Development of a plant-based culinary nutrition model for sports science students

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ABSTRACT

Introduction: Food and fitness levels are key factors required to maintain functional life. Hence, nutrition education is crucial in spreading awareness among Sports Science students. There is a paucity of plant-based nutrition knowledge and plant-based culinary skills for fitness locally. Therefore, this study aimed to develop a valid Plant-Based Culinary Nutrition Model (PBCNM) with nutrition knowledge and basic culinary skills to improve fitness among Sports Science students. **Methods:** This exploratory sequential mixed method study consisted of 2 phases. In Phase 1, a three-round modified Delphi method was conducted with 13 experts to generate a questionnaire that was validated. Lawshe worksheet determined the content validity ratio (CVR) for an item. Content validity index (CVI) for each section and the overall instrument was calculated. In Phase 2, quantitative data collection and analysis addressed the research questions and research gaps leading to model development. A total of 271 undergraduate Sports Science students at higher learning institutions were recruited as respondents. **Results:** In Phase 1, CVR of the overall survey was 1.0 and CVI was 0.834. Subsequently, the questionnaire was pilot tested for reliability and a Cronbach's alpha score of 0.836 was obtained for the overall questionnaire. In Phase 2, the respondents' mean and standard deviation score for the model's components and needs was 4.21±0.73 for items 1-15. The integration of experts' perspectives on the need of PBCNM for fitness and feedback from respondents resulted in the development of PBCNM. **Conclusion:** This study highlighted PBCNM as a helpful guideline for better fitness management.

Keywords: Delphi method, education, fitness, nutritional knowledge, plant-based diet

INTRODUCTION

A plant-based diet essentially involves eating fresh or less processed foods closer to nature. Plant-based diets, such as those encompassing vegetables, fruits, and pulses, have been associated with substantial health benefits and overall health improvement, including the potential prevention of chronic diseases such as heart diseases and cancer (Hemler & Hu, 2019; Medawar *et al.*, 2019). The variety of plant-based dietary patterns are lacto-ovo-vegetarian, lacto-vegetarian, and vegan. Vegan excludes dairy and all animal-related products in their lifestyle. Many self-proclaimed vegetarians define a plant-based diet based on their perceptions (Hargreaves *et al.*, 2021).

Transition to a plant-based diet can have a significant impact on the health and fitness of an individual (Adesogan

et al., 2020). The main concern is lack of nutrients like calcium, iodine, iron, vitamin D, zinc, long-chain omega-3 fatty acids, as well as vitamin B12 even though deficiency can occur across diets (Wirnitzer, 2020). Therefore, the key is well-planned plant-based meals, which could prevent nutritional deficiencies for any age group, including athletes (PCRM, 2014).

A nutrient-dense plant-based diet includes whole foods, which is an evidence-based recommendation, thus should be practised as a health promoting option (Lynch, Johnston & Wharton, 2018). However, studies revealed that those practising a plant-based diet lacked skills in preparing whole food plant-based meals (Tani, Fujiwara & Kondo, 2020). Therefore, the emphasis should be on acquiring nutrition and culinary skills to prepare plant-based meals. The literature review reported the importance of cooking skills in maintaining fitness. One study revealed that learning culinary skills could improve food choices, fitness, and overall health (Knowlden, Robbins & Gardner, 2018). It is therefore crucial for Sports Science students to recognise the relationship between nutrition and culinary skills for fitness and disease prevention.

Prior studies revealed more research on how plant-based diets interact with health, environment, and food businesses (Lynch *et al.,* 2018). Sustainable diets promote a healthy and fit lifestyle for individuals with minimal impact on the environment (Fanzo, 2019). There is evidence from systematic reviews and meta-analyses about the preventive impact of a plant-based diet in the treatment of various chronic diseases; however, clinicians are not trained with the skills and education to prescribe plant-based nutrition (PCRM, 2014). Despite the prejudice, relevant research on athletes' health and fitness is growing. Plant-based diets contain higher carbohydrates and antioxidants, thus may enhance athletic performance, particularly in endurance sports (Devrim-Lanpir, Hill & Knechtle, 2021). The best sources of carbohydrates are those rich in fibre and nutrients, like wholesome vegetables, fruits, whole grains, and legumes (Wirnitzer, 2020). As sports and exercise are vital components in the promotion of health, athletes should be supported with a balanced whole food plant-based diet (Wirnitzer, 2020).

There are many factors involved in the changes of human behaviour. As described by other researchers, such factors can be grouped under the social-cognitive theory (SCT) (Torkan *et al.*, 2018), diffusion of innovation theory, and health belief model (HBM) (Keshani *et al.*, 2019). The SCT encompasses three triads of human behaviour: individual cognitive factors (knowledge, expectations, and attitudes), behavioural factors (skills, practice, and self-efficacy), as well as environmental factors (social norms, access, and influence of others on their environment) (Harris, Carins & Rundle-Thiele, 2021). Some healthy eating studies have used part of the model by choosing one or more of these factors (Cox *et al.,* 2017; Knowlden *et al.*, 2018); we have yet to find studies that applied all nine factors in one research. According to Bandura (2004), the field of health has changed towards health modelling. Thus, the emphasis on the importance of educating people about the benefits of eating whole foods and learning to cook is essential. In this context, the development of a plant-based culinary nutrition education programme (PBCNM) for fitness is an effective way to advocate a plant-based lifestyle for long-term health benefits. Hargreaves *et al.* (2021)'s research supports that similar programme can have a positive impact on health outcomes.

The diffusion of innovation (DOI) theory suggests that new ideas can spread through a society over time,

with different groups of people adopting the behaviour at different rates. DOI emphasises the importance of communication channels and social networks in the process (Mallinson, 2020). Thus, in the context of promoting a plant-based culinary nutrition lifestyle, effective communication can accelerate the adoption of this lifestyle among society. Targeted campaigns and providing easy-to-follow culinary nutrition education could accelerate the adoption process.

Lastly, the HBM centres on the desire to avoid disease and the belief that a particular health action will prevent or cure disease (Lim, Okine & Kershaw, 2021). A person's course of action depends on how he perceives the benefits of adopting a behaviour and the consequences of not changing it. Therefore, an individual's beliefs can influence his/her desired behaviour. HBM was used to identify the perceived benefits and barriers, self-efficacy, severity, and vulnerability to healthy eating (Keshani *et al.*, 2019). In the context of promoting a plant-based lifestyle and developing culinary skills, people may adopt these behaviours to decrease their risk of developing diseases (Keshani *et al.,* 2019).

Overall, these theories provide a strong foundation for promoting the diffusion of plant-based culinary nutrition ideas and increasing the adoption rate among population over time. This study aimed to develop a valid Plant-Based Culinary Nutrition Model (PBCNM), which incorporates the fundamentals of nutrition and culinary skills to improve fitness among Sports Science students. PBCNM was initiated to support a number of initiatives by the Ministry of Health to manage national fitness. Similarly, PBCNM could guide Sports Science students in managing their fitness through plant-based culinary nutrition (Morji, Razak & Hamzah, 2021).

MATERIALS AND METHODS

This study applied the mixed method exploratory sequential design, and included both qualitative and quantitative data collection and analyses. The mixed method can generate comprehensive evidence to address research problems, especially in a health-related context (Almeida, 2018). There were two phases and the study was conducted with the approval of the Universiti Malaya Research Ethics Committee (UM.TNC2/ UMREC–431). The participants provided written consent. Figure 1 shows the overview of the research design.

Phase 1
Phase 1 involved a modified Delphi approach, optimised and tested through the analysis, design, development, implementation, and evaluation (ADDIE) framework. The researchers focused only on the design and development stages of the ADDIE model. The evaluation stage was not planned for this study; it would be for future research. ADDIE was optimised to generate a questionnaire to be used in Phase 2's quantitative data collection. The design and development of the research instrument and research method steered by the ADDIE model was used to develop efficient instructional materials. Three theories – the SCT, the DOI theory, focused on the diffusion of new ideas, and the HBM theory that predicts health-related behaviour were applied to facilitate the research design and analysis process incorporated in both phases.

In Phase 1, a panel of experts was selected based on their expertise in the area of sports nutrition and dietetics, coaching, athletics, academics, sports science, and nutritional sciences (Table 1). This approach ensured that the participants were knowledgeable about the topic being studied and could provide valuable insights and perspectives. There were no strict rules
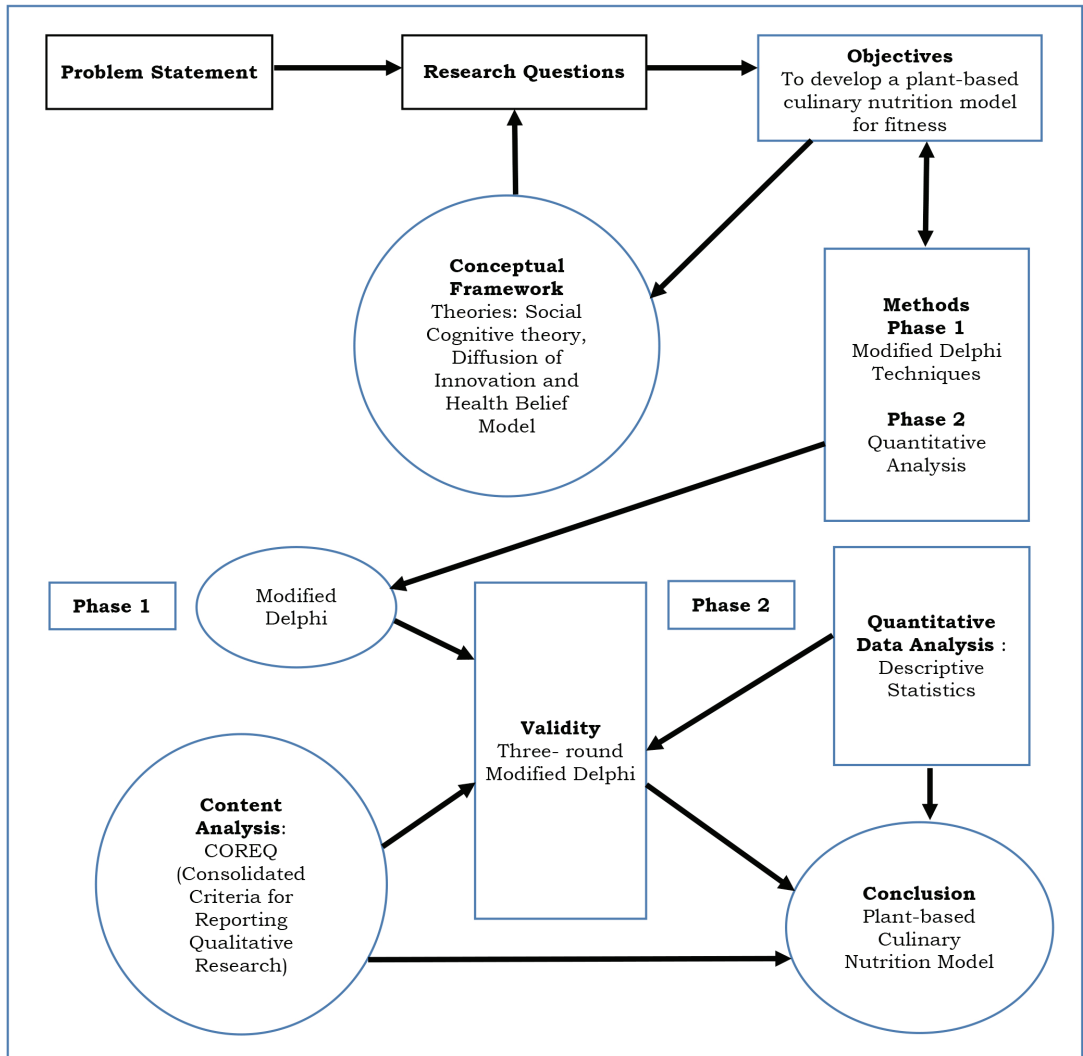
Figure 1. An overview of the study design

on the number of experts required for this study (Tong, Sainsbury & Craig, 2018). Thus, based on the needs and availability of the experts at the point of study, 13 experts were identified and interviewed. The interview process was guided by the Consolidated Criteria for Reporting Qualitative Research (COREQ) (Tong *et al*. 2018). The COREQ is a formal checklist used for focus group discussions and in-depth interviews. This study was reported based on three key areas: reflectivity of the researcher and research team, study design, as well as analysis and results.

Phase 2

Six interview questions were created based on the research questions and reviewed by the experts before the interviews for Phase 2. In the pilot study for Phase 2's quantitative study, 30 Sports Science students pursuing their first degree at a local public university were recruited. Other criteria for selection such as athlete's status, eating

Table 1. The expert panels' experiences and expertise

Expert	Expertise	Years of experience
1	Dietitian and assistant director (sports performance)	More than 20 years
2	Sports nutrition lecturer	More than 10 years
3	Director, Division of research and innovation	More than 20 years
4	Executive chef,	More than 15 years
5	Sports medicine specialist	More than 20 years
6	Sports coach and tower runner	5 years
7	Endurance sports coach	More than 10 years
8	Sports coach (dodgeball)	More than 10 years
9	Head of sports and exercise science postgraduate studies	More than 20 years
10	Plant-based sports scientist	More than 20 years
11	Emeritus Professor in nutrition	More than 30 years
12	Director of plant-based nutrition education	More than 15 years
13	Advanced sports dietitian	More than 20 years

disorders, food restrictions, recent dieting attempts, and health conditions were excluded. Non-Sports Science students were excluded from this study. In Phase 2, the study population was Sports Science students, which included 271 students from two local public universities offering undergraduate Sports Science programmes. This was the actual sample size retrieved based on the Krejcie & Morgan provisions (Krejcie & Morgan, 1970). The students were between 19-25 years old, pursuing various degree programmes in Sports Science and were in the 1st to 3rd year of their studies at the time of data collection. They were purposively selected due to the reason that PBCNM was targeted to equip Sports Science students with relevant culinary skills applicable for managing fitness.

Instrument development using Delphi technique
The Delphi method was modified for a few reasons. Firstly, the interview was conducted in-person rather than by email in this study. Secondly, external experts were recruited to participate in a few subsequent rounds (Tong *et al.*, 2018). A content analysis of the interview data was performed to identify the themes and level of agreement among experts on the need for PBCNM and the components that should be included in the model. In essence, the in-depth interview was conducted as a needs analysis of this research. The needs analysis was a crucial part of this study as the current problem has not been explored in-depth before in the local setting (Morji *et al.*, 2021).

Based on the analysis of the interview in Round 1 of the Delphi study, a questionnaire was drafted. This questionnaire had two parts: Part I was the Demographics with eight items; and Part II had two sections, Section A with 12 items and Section B with eight items. Part II initially consisted of 20 questions on a 5-point Likert scale. This questionnaire draft was reviewed and further analysed in Rounds 2 and 3 by six experts. After the review, few questions were eliminated and few were merged. Finally, Part I remained with eight questions on Demographics, while Part II contained a total of 15 items – Section A had eight items and Section B had seven items.

There were several steps involved in the development of the instrument. Firstly, a thorough literature review ensured the research was grounded in existing knowledge and the findings were meaningful and relevant to the field. Next,

a needs analysis or an in-depth interview enriched the content area. Experts contributed valuable experiences and expertise in the field. The researchers ensured that the items would reflect the research questions of this study. Any item deemed essential by more than half of the panellists must obtain a certain degree of content validity to quantify the consensus reached. Secondly, the higher the number of panellists who considered an item to be essential, the greater the degree of content validity (Lawshe, 1975). This quantification was determined via content validity ratio (CVR) and content validity index (CVI). CVR can range from 1 to -1; a higher score indicates a higher agreement. For this study, a CVI average of 0.62 for each item was considered as an acceptable threshold.

Statistical analysis

Descriptive statistics from the IBM SPSS Statistics for Windows version 23.0 (IBM Corp, Armonk, New York, United States) were utilised to analyse the data in Phase 2. Sample size calculation for Phase 2 was based on Krejcie and Morgan's table (Krejcie & Morgan, 1970). Reliability was tested using Cronbach's alpha, measuring the internal reliability of an instrument based on the average inter-item correlation (Taber, 2018). Cronbach's alpha was used to run on a sample size of 30 respondents and optimised for reliability. Cronbach's alpha values of >0.9, 0.8, 0.7, 0.6, and 0.5 were deemed excellent, good, acceptable, questionable, and poor, respectively; while values <0.5 were considered unacceptable (Göleç & Maksudunov, 2019). Results of reliability were expressed as mean±standard deviation (*SD*). CVR and CVI calculations, which evaluate the study instrument's content validity, were done using the Lawshe worksheet. Frequency was optimised to analyse Likert scale data. Mean and standard deviation were used to characterise the central tendency and variability of the data**.**

RESULTS

A three-round modified Delphi method was conducted in Phase 1 of this research. Based on the findings in the first round, the 13 experts agreed to include plant-based culinary nutrition as part of a module in the current Sports Nutrition curriculum. As high as 84.6% or 11 experts were confident this could be done. The experts believed a PBCNM for fitness is essential. To further consolidate the consensus, two more rounds of Delphi were conducted. A total of six experts were recruited, of which three were external experts outside of the university. They believed athletes should learn to cook simple meals and plan meals based on their daily energy requirements. One of the experts mentioned that cooking is not complicated and healthy eating can start with simple tasks such as boiling water for beans and rice. In this study, the experts' suggestions had reinforced the importance of developing the PBCNM.

The consensus among experts was crucial to create a valid survey instrument. Pilot testing was conducted to test its reliability. Reliability was calculated using Cronbach's alpha. For Part I, the need for PBCNM scored a Cronbach's alpha of 0.709. For Part II, the components of the model scored a Cronbach's alpha of 0.832. The overall reliability of the instrument for this research was Cronbach's alpha 0.836. The consensus standardised the survey items. The CVR score and the acceptability or non-acceptability of each item were included. The validated questionnaire comprised of two parts, Part I the Demographics with eight items and Part II with a total of 15 items. The CVR and CVI of these 15 items were based on experts' advice and the scores remained high. The score of CVR was 0.667 and above for each item, and this was accepted as valid**.** However, one item with the score of only 0.33 was removed due to lack of consensus.

Table 2. Demographics of respondents (*n*=271)

Demographic	Number of respondents	Percentage (%)
Gender		
Male	162	59.0
Female	109	41.0
Year of study		
1	97	36.0
2	102	38.0
3	72	26.0
Sports played		
Basketball	35	13.0
Football	45	16.6
Futsal	35	13.0
Rugby	5	1.8
Athletics	45	16.6
Ping Pong	33	12.0
Frisbee	1	0.4
Fencing	3	1.1
Javelin	5	1.8
Hockey	35	13.0
Badminton	29	10.7
Level		
National	39	14.0
State	105	39.0
University	95	35.0
Not stated	32	12.0
Cooking ability		
No	194	72.0
Yes	77	28.0
Practise plant-based diet		
No	212	78.0
Yes	59	22.0
Reason to cook		
Health	51	66.0
Love cooking	6	8.0
Limited budget	9	12.0
No reason given	11	14.0

Following experts' suggestions to merge and eliminate few items, consequently, Phase 1 of the study resulted in the development of a questionnaire, which included the needs and components, respectively. Each section scored a CVI of 1.000 and 0.834, respectively. CVI value was based on CVR calculation of each item in the questionnaire survey. Some of the research questions dealt in-depth with the process development of the PBCNM.

Consensus was achieved via a three-round modified Delphi approach that incorporated experts' opinion on the importance and necessity of the PBCNM for the maintenance of fitness. Finally, after the instrument was constructed and the items refined, it was prepared in the form of questionnaire suitable for data collection.

Phase 2
In Phase 2, the quantitative analysis included discussion of the results and expert panels' responses to the four research questions. The questions were: 1) How significant is a plant-based culinary nutrition model for fitness according to experts' perception?, 2)

What are the components of a plant-based culinary nutrition model for fitness?, 3) What is the consensus level of experts on components in a plant-based culinary nutrition model?, and 4) What is the developed model to be incorporated into daily lifestyle?

All participants completed the questionnaire and there were no drop-outs. Among these respondents, based on the demographics, 72% of respondents did not cook and if they had to cook, it was because of their love for cooking, health issues or limited budget in campus as students. However, majority of the students, 78% of them did not live a plant-based diet lifestyle. There were only 22% of 271 respondents who practised a plant-based diet (Table 2).

Based on the data collected, 57.9% respondents agreed and 14.8% strongly agreed about the need to have PBCNM for fitness. This made a total of 72.7% respondents eager to have the model. The strong need from respondents compelled the development of components for the PBCNM model. In addition, 71.9% of them agreed that there was a need for a plant-based culinary nutrition programme at higher learning institution. Data analysis conducted for the need and components of items 1-15 yielded in a mean and standard deviation score of 4.21±0.73. While there were differences in the scores, for most items, respondents' viewpoints concurred with the expert panels' viewpoints, hence leading to the development of PBCNM for fitness. In particular, 72.7% of the 271 respondents eagerly anticipated the PBCNM, while 84.6% of the 13 experts were confident that the inclusion of PBCNM in the Sports Nutrition curriculum could be done. Furthermore, the external experts also acknowledged the need for basic culinary skills among athletes; hence, the need for PBCNM in sports nutrition. The standpoint was collective and this research is an original contribution of knowledge.

DISCUSSION

This study aimed to develop a plant-based culinary nutrition model for fitness among Sports Science students. This was a mixed method study that required both qualitative and quantitative data to develop the PBCNM model. The ADDIE process was used to validate the stages in the development of this model. Qualitative data collection and analysis achieved through a modified Delphi process was quantified through quantitative analysis in the next phase using SPSS. The quantitative analysis supported the qualitative part of this research, providing substantial evidence that the PBCNM was needed. The combination of both quantitative and qualitative data provided a robust approach to the development of the PBCNM.

This research was significant because at the point of writing, it was the first local study integrating plant-based nutrition knowledge with culinary skills into a model for fitness improvement among Sports Science students. The mixed method approach applied in the study allowed for comprehensive understanding of the topic, combining quantitative and qualitative data. The expert panel interview was crucial in providing valuable insights into the need for PBCNM, highlighting the importance of including plant-based culinary nutrition in the Sports Nutrition curriculum. The experts' suggestions regarding the inclusion of PBCNM as a course in the Sports Nutrition curriculum further reinforced the importance of this research. Overall, achieving expert consensus on model components was critical in PBCNM development.

The development of PBCNM
This study focused on the development of PBCNM that was intended to fulfil the lack of reference in educational institutions and sports institutions for future plant-based culinary nutrition programme
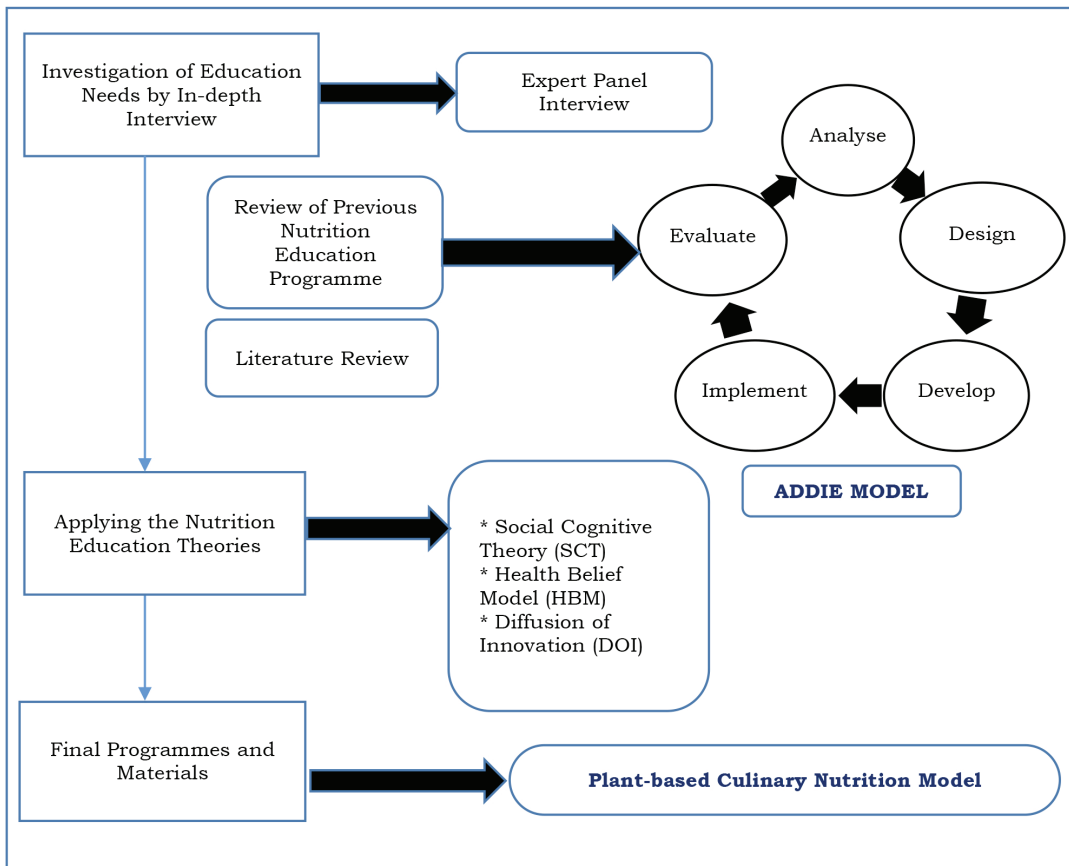
Figure 2. Model development process

development. The conceptual framework was based on three theories commonly used in health promotion research or programme development – SCT, DOI, and HBM, advocating the development of PBCNM for fitness among Sports Science students. The constructs from these theories supported the research findings as shown in Figure 2.

The ADDIE model, a structured approach to human learning and information systems was optimised (Patel *et al.* 2018). The ADDIE framework comprises five phases in developing instructional materials. However, this study utilised the first three steps – analysis, design, and development phases. The implementation and evaluation phases were not optimised.

In addition, this study was based on the premise that prevention is better than seeking cure. The SCT is a guideline providing indicators to enable people to adopt health-promoting behaviours and reduce detrimental behaviours (Oyibo, Adaji & Vassileva, 2018). The Academy of Nutrition and Dietetics stated that a carefully planned vegetarian and vegan diet is nutritionally appropriate, thus, providing health benefits in the prevention and treatment of various diseases (Kahleova & Katz, 2020). Self-efficacy is the confidence a person has in his/her own ability to perform a behaviour successfully. Therefore, mastering basic culinary skills can boost confidence in managing personal health through nutrition. Teachers and

trainers play important roles in helping individuals build confidence to manage their personal health. The PBCNM for fitness in this study was specifically designed for Sports Science students to learn basic culinary skills and master plant-based, home-cooked foods to maintain fitness. Individuals should organise their own daily nutrition routine and incorporate plant-based foods into existing diet to manage their personal health (Fanzo, 2019).

For behavioural modifications, the perceived benefits are positive outcomes related to the behaviour in relation to perceived vulnerability (Glanz, Rimer & Viswanath, 2008). For instance, the perceived susceptibility could be a chronic disease resulting from a sedentary lifestyle and unhealthy eating habits. Plant-based culinary nutrition is the application of behaviours connected to the belief that the health benefits of a plant-based diet could reduce risks of diseases and maintain fitness throughout life. Since PBCNM incorporates culinary sciences in sports nutrition, consequently, it is vital to learn culinary skills to prepare plant-based meals. One expert believed that Sports Science students would benefit greatly from culinary skills and the consumption of whole foods.

On the other hand, HBM is about expectation and threat perception. Most people need to feel personally threatened by diseases before they accept new ideas. The influence of higher authorities, media, family, and friends who live a plant-based lifestyle may convince individuals that prevention is better than cure. The main constructs of the HBM include perceived susceptibility, severity, benefits, barriers, added incentive to act, and self-efficacy. In this study, the focus was on perceived vulnerability and benefits. Accordingly, the DOI theory explains how idea gains momentum and spreads through a particular population or social system. The result of this spread is the adoption of new ideas.

Therefore, PBCNM is a progressive step in sports nutrition. The key factors that influenced the development of PBCNM were:
i. Advantage and influence of plant-based diet in the sports environment.
ii. Compatibility of a plant-based diet with the lifestyles of Sports Science students or athletes.
iii. Cooking is possible and pursuing a plant-based diet is straightforward.

There has been research on the connection between food and home cooking, as well as garden-based curriculum, but local studies exploring plant-based culinary nutrition for fitness was none. The wellbeing of Sports Science students is still closely related to their dietary habits and vulnerability to lifestyle diseases. Thus, athletes should learn to cook to maintain long-term fitness. In order to provide the necessary support, the development of PBCNM was conceptualised for Sports Science students, as shown in Figure 3. Eating the least processed food should become a norm in daily food consumption. However, pre-prepared plant-based food could still be a better alternative (Gonera *et al.,* 2021).

The PBCNM consists of three parts. The first part, which is the top, comprises components of the model. The middle circle includes plant-based nutrition, which alongside culinary skills, is the integration of both. This circle is surrounded by seven circles, which are components of the model. These include fundamentals of nutrition, culinary kitchen set up, menu planning, ingredients substitutions, shopping list, cooking methods, and culinary herbs and spices. The fundamentals of nutrition and culinary skills should be applied in daily food consumption to maintain fitness. At the middle part of the model, the Power Plate for Fitness is the circle which represents a healthy plate. Power Plate was created by experts at the Physicians Committee for
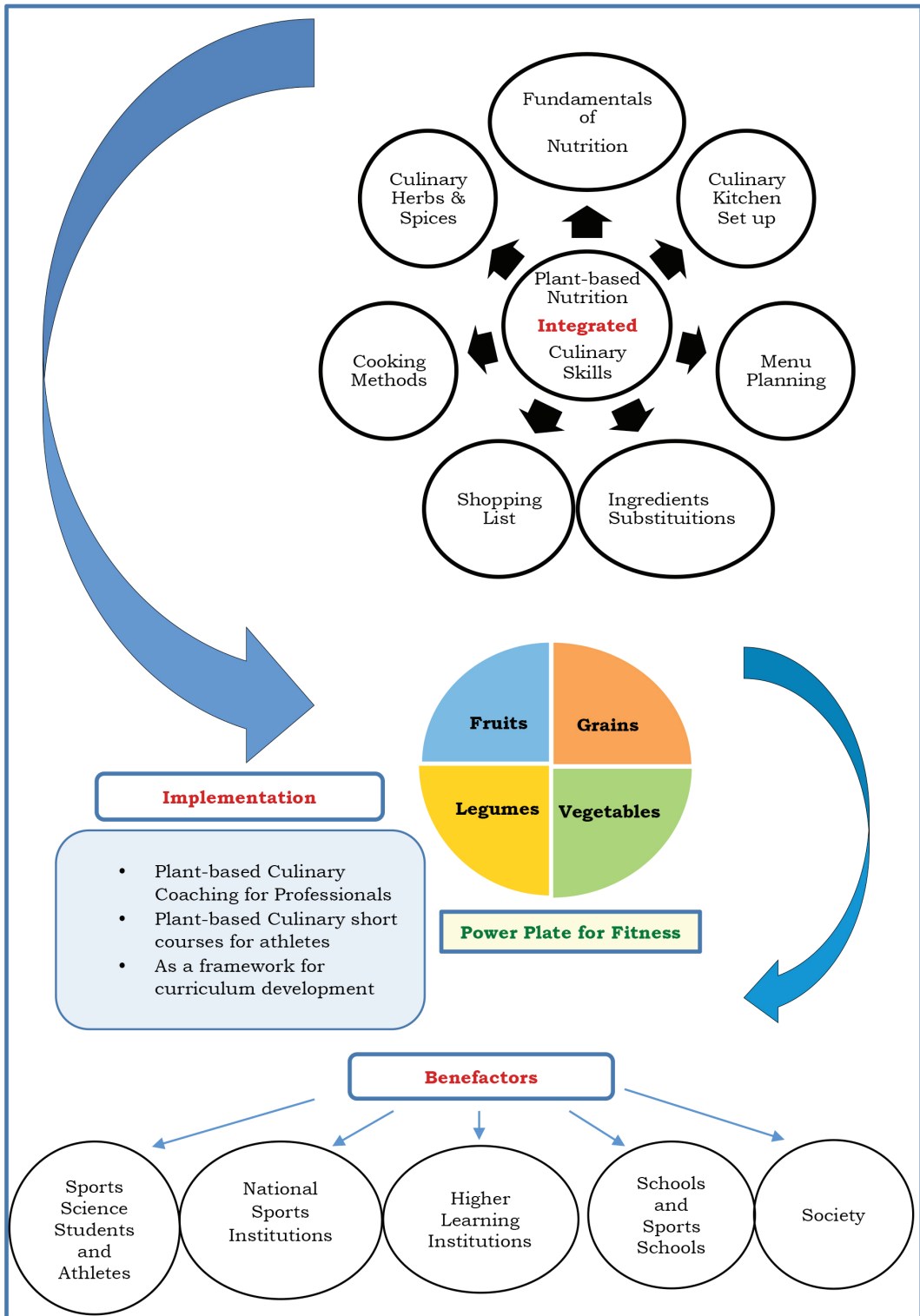
Figure 3: Plant-based Culinary Nutrition Model (PBCNM)

Responsible Medicine (PCRM) to prevent lifestyle diseases such as diabetes, obesity, cardiovascular diseases, and cancers. Accordingly, this Power Plate was appropriately adopted and adapted for this research as the Power Plate for Fitness in PBCNM, featuring four food groups which are essential for health management - vegetables, fruits, whole grains, and legumes. Dietary intake is specific to athletes' requirement for competitions, but generally plant-based portions recommended in the Power Plate will supply a good amount of fibre, protein, calcium, minerals, and vitamins daily. Finally, the third part is the benefactors. PBCNM is particularly developed for Sports Sciences students and athletes. Other beneficiaries are trainers, nutritionists and dietitians, culinary experts, and sports coaches. This model could guide people in warding off obesity, type 2 diabetes, heart diseases, cancers, and stroke if followed closely.

In modern times, globalisation and advances in communication technology have accelerated innovation. The new motto of lifestyle medicine spurred the acceptance of plant-based nutrition and home cooking for health maintenance (PCRM, 2014). This study focused on imparting the necessary culinary skills to prepare healthy plant-based meals according to established nutrition knowledge. Therefore, successful adoption of the PBCNM can be seen as a result of good understanding of the factors influencing the rate of adoption. Since DOI is a social process, the model is likely to be adopted by Sports Science students if it is communicated through the right network, such as Sports Nutrition courses at higher learning institutions. As commonly acknowledged, theories are an integral part of health care as they can be applied to clarify certain healthcare issues (Parker *et al.*, 2022). The PBCNM in this study was conceptualised based on the data from in-depth interviews and quantitative survey supported by SCT, HBM, and DOI theories.

Based on the study findings, the PBCNM for Sports Science students combined the principles of nutrition and culinary science to provide a foundation for Sports and Exercise Science curricula, courses, programmes, and others. While the PBCNM was developed primarily for Sports Science students and athletes, anyone can adapt it to their personal needs or for those unfamiliar with the diet (PCRM, 2014). Due to the lack of research in plant-based culinary nutrition locally, this study can be a steppingstone to expanding research in this field. Future research can apply intervention design and randomised controlled trials, both of which are common in health promotion studies. Researchers can also use the ADDIE model to systematically evaluate the implementation of PBCNM, especially its impact on Sports Science students and athletes.

CONCLUSION

Diet and exercise are considered "medicine" for healthy lifestyle. Despite certain prejudices against plant-based diets and their associated benefits for health, fitness, and athletic performance, convincing scientific evidence related to this diet has surfaced. The PBCNM in this study can be a reference for athletes who wish to practise culinary skills built on plant-based nutrition knowledge for fitness management. However, it will only be effective if athletes adopt and adapt the PBCNM into their lifestyle, regardless of their background and religious beliefs.

In summary, athletes who would like to try plant-based diet must be equipped with the necessary scientific knowledge to prepare balanced meals to meet their nutritional needs. Comprehensive information about plant-based diet is critical in promoting plant-based food consumption to reduce the negative

impacts of global health. Scientific knowledge can come from trainers, reading materials, videos, seminars, and even "culinary medicine", the latest booming trend in the medical world. This study highlighted the importance of plant-based culinary nutrition to maintain fitness among Sports Science students and athletes. To further support the beneficial effects of plant-based nutrition on athletic performance, more research on the effects of vegetarian diets on the fitness of athletes at various levels of performance in sports is recommended.

Acknowledgement

Authors' contributions

Baboo Morji B, conducted the study, data collection, prepared the draft of the manuscript; Sareena Hanim H, principal investigator, conceptualised and designed the study, reviewed the manuscript; Ahmad Zabidi AZ, advised on data analysis and interpretation, and reviewed the study design and model development.

Conflict of interest

The authors declare no conflict of interest.

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