individuals with MetS. The nutrition education module will serve as one of the main education materials for clinical dietitian to utilise during the dietetic consultation.

2. MATERIALS AND METHODS

2.1 Study design

The present study was conducted in three phases: Phase 1 Needs assessment, Phase 2 Development and validation of nutrition education module, and Phase 3 Feasibility study. Phase 1 Cross-sectional study and Phase 2 Development and validation of nutrition education module are complete, while Phase 3 Feasibility study is still in progress.

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2.2 Phase 1 needs assessment

The study design of Phase 1, which is a cross-sectional study has been documented in another publication [22]. Sample size was calculated based on the objective of the study, using the standard formula n=[(Zα+Zβ)/C]2+3[23]. A sample size of 191 was needed with 95% level of significance and 80% power. The drop-out rate was assumed to be about 20%, hence a minimum sample size of 229 was needed. The cross-sectional study showed that the CMR among general population (adult Malaysians) was 39.6% and the quantity of sugars added in coffee was one of the factors that was significantly associated with CMR [22]. Hence, we further conducted a physical survey to investigate the amount of free sugar consumed by individuals with MetS, and a clinical observation to investigate the structure of free sugar education for patients with MetS during their dietetic consultation with the clinical dietitian.

2.2.1 Physical survey of daily sugar intake in patients with MetS

The inclusion criteria included Malaysian citizen; patients from the Hospital Sultan Abdul Aziz Shah (HSAAS); aged 30-65 years old; able to communicate in Malay or English; presence with MetS. The researcher obtained permission from HSAAS to access the list of patients' who are present with MetS and contact them via WhatsApp. The potential candidates were informed about the nature of the research and if they agreed to participate, an appointment would be arranged to meet the researcher at HSAAS. Potential candidates who agreed to participate in the survey signed the written informed consent. They provided their daily total sugar intakes by completing two questionnaires, which were the 24-hour diet recall and semi-quantitative Food Frequency Questionnaire (FFQ) of added sugar intake [24].

The estimated basal metabolic rate (BMR) was calculated using the Harris-Benedict equations [25,26]. The reliability of dietary intake data was evaluated using the Goldberg method for the misreporting of energy intake [27]. All the foods obtained were analysed using Nutritionist Pro Software (Axxya Systems, United States) for energy and macronutrients. In addition, free sugar was analysed using the sugar database [14,28].

2.2.2 Clinical observation of dietetic consultation

The inclusion criteria included Malaysian citizen; patients from HSAAS; aged 30-65 years old; able to communicate in Malay or English; presence with MetS; seeing the clinical dietitian in HSAAS. The sample size estimation was 20 patients or until data saturation has been achieved.

The researcher obtained permission from the clinical dietitians in HSAAS to access the list of patients who are present with MetS and had face-to-face session with the clinical dietitian. The clinical dietitians who agree to let the researcher observed their session with patients signed the written informed consent. The researcher then sat in and observed the whole session without interfering with the discussion. The researcher filled up a clinical observation form where it included information about nutrition assessment, nutrition diagnosis, and nutrition intervention of the patients. A reference list of the recommendations related to sugar intake for the dietetic session was used to indicate the sugar-related information provided by the clinical dietitian.

2.3 Phase 2 Development and validation of nutrition education module

2.3.1 Development of nutrition education module

The content of the nutrition education module was developed based on the international and local guidelines, which were the Medical Nutrition Therapy and Clinical Practice Guidelines [12, 29–38]. A psychosocial theory, the Health Belief Model (HBM) was incorporated in the module. Besides, scientific

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facts, strategies used in other nutrition education interventions, and findings of the needs assessment study were also included in the module. To better fit the dietary intake of Malaysian adults, local and common food choices were incorporated in the module. This module also included information from Phase 1 Needs assessment, which were the foods and drinks that are high in free sugar that were commonly consumed by individuals with MetS and maximum daily free sugar allowance for individuals with MetS.

The module development involved three dietitians (B.N.M.Y., Z.A.Z. and W.L.C.), a nutritionist (A.A.), and a physician (I.Z.I.). The module consisted of a flip chart and a booklet, which was used by the dietitian during the consultation sessions with patients with MetS in the nutrition education intervention. Clear and simple language and realistic and suitable examples were used in the module to facilitate effective communication.

2.3.2 Validation of the nutrition education module

The face and content validation of the nutrition education module was done by the expert panels and target audiences. The selection criteria for the expert panels were health care experts, who had a background in nutrition and dietetics, and with experience in providing the health care process to individuals with MetS. Meanwhile, the selection criteria for the target audiences were patients from HSAAS, Malaysian citizens, aged 18 to 65 years old, Malay literate, and present with MetS.

The evaluation process was conducted from November 2022 to January 2023. The validation form, adapted from a local study was used to determine the face and content validation of the module [39]. Face validity was conducted to determine the degree to which the module appears, on its face value, to deliver the aspects that it intends to deliver [40]. Meanwhile, content validity is the extent to which a measurement tool detects the different facets of an entire aspect area [41].

2.3.2.1 Validation by expert panels

The validation form for the expert panels consisted of seven aspects, which were scientific accuracy, content, format, illustration, design and layout, presentation and organisation, and quality of information. The scientific accuracy and content were used to evaluate the content validity of the module and the remaining aspects were used for face validity. The components in the module were rated using the four-point Likert scale (1 = not relevant, 2 = some revision required, 3 = relevant but needs minor revision, and 4 = very relevant).

A content validity index (CVI) was used to quantify the content validity and the proportion of agreement on the appropriateness of the aspects was expressed between zero and one [42,43]. To determine the CVI, the number of experts who rated the components of the two aspects (scientific accuracy and content) as relevant, which is rating 3 and 4, were divided by the total number of experts [43]. A CVI of more than 0.79 indicates that the item is acceptable, 0.7 to 0.79 indicates that the item needs revision and less than 0.7 indicates that the item should be eliminated [43].

For face validity of the module, the rating of the components in each aspect (format, illustration, design and layout, presentation and organisation, and quality of information) were determined. The average score of each aspect has to be at least 75%, to be considered appropriate [44].

2.3.2.2 Validation by target audiences

The target audiences were required to evaluate the module and completed a validation form that consisted of five aspects: format, illustration, design and layout, presentation and organisation, and quality of information. The components of the aspects were rated as ‘1 = yes’ or ‘0 = no’. The average score of each aspect was determined and only those aspects with at least 75% were considered appropriate [44]. The validation process was carried out until data saturation had been achieved.

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2.4 Statistical analysis

Statistical analysis of Phase 1 data was performed using the IBM Statistical Package for Social Sciences (SPSS) Version 25. All statistical tests were set at a significance level of $p<0.05$. Distribution normality of continuous data was checked using the Shapiro-Wilk test. Descriptive analysis was conducted to determine the means and standard deviations for continuous data, and percentages and frequencies for categorical data.

3. RESULTS

3.1 Phase 1 physical survey of free sugar intake in patients with MetS

A total of 39 patients with MetS aged 30 to 65 years old from HSAAS participated in the survey. By using the Goldberg method for the misreporting of energy intake, 5 misreporting patients were excluded from the analysis. Table 1 shows the demographic characteristics of the patients involved in the survey. The median age of the patients was 44.0 years, with an interquartile range (IQR) of 36.00 to 52.00. About half (52.9%) of the patients were male and 97.1% were Malay. A total of 17.6% of them were overweight and 79.4% were obese.

Table 1. General characteristics of the participants (n=34)

Variables	n (%)
Age (year)	Median (IQR): 44.0 (36.00 to 52.00)
Age category	
30-39	10 (29.4)
40-49	12 (35.3)
50-59	9 (26.5)
60 and above	3 (8.8)
Sex	
Male	18 (52.9)
Female	16 (47.1)
Ethnicity	
Malay	33 (97.1)
Chinese	0 (0.0)
Indian	1 (2.9)
Others	0 (0.0)
Height (m)	Mean (SD): 1.6 (0.09)
Weight (kg)	Mean (SD): 88.4 (22.83)
BMI (kg/m^2)	Median (IQR): 32.4 (28.11 to 36.69)
BMI category (kg/m^2)	
<18.5	0.(0.0)
18.5-22.9	1 (2.9)
23.0-27.5	6 (17.6)
>27.5	27 (79.4)
Supplement usage	
Yes	18 (52.9)
No	16 (47.1)

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Cigarette smoking	
Yes	4 (11.8)
No	30 (88.2)
Past medical history	
Type 2 diabetes	
Yes	22 (64.7)
No	12 (35.3)
Dyslipidaemia	
Yes	34 (100.0)
No	0.(0.0)
Hypertension	
Yes	24 (70.6)
No	10 (29.4)
Others	
Yes	4 (11.8)
No	30 (88.2)

Source: Wan Ling Chiang et al (2026)

The mean energy intake of the participants was 1725.1 (370.55) kcal/day, while the carbohydrate, protein and fat intake were 55.1 (7.50) % total energy intake (TEI), 15.2 (2.44) % TEI and 30.1 (6.65) % TEI, respectively. The median fibre was 4.8 g (2.63 to 6.98) and mean free sugar was 18.6 (9.09) % TEI. The dietary energy and nutrient intakes of the participants was shown in Table 2.

Table 2. Descriptive findings of dietary energy and nutrient intakes of the participants (n=34)

Dietary variables	Range	Intake Mean (SD)	Recommendation
Energy (kcal/d)	1195 – 2710	1725.1 (370.55)	1780 – 2460[a]
Carbohydrate (% TEI)	32 – 69	55.1 (7.50)	55 – 70[a]
Protein (% TEI)	9 – 20	15.2 (2.44)	10 - 15[a]
Fat (% TEI)	18 – 49	30.1 (6.65)	20 - 30[a]
Fibre (g)	1 – 18	4.8 (2.63 to 6.98)*	20 – 30[b]
Free sugar (% TEI)	4 – 36	18.6 (9.09)	<10[c]
Vitamin A (mcg RE)	62 – 837	450.6 (161.83)	-
Thiamine (mg)	0 – 2	0.7 (0.58 to 0.82)*	1.1 – 1.2[a]
Riboflavin (mg)	0 – 3	1.1 (0.47)	1.1 – 1.3[a]
Niacin (mg)	6 – 33	11.4 (9.20 to 13.61)*	14 - 16[a]
Folate (mcg)	49 – 736	236.6 (190.94 to 282.27)*	400[a]
Vitamin C (mg)	7 – 213	93.4 (44.63)	70[a]
Vitamin D (mg)	0 – 6	0.0 (-0.31 to 0.31)*	5 - 10[a]
Vitamin E (mcg)	3 – 32	6.3 (3.86 to 8.75)*	7.5 - 10[a]
Calcium (mg)	183 – 978	477.0 (203.44)	800 - 1000[a]
Iron (mg)	1 – 45	17.4 (7.78 to 27.02)*	11 - 29[a]
Zinc (mg)	2 – 20	5.4 (4.08 to 6.72)*	4.9 – 6.7[a]
Selenium (mcg)	0 - 99	26.6 (16.37 to 36.84)*	25 - 33[a]

*Median (IQR); [a] Recommendations by the Malaysian RNI; [b] Recommendations by the Malaysian Dietary Guideline;

[c] WHO recommendation; RE, retinol equivalent.

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The food groups in the FFQ of added sugar intake was classified into the descending order of their contribution to the free sugar intake. About 2/3 (66.9%) of the free sugar intake of the patients were contributed by mixed drinks, where majority were homemade or non-franchised coffee/ tea/ malt drink. This order was followed by canned/box/bottle drink (7.1%), miscellaneous (including jam, coconut milk jam [kaya] and honey).

3.2 Clinical observation of dietetic consultation

A total of 20 patients with MetS aged 30 to 65 years old from HSAAS participated in the clinical observation. Table 3 shows the demographic characteristics of the patients. The mean age of the patients was 50.8 (10.88) years. About 40% of the patients were male, 85.5% were Malay and 60% were first visit. A total of 65.0% of the patients has obesity and 70% of the patients had high fasting blood glucose, 45.0% had high triglyceride and 35.0% low HDL-cholesterol and 60.0% had high blood pressure.

During the clinical observation, the dietitians asked patients to reduce foods/ drinks high in sugar, discussed the types of foods/ drinks high in sugar and suggested the alternatives to reduce foods/ drinks high in sugar. The dietitians also educated patient about the recommended type and amount of dietary sugar intake. However, the dietitians did not inform patients about his/her maximum daily free sugar allowance and educate patients about calculating the daily free sugar.

Table 3. General characteristics of the participants (n=20)

Variables	n (%)
Age (year)	**Mean (SD):** 50.8 (10.88)
Age category	
30-39	1 (5.0)
40-49	8 (40.0)
50-59	6 (30.0)
60-65	5 (25.0)
Sex	
Male	8 (40.0)
Female	12 (60.0)
Ethnicity	
Malay	17 (85.0)
Chinese	1 (5.0)
Indian	2 (10.0)
Others	0 (0.0)
Dietetic consultation	
New	12 (60.0)
Follow-up	8 (40.0)
Duration of follow-up (months)	3
Height (m)	Mean (SD): 1.6 (0.09)
Weight (kg)	Mean (SD): 84.5 (23.15)
BMI (kg/m^2)	Mean (SD): 31.8 (7.09)
BMI category (kg/m^2)	
<18.5	0 (0.0)
18.5-22.9	2 (10.0)
23.0-27.5	5 (25.0)
>27.5	13 (65.0)

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HbA1c (%)	Mean (SD): 7.3 (1.62)
Fasting blood glucose (mmol/L)	Median (IQR): 6.5 (5.70 to 7.30)
High fasting blood glucose (≥5.6mmol/ L) or diabetes)	
Yes	14 (70.0)
No	6 (30.0)
Triglyceride (mmol/L)	Mean (SD): 1.6 (0.56)
High triglyceride (≥1.7 mmol/ L or on triglycerides treatment)	
Yes	9 (45.0)
No	11 (55.0)
HDL-cholesterol (mmol/L)	1.3 (0.42)
Low HDL-cholesterol (<1.0 mmol/ L in men or <1.3 mmol/ L in women or on HDL- cholesterol treatment)	
Yes	7 (35.0)
No	13 (65.0)
High blood pressure (≥130/ 85 mmHg or on anti-hypertensive therapy)	
Yes	12 (60.0)
No	8 (40.0)

Source: Wan Ling Chiang et al (2026)

3.3 Development and validation of nutrition education module

A total of five experts, composed of three clinical dietitians, a community dietitian, and a lecturer were invited to review, provide feedback and judge the validation of the nutrition education module. The three clinical dietitians are working in the clinical field and the community dietitian is from the Disease Control Division, Ministry of Health, Malaysia. The lecturer, with a background in nutrition and dietetics, is currently working at a local government university.

A total of 32 patients with MetS, aged 18 to 65 were recruited from the HSAAS to participate in the validation of the nutrition education module. Table 4 shows the characteristics of the patients. Most (43.8%) of the subjects were in the age range of 40 to 49 years old, 90.6% were Malay, 90.6% had a tertiary education level and 68.8% were working. The median Body Mass Index (BMI) for the subjects was 27.7 kg/m2, where 40.9% of them were in the BMI range of 25.0 to 29.9 kg/m2.

Table 4. Characteristic of target audiences (n=32)

Characteristics	Male (n=12) n (%)	Female (n=20) n (%)	Overall (n=32) n (%)
Age (years) (median [IQR])	42.5 (35.00 to 50.00)	48.0 (41.00 to 55.00)	46.0 (38.00 to 54.00)
Age group	0 (0.0)	0 (0.0)	0 (0.0)
18 to 29	4 (33.3)	3 (15.0)	7 (21.9)
30 to 39	5 (41.7)	9 (45.0)	14 (43.8)
40 to 49	3 (25.0)	8 (40.0)	11 (34.4)
50 to 60			
Ethnicity			
Malay	11 (91.7)	18 (90.0)	29 (90.6)

Chinese	1 (8.3)	1 (5.0)	2 (6.2)
Indian	0 (0.0)	1 (5.0)	1 (3.1)
Others	0 (0.0)	0 (0.0)	0 (0.0)
Education level			
No formal	0 (0.0)	0 (0.0)	0 (0.0)
Primary education	0 (0.0)	0 (0.0)	0 (0.0)
Secondary education	1 (8.3)	2 (10.0)	3 (9.4)
Tertiary education	11 (91.7)	18 (90.0)	29 (90.6)
Employment status			
Working	9 (75.0)	13 (65.0)	22 (68.8)
Not working	3 (25.0)	7 (35.0)	10 (31.2)
Body Mass Index (BMI) (kg/m^2) (median [IQR])	27.5 (23.39 to 31.61)	28.7 (24.34 to 33.07)	27.7 (23.92 to 31.49)
BMI category			
<18.5	0 (0.0)	0 (0.0)	0 (0.0)
18.5 to 24.9	2 (16.7)	5 (25.0)	7 (21.9)
25.0 to 29.9	6 (50.0)	7 (35.0)	13 (40.6)
≥30.0	4 (33.3)	8 (40.0)	12 (37.5)

Source: Wan Ling Chiang et al (2026)

3.3.1 Development of a nutrition education module

The nutrition education module consists of a flip chart and a booklet that will be used in the Phase 3 nutrition education intervention. The constructs of HBM (perceived susceptibility, perceived seriousness, perceived benefits, perceived barriers, self-efficacy, and cues to action) were incorporated in the flip chart and booklet (Table 5).

The flip chart is a nutrition guide for clinical dietitian's use during the consultation sessions with patients with MetS. It has a dietitian's view (detailed explanations) and a patient's view (simple language and infographics). The flip chart is double-sided and consists of 30 pages. The dimensions of the flip chart are 7.5 inches x 10.8 inches.

The booklet provides detailed information of free sugar, including the quantity of free sugars in foods and drinks that were commonly consumed by individuals with MetS, as reported in Phase 1 Needs assessment. It also provides information of the maximum daily free sugar allowance based on patients' daily energy intake, which the dietitians did not inform the patients during the dietetic consultation. Besides, the booklet contains a fill-in-the-blank activity, crossword puzzles, and a scenario of calculating daily sugar intake to facilitate learning and critical thinking. The booklet is double-sided and consists of 31 pages. The dimensions of the booklet are 5.9 inches x 8.3 inches.

Table 5. Description of dietary modification based on the Health Belief Model constructs

No.	Health Belief Model constructs	Topic	Description	Tools
1	Perceived susceptibility	• Prevalence of MetS • Risk factors of MetS • Free sugar intake in Malaysia	• Overview of the MetS and the prevalence of overweight/ obese, diabetes, hypertension, and dyslipidaemia in Malaysia • Discussion on the risk factors of MetS based on the subjects' medical	Flipchart

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			condition and emphasise subjects' susceptibility to cardiometabolic conditions • Overview of free sugar and the consumption of free sugar among Malaysian population	
2	Perceived severity	• Health complications of MetS	• Discussion on the severity and complication of cardiometabolic conditions in relation to high free sugar intake	• Flipchart and booklet
3	Perceived benefits	• Benefits of adhering to the dietary recommendation and reducing free sugar	• Discussion on the benefits of adhering to the dietary recommendation and reducing free sugar intake based on the subjects' medical condition	• Flipchart and booklet
4	Perceived barriers	• Barriers of adhering to the dietary recommendation and reducing free sugar	• Discussion on the barriers when adhering to the dietary recommendation and reducing free sugar intake based on the subjects' background including socioeconomic status and dietary behaviour	• Booklet
5	Cues to action	• Guidelines of free sugar intake • Strategies on reducing free sugar • Application of Free Sugar Point System	• Discussion on the international and local guidelines of free sugar • Discussion on tips to reduce free sugar • Calculate maximum free sugar intake using Free Sugar Point System, based on daily energy intake	• Flipchart and booklet
6	Self-efficacy	• Set personal goal	• Discussion on the personal goals	• Booklet

Source: Wan Ling Chiang et al (2026)

3.3.2 Content validation by the expert panels

Both the two aspects "scientific accuracy" and "content" obtained a CVI of 1.0, indicating an excellent agreement on the appropriateness of the aspects. Three out of five experts agreed that the "scientific accuracy" was relevant but needs minor revision. Their comments were (a) to provide more explanation on the difference between added sugar and free sugar, (b) to elaborate more about different types of sugar, and (c) not to use 'sugar exchange' to avoid confusion with 'carbohydrate exchange'. Other minor changes were to replace technical terms with layman terms and some grammatical errors. All the feedback from the experts was reviewed and the nutrition education module was revised based on the feedback.

3.3.3 Face validation by the expert panels and target audiences

The average score of the aspects by the expert panels ranged from 78.3% to 91.7%, and 96.9% to 100.0% by the target audiences, both were considered appropriate (≥75.0%) (Table 6). The comments of the experts

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included reformulating illustrations and to standardise the font size, as well as having more examples and pictures of food items. In terms of format, all the audiences commented that the size of the letters was appropriate, the spaces between the letters and words facilitate reading, and the font was easy to read. All the audiences also commented that the illustration was properly labelled and the colour was appropriate, the design and layout were harmonious, and the length of the sentence is suited to the comprehension level of the target audience. However, they suggested including more pictures and fewer words, elaborating on the difference between added sugar and free sugar, and some grammatical errors.

Table 6. Face validity of nutrition education module by the experts (n=5)

Criteria	Experts (n=5) Percentage (%)	Target audiences (n=32) Percentage (%)
Format	91.7	100.0
Illustration	86.0	98.1
Design and layout	80.0	97.9
Presentation and organisation	88.8	97.7
Quality of information	78.3	96.9

Source: Wan Ling Chiang et al (2026)

4. DISCUSSION

The physical survey on dietary free sugar showed that individuals with MetS consumed high free sugar, which exceeded the World Health Organisation recommendation of no more than 10% of the total daily energy intake. This was in line with the finding of a local study, where Malaysians consumed high sugar intake [13]. This high sugar intake is paralleled by consequent rises of MetS, where the prevalence of MetS in Malaysia is higher than the prevalence of MetS of the worldwide adult population [3,4]. Excessive dietary sugar is associated with MetS where it affects the regulation of lipid and carbohydrate metabolism directly or indirectly, by promoting positive energy balance, resulting in weight gain, dyslipidaemia, insulin resistance and glucose intolerance or T2DM and hypertension [8–10,45,46]. The clinical observation of dietetic consultation also confirmed the lack of nutrition education module on free sugar intake for individuals with MetS. Therefore, it is vital to develop a nutrition education module targeting individuals with MetS on their free sugar intake.

We have successfully developed a nutrition education module focusing on dietary sugar for individuals with MetS. This module was developed based on the finding of the needs assessment study and would be used by the clinical dietitians as one of the educational materials when providing care for patients with MetS. The goal of the education intervention is to educate patients with MetS on daily sugar calculation, and manage their daily meal plan more effectively, which then encourages long-term behavioural changes in sugar intake.

The developed nutrition education materials were tailored to the needs of Malaysian adults with MetS who had high free sugar intake. We incorporated local food choices to encourage behavioural change. This is because tailored print materials were more effective than non-tailored materials in influencing individuals to change their health-related behaviours [47]. Besides, we used pictures in our educational materials as the use of pictures in addition to the written and spoken text increases the patient's attention, recall, and adherence to the recommended dietary advice [48].

We incorporated HBM into our nutrition education module and the topics of the module were based on the constructs: perceived susceptibility; perceived severity; perceived benefits; perceived barriers; cues to action; self-efficacy. This is because the use of a theoretical framework in developing educational interventions improves the success of the interventions [18]. A scoping review reported that nutrition interventions that incorporated theories had positive impacts in reducing the consumption of sugar-sweetened beverages and 100% fruit juice in children and adolescents [49]. Moreover, integrating HBM in

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three to 12 months of nutrition education has been shown to improve dietary habits, physical activity levels, knowledge, health belief, and anthropometric and MetS factors in individuals with MetS [21].

In our study, we had five expert panels and they agreed on the appropriateness of the aspects for content validity. Studies have recommended at least five experts in module evaluation to avoid chance agreement [50,51]. Hence, the number of our experts was adequate and able to provide complementary areas of expertise in evaluating the module. The CVI is commonly used to measure the content validity of the developed education materials [52,53]. Previous studies of various areas had used CVI to measure the content validity of their educational materials and amendments were made until the validated final version was reached [39,44].

Our study was the first study in Malaysia to develop a nutrition education module focusing on free sugar education that is tailored for individuals with MetS whose free sugar intake exceed the recommendation. It was developed based on scientific evidence and the latest guidelines. The nutrition education module has also been validated by expert panels and target audiences. The limitation of the study is that the module was developed in the Malay language only and this may cause language barriers in individuals who are not Malay literate. Moreover, the information in the nutrition education module may be difficult for patients to understand. Hence, clinical dietitians need to assist patients when using the nutrition education module.

5. CONCLUSION

Individuals with MetS consumed high free sugar and there is a notable lack of nutrition education modules addressing free sugar intake tailored for them. The newly developed nutrition education module from My 3S (Smart Sugar Study) can be used to educate individuals with MetS and high free sugar intake. It will also be used in the Phase 3 Feasibility study to determine the feasibility of this nutrition education module, with the aim to increase nutrition knowledge, particularly dietary sugar among individuals with MetS.

6. ACKNOWLEDGEMENTS

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7. CONFLICT OF INTEREST STATEMENT

Authors declare none.

8. AUTHORS' CONTRIBUTIONS

WLC, BNMY, AA, IZI and ZAZ participated in the conception and design of the study protocol. WLC involved in the writing of the manuscript. BNMY involved in the critical revision of the manuscript. All authors approved the final version of the manuscript that has been submitted.

9. ETHICS STATEMENT

Ethics approval was obtained from the Research Ethics Committee of Universiti Putra Malaysia (No.: JKEUPM-2023-044). Only participants with written, informed consent were recruited. This study is registered under ClinicalTrials.gov NCT05746000.

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