Perceived barriers towards whole grain consumption among the Malaysian adult population: findings from a theory-based qualitative study

Received 26 October 2021
Revised 24 March 2022
25 April 2022
Accepted 25 May 2022

Danaselvam Ugunesh
Department of Bioscience, Faculty of Applied Sciences, Tunku Abdul Rahman University College, Kuala Lumpur, Malaysia
Ching Sin Siau
Faculty of Health Sciences, Centre for Community Health Studies (ReaCH), Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia
Mohd Nor Ahmar Bin Mohd Sanip
Department of Hospitality Management, Faculty of Social Science and Humanities, Tunku Abdul Rahman University College, Kuala Lumpur, Malaysia, and
Hui Chin Koo
Department of Bioscience, Faculty of Applied Sciences, Tunku Abdul Rahman University College, Kuala Lumpur, Malaysia

Abstract

Purpose – The paper aimed to explore the factors leading to lower rates of whole grain consumption amongst the Malaysian adult population according to the Reasoned Action Approach (RAA) model.

Design/methodology/approach – This paper employed a qualitative approach to explore the factors that influence whole grain consumption. Individual interviews were conducted online amongst Malaysian adults aged 18 years and above who purchase groceries and are responsible for food preparation at home. Interviews were transcribed verbatim and analysed thematically using the NVivo version 12 software.

Findings – A majority of the respondents ($N = 30$; mean age = 39.2 years old) were females ($n = 19$, 63.3%) and lived in urban areas ($n = 23$, 76.7%). Even though over 86.7% of respondents ($n = 26$) had consumed whole grain products, a majority of them had inadequate knowledge surrounding whole grains ($n = 25$, 83.3%). Predominant barriers to whole grain consumption were perceived cost ($n = 30$, 100%), dislikes towards the sensory aspects of whole grain foods ($n = 28$, 93.3%), inadequate knowledge in identifying whole grains in foods ($n = 25$, 83.3%), poor awareness ($n = 25$, 83.3%), lack of knowledge in preparation of whole grain foods ($n = 25$, 83.3%), a wide variety of other tasty cuisine alternatives in Malaysia ($n = 25$, 83.3%), low availability and accessibility of whole grain products ($n = 18$, 60%), cultural eating behaviours ($n = 17$, 56.7%) and family influence ($n = 16$, 53.3%). Besides that, having a longer preparation time, restrictive diets and social influences were minor barriers.

The authors express sincere gratitude to all the respondents for their time and effort in participating in the in-depth online interviews.

Funding: The present study was supported by Tunku Abdul Rahman University College (TAR UC/EC/2020/08–3). The funder played no role in the design, conducting or interpretation of this research, or the decision to publish.

Author contributions: H.C.K, C.S.S and M.N.A. were responsible in conceptualising the study design, overseeing data collection, advising on data analysis and data interpretation. U.D. coordinated data collection, data entry, data analysis and drafted the manuscript. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: The authors declare no conflicts of interest.

British Food Journal
© Emerald Publishing Limited
0007-070X
DOI 10.1108/BFJ-10-2021-1152

Research limitations/implications – This study addresses the barriers that should be highlighted in future health educational interventions, and presents a challenge to the food industry to develop whole grain foods which are easily accepted by consumers.
Originality/value – This is the first paper to outline the factors associated with poor consumption of whole grains amongst the Malaysian adult population.

Keywords Whole grain, Qualitative research, Barriers, Reasoned action approach (RAA)
Paper type Research paper

1. Introduction

Whole grains are a major supply of dietary fibre and are also enriched with vitamins, minerals and phyto-chemicals (McRae, 2017). Several studies have reported that elevated consumption of whole grains might bring about numerous health benefits to an individual (Kyro and Tjønneland, 2016; Seal *et al.*, 2021). For instance, consumption of whole grains has been effectively shown to reduce the risk of chronic illnesses such as insulin resistance, low blood pressure, type 2 diabetes, cardiovascular diseases, colorectal cancer and obesity (AK *et al.*, 2015; Aune *et al.*, 2016). Although there is no universal definition for whole grains, the whole grain definition from Malaysia Food Regulation (2020) has been applied in the present study. The regulation defines whole grain as the intact, ground, milled, cracked or flaked kernel after the removal of the inedible parts (Food (Amendment) (No.4) Regulations, 2020). The whole grain definition from the Malaysia Food Regulation is similar to the definition suggested by the American Association of Cereal Chemists International (AACCI). The nutritional benefits that are derived from whole grains, in comparison to refined grains, are due to their structure of whole grain kernels which consist of the germ, bran and endosperm, unlike the refined grains which only contain the endosperm after having gone through the refinement process (Zhang *et al.*, 2020).

The recommendations made regarding the consumption of whole grains differ widely between different countries. For instance, the United Kingdom (UK), Australia, Canada, Mexico and Malaysia provide more general recommendations that focus on the types of food consumed in relation to whole grains; as can be seen in the Malaysian Dietary Guideline 2020, which recommends "consuming an adequate amount of rice, other cereals, whole grain-based cereal products, and tubers" (NCCFN, 2021). The UK also recommends individuals to "consume more bread, rice, potatoes, pasta and other starchy foods daily, but go for whole-grain options whenever possible" (Mann *et al.*, 2015). Guidelines suggested by other countries adopt a more general approach, such as the Australian Dietary Guidelines (2013) which recommend eating predominantly whole grain foods, Canada's dietary guidelines which highlight regular intake of whole grain foods along with vegetables and other proteins (Canadian Dietary Guideline, 2019), and Mexico's dietary guidelines which focus on the consumption of whole grains, so as to promote a number of health benefits towards the individual (Rafael, 2016). On the other hand, countries such as the United States of America (USA), the Netherlands, Denmark and Sweden provide more specific recommendations in terms of intake quantities. Denmark and Sweden, for example, recommend consumption of 75 g of whole grain products per 10 MJ/d (Xiong *et al.*, 2022), while the USA recommends 48 g/d (Slavin *et al.*, 2013) and the Netherlands 90 g/d (Seal *et al.*, 2016).

Despite all the potential health benefits whole grains provide, whole grain intake is reported to be relatively low worldwide. A previous study showed that the average daily intake of whole grains amongst adult populations vary, ranging from 4 g in Italy and 15 g in the USA, to 28 g in Ireland (Meynier *et al.*, 2020). In Malaysia, a small-scale research showed that only 51% of the medical students from a university in Selangor were whole grain consumers. The study did not report the daily whole grain consumption of the population (Subramaniam *et al.*, 2019). It is necessary for future studies to examine daily whole grain consumption, as well as the factors that influence said consumption amongst the Malaysian

adult population in order to develop effective interventions or programs that aim to encourage the consumption of whole grains, specifically amongst this population (AK *et al.*, 2015).

A number of qualitative studies on attitudes, perceptions and barriers towards whole grain consumption have been conducted in Western countries (Murimi *et al.*, 2016). These studies indicated that the potential barriers of whole grain intake might be the taste of whole grains, a poor understanding of their health benefits when consumed, family influence, cost and accessibility. Although research has demonstrated, such factors might not apply to the Malaysian adult population due to the differences in cuisine, food accessibility, culture, socioeconomic factors and food preference across settings and contexts. (Moghames *et al.*, 2015). A national study conducted in Malaysia showed that children from high-income family were most likely to consume whole grains (AK *et al.*, 2015). In addition, a quantitative study that explored the whole grain consumption and its determinants amongst Malaysian medical students revealed that culture and self-beliefs influence whole grain consumption (Subramaniam *et al.*, 2019). These studies implied that cost, parental influence, cultural background and self-belief might be the potential factors that influence whole grain consumption in Malaysian children and adolescent populations. To date, there have not been any qualitative studies accessing the factors that might influence whole grain consumption amongst the Malaysian adult population. Within the context of Malaysia, it is necessary to understand the factors affecting consumption, not only to consider the current situation in Malaysian adults, but also to help develop future strategies for global whole-grain food producers and public health agencies to target increased and lifelong intake of whole grains. A qualitative research study would thus be the best approach in gaining an in-depth insight on the factors that might influence whole grain consumption in a given population. An insightful in-depth interview may facilitate understanding of one's experiences, impressions, knowledge and ideas, as well as their thoughts toward developing a dietary habit (Coleman, 2019,). Gray (2018) revealed that interviews may be considered the most logical research technique when the objective of the research is largely exploratory. The findings of the present study may provide insights to the global food industry for developing a well-accepted whole grain food selection which not only caters Western countries, but also amongst Asian populations.

The theory of Reasoned Action Approach (RAA), a theory developed and brought about from both the Theory of Planned Behaviour (TPB) and the Theory of Reasoned Action (TRA) (Ajzen, 1998), is an extension of the TPB model where intention is predicted based on three constructs: attitude, perceived norms and behavioural control. It treats environmental and knowledge associated variables that were not specifically found in the TPB model as background variables that distantly affect health behaviour (Ajzen, 1991). Attitudes were considered to be made up of two parts: experiential and instrumental attitudes; perceived norms consisted of both injunctive and descriptive norms, and perceived behavioural control consisted of capacity and autonomy (Ajzen, 1988; Backman *et al.*, 2002). Experiential attitudes refer to an individual feeling towards executing a suggested behaviour, while instrumental attitudes relate to the beliefs towards the outcomes of a recommended behaviour (Ajzen, 1991). On the other hand, injunctive norms are thought of by others regarding what one is required to do whereas descriptive norms describe what others really do (Ajzen, 2011). Perceived behavioural control can be interpreted in terms of perceived control over the suggested behaviour as predicted by environmental factors that either make it easier or harder to perform the specific suggested behaviour (Ajzen, 2011). The inclusion of the RAA model, which includes environment, skills and abilities, as well as the background factors construct, may be new and significant; but are indeed relevant for investigating dietary behaviour factors amongst Malaysian adult population. The RAA model has also been applied in previous studies to investigate the factors influencing whole grain intake amongst

the adolescent population in the UK (Kamar *et al.*, 2016) and among the lower income population in the US (Chea and Mobley, 2019). In such studies, conducting open-ended interviews based on RAA constructs was an essential part in determining the factors based on the RAA theory (Chea and Mobley, 2019). We believe the RAA may provide an insight regarding factors and barriers towards whole grain consumption amongst the Malaysian population too.

To our best knowledge, this is the first study conducted amongst the Malaysian adult population to investigate the barriers of whole grain intake using the RAA model. The findings of this study may shed light on factors that influence whole grain consumption amongst Malaysian adults and may assist in the development of successful interventions to improve the whole grain consumption levels in the Malaysian and Asian populations.

2. Methods

2.1 Study design and participant recruitment

A sample of 30 Malaysian adults aged 21–72 years, participated in an individual in-depth online interview. Through the use of a combination of snowballing and purposive sampling, all the adults who fulfilled the inclusion criteria were invited to participate in the study via word-of-mouth, through community groups, as well as advertisements on social media platforms such as Facebook, Twitter and Instagram (Foster *et al.*, 2020). The study was conducted from March to May 2021. The study protocol was approved and reviewed by the Tunku Abdul Rahman University College Research Ethics Committee (TAR UC/EC/2020/08–3). The inclusion criteria were: (1) Malaysian adult aged 18 years and above, (2) someone who is responsible for purchasing household groceries, (3) someone who is responsible for preparing meals and (4) has the ability to understand and communicate in the English language. Adults with formal academic credentials in nutrition or who are primarily engaged in nutritional education were excluded from the study, as they are more likely than the general population to have more knowledge about whole grains (Foster *et al.*, 2020). The recruitment stage ended and theme saturation was deemed to have been achieved after completion of the 30 in-depth interviews.

2.2 In-depth online interview

The in-depth online interviews were both audio and face recorded prior to data analysis, with the respondents' written consent obtained and the audio transcribed verbatim. Each interview was conducted individually by the first researcher (U.D.) and lasted for approximately 60–85 minutes (Murimi *et al.*, 2016; Kamar *et al.*, 2016). A number of semi-structured interview questions were adopted from several published studies which assessed consumer's perceptions, barriers to, as well as the facilitators of whole grains consumption in the US (Chea and Mobley, 2019), the UK (Kamar *et al.*, 2016), Australia (Foster *et al.*, 2020) and Northern Ireland (McMackin *et al.*, 2012). The questions were further refined towards the construction of the RAA model (Figure 1). The questions had content validity, as they were validated by an expert panel consisting of nine dieticians and nutritionists. Individual in-depth online interviews enabled the participants to share their opinions and experiences freely, which allowed us to probe for further information. A pilot interview was conducted amongst seven adults aged 21–35 years to assess the interview flow and duration, as well as questions' format. The questions were well received by all seven subjects, and the interview flow has been improved after the pilot testing. The time allocated for each interview was extended, as researcher tried to apply the probing technique into each interview session, for a better understanding of barriers influencing whole grain consumption. The questions (as seen in Table 1) focus on the dietary habits (such as avoidance of or adherence to any specific

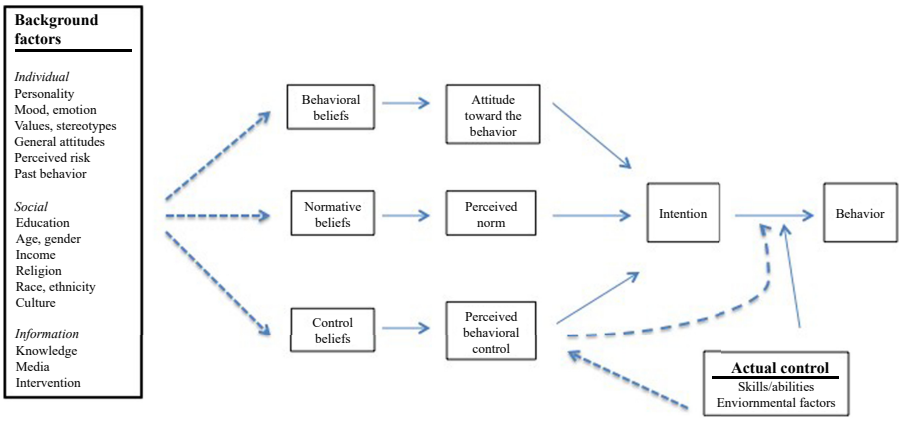

Figure 1.
Main constructs of the Reasoned Action Approach (RAA) model

diet), barriers to eating whole grains, strategies or facilitators that assist whole grain intake and their perceptions of whole grain consumption (refer to Table 1 and Figure 1).

2.3 Data preparation and analysis

The RAA model has been used to describe and investigate whole grain consumption patterns amongst adults in Malaysia. We investigated the level by which RAA constructs were represented. All in-depth interviews were transcribed and data were analysed using thematic analysis proposed by Braun and Clarke (2006). NVivo Version 12 Qualitative Research Software (QSR International, Melbourne, Australia) was used to manage the coded data. The transcripts were carefully read for at least three times, followed by coding with descriptive labels. All the descriptive labels were converted to the provisional codes, which consisted of common labels respectively. The transcription, coding and interview continued to be carried out until data saturation was reached (no new data emerged) (McMackin *et al.*, 2012). Inter-reliability tests were conducted in order to ensure the validity of the research and was found to be acceptable with a Cohen's Kappa score of 0.92 (Ajzen, 2011; Kamar *et al.*, 2016). Codes were assigned to a series of themes and subthemes for ease of data presentation (as required). Each common code was screened and categorised under its respective themes. The same text or example quote could be found in more than one theme depending on the codes generated under the same unit (Ajzen, 2011; Kamar *et al.*, 2016). The coding was independently verified by another researcher.

3. Results

3.1 Subject demographics

A sample of 30 multi-ethnic Malaysian adults aged 21–72 years (mean age = 39.2, standard deviation (SD) = 15.7) participated in this qualitative study. Respondents were divided into age groups that consisted of young adults (19–29 years old), middle-aged adults (30–50 years old) and older adults (>50 years old). The age groups were categorised according to the age groups demonstrated in the Malaysian Recommended Nutrients Intake (NCCFN, 2017). Demographic characteristics of the respondents are presented in Table 2. A majority of the respondents were working adults (n = 22; 73.3%), were enrolled in tertiary education (n = 23; 76.7%), and lived in urban areas (n = 23, 76.7%) (refer to Table 2).

Table 1.
Semi-structured in-depth interview guide

Question pointers	Questions
Part 1	
Dietary factors	• Do you follow a specific diet? Why? • Do you consume grain foods? • How many times do you consume whole grains in a week/month/year?
Part 2	
Personal factors	• A set of pictures were displayed, and the respondents were asked to identify whole grain food, and differentiate whole grain from non-whole grain foods. Once the identification activity has been completed, the interviewer asks, "How did you identify the whole grain foods?" • What do you know about whole grains?
Part 3	
Background factors	• What are the possible factors that affected your consumption of whole grains in the past?
Part 4	
Barriers on wholegrain consumption	
- Self-efficacy	• What are the whole grain products you usually purchase the most? Why?
- Attitudes: Sensory	• What do you think of the taste and look of whole grains? Why?
- Family influence	• Have you cooked any whole grain foods before? Why? • Do you think your family affects your whole grains consumption choice? Why?
- Perceived behavioural control: cost	• Do you think whole grain foods are cheap/expensive? Why? • Do you think that your food preparation skills affect your whole grains intake? Why?
- Skills	• Based on the rating scale of 1 (easy) to 10 (hard), how often do you find whole grains in the shelves (availability)? Why?
- Physical environment	• If you easily get non-whole grain products compared to whole grain products, will it affect your whole grains consumption (accessibility)? Why?
Part 5	
New whole grain promotions/tool	• Have you considered any strategies to increase your whole grains intake? Why? • Do you think whole grain cookbooks will increase your whole grains intake? Why?
Part 6	
Parents with children (Additional)	• Do you introduce whole grain foods to your children/grandchildren/nephew/niece at home? Why? • How did you introduce the whole grain foods? • How did your children respond to it?

Demographic variable		Young adults	Middle-aged adults	Older adults
Age range (years)		19–29	30–50	>50
n (%)		17 (56.7)	7 (23.3)	6 (20.0)
Gender n (%)	Female	10 (52.6)	6 (31.6)	3 (15.8)
	Male	7 (63.6)	1 (9.1)	3 (27.3)
Ethnicity n (%)	Malay	3 (37.5)	4 (50.0)	1 (12.5)
	Chinese	7 (63.6)	1 (9.1)	3 (27.3)
	Indian	5 (62.5)	2 (25.0)	1 (12.5)
	Other	2 (66.7)	0 (0.0)	1 (33.3)
Household income (RM) n (%)	1,000–5,000	9 (64.3)	1 (7.1)	4 (28.6)
	5,001–10,000	7 (53.8)	4 (30.8)	2 (15.4)
	10,001–15,000	1 (33.3)	2 (66.7)	0 (0.0)
Education level n (%)	Secondary	1 (14.3)	1 (14.3)	5 (71.4)
	Tertiary	16 (69.6)	6 (26.1)	1 (4.3)
Residential area n (%)	Rural	3 (42.9)	1 (14.3)	3 (42.9)
	City	14 (60.9)	6 (26.1)	3 (13.0)
Whole grain consumption n (%)	Very frequent (≥5 times per week)	7 (87.5)	1 (12.5)	0 (0.0)
	2–3 times per week	8 (66.7)	1 (8.3)	3 (25.0)
	Rarely in a month	1 (16.7)	3 (50.0)	2 (33.3)
	No intake at all	1 (25.0)	2 (50.0)	1 (25.0)

Table 2. Characteristics of study respondents ($N = 30$)

3.2 RAA constructs

Findings of the present study are captured and presented under the RAA model (i.e. themes falling under the background factors, behavioural/attitudinal beliefs, normative beliefs and/or control beliefs) (Kamar *et al.*, 2016). Figure 2 depicts a summary of the in-depth interview themes categorised according to the RAA theory constructs (refer to Figure 2).

3.2.1 Background factors.

(1) Knowledge and awareness towards whole grain products

In the in-depth online interview, a majority of the respondents ($n = 25$; 83.3%) expressed those whole grains are free from chemicals and they defined whole grains as "natural", "original", "unrefined", "unpolished ones", "low preservatives added", "healthier", "contain seeds", "nutritious", "increases satiety" and "easier to digest". Only a minority of them ($n = 14$; 46.7%) claimed that they were unaware of whole grain foods and did not know how to differentiate between whole grain foods and other foods.

All the respondents were able to identify correctly that brown rice was a whole grain product. Respondents also quoted that with whole grain products, certain words were provided on the food labels of these products, e.g. "whole grain", "100% original or natural", "whole grain logo". Several statements were made by respondents, such as ["*There is a clear tick on the packaging which show that this is the whole grain product*"] demonstrating that whole grain food, namely brown rice, is clearly labelled and packaged.

When it came to the identification of corn and barley, a majority of the respondents ($n = 22$; 73.3%) were able to identify them correctly. However, some of them were in doubt when answering the question as compared to the question on brown rice. An example quote from one of the respondents was ["*Because, I just know the corn in the field, it tastes sweet and I don't know which type of it*"].

Respondents made similar statements regarding the identification of barley. They mentioned barley is easier to be found in grocery stores than in hypermarkets in rural areas, as compared to urban areas. Besides, barley product is not well packed or anywhere indicated it

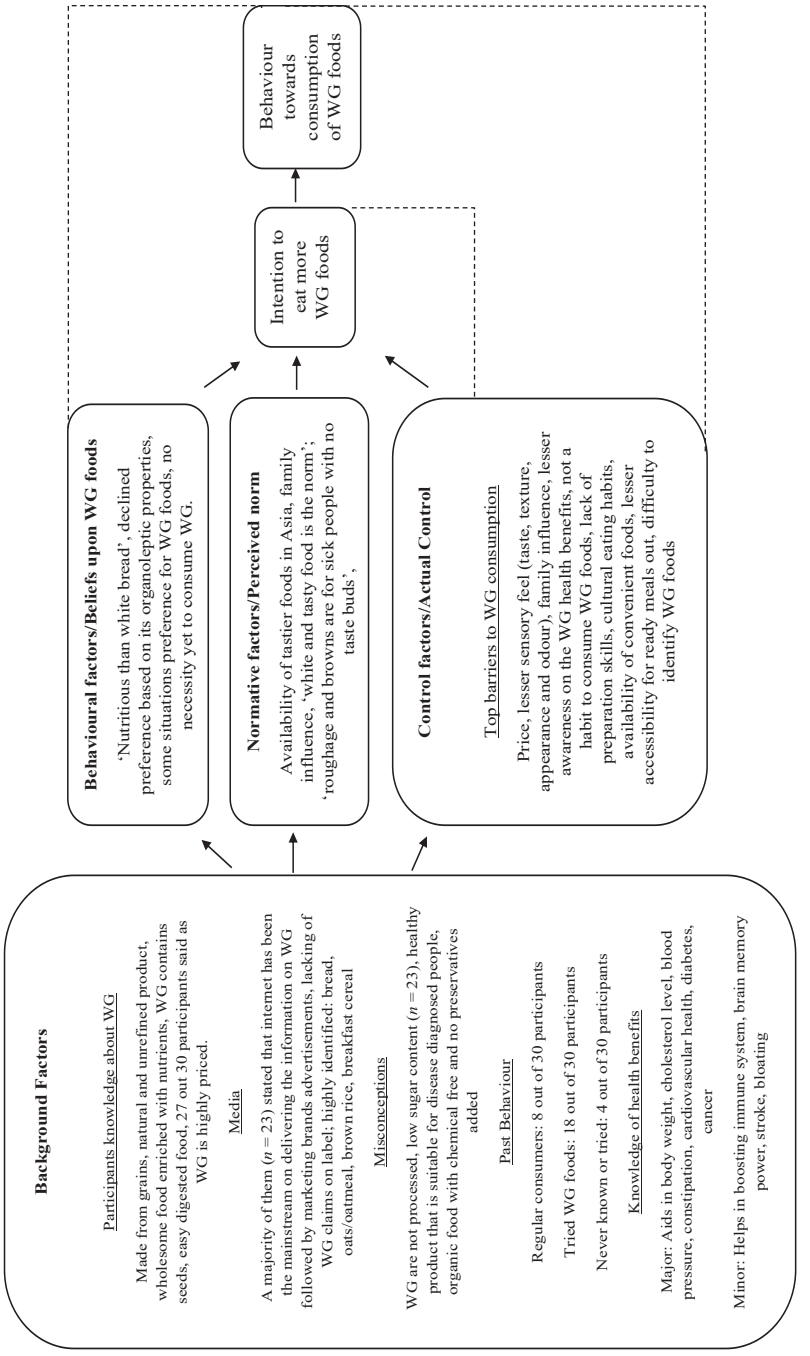

Figure 2.
Summary of the In-depth interview themes under the RAA theory constructs

is a whole grain product, in both urban and rural areas. For example, one of the responses given by the respondent was: ["*Yes, barley is a whole grain. However, it is simply packaged and very plain*"]. Besides, assumptions were made that whole grains are always the healthiest of foods; hence, when identifying corn and barley, they are often associated with the health benefits that they provide. For instance, the comments given, such as [*"no side effects, no cholesterol, protein high, natural food"*], indicate that whole grain foods should be appropriately packaged and labelled, so as to assist in the identification of whole grain products.

During the in-depth interview, misinformation or misconceptions about whole grain foods were affirmed during the identification stage. The misconceptions found amongst respondents were as such: (1) all grains are the same, regardless of whether they are multi-grain, nutri-grain, or whole grains ["*I think maybe is the same because all the names of the product have label of grains behind it*"]; (2) whole grains are foods that have lower content of preservatives or none at all, and are chemical free ["*Maybe less in preservative maybe like the whole grains shelf life is not long also so maybe that's why I said that it has lesser preservative"*]; (3) whole grain foods have little to no processing as compared to refined grains, which are more highly processed ["*I think I don't say the brown rice, they don't have a process at all. Maybe their process level is minimal compared to the white rice"*]; (4) whole grain foods are low in sugar or do not contain any sugar at all ["*They have lower sugar content too*"]; (5) whole grain foods are less starchy and contain fewer carbohydrates, or none at all ["*lesser carbohydrate*"]; (6) popcorn is not considered to be a whole grain food ["*Yeah, they never mentioned as it's a whole grain product*"].

(2) Whole grains consumption

In one of the questions, respondents were asked "have you ever consumed whole grain foods before?"; a majority of the participants ($n = 26$; 86.7%) responded positively. However, when they were asked about their regularity in consumption of whole grain products (measured as on a daily basis, or at least 1 to 2 times per week), only a minority of them ($n = 8$, 26.7%) responded positively. Interestingly, the frequency of whole grain consumption was rated especially high for breakfast meals, where participants consumed (in order of increasing frequency) breakfast cereals, ["*Erm, I normally consume the cereals*"], whole grain bread ["*I'll just grab a whole grain gardenia*"] and oatmeal ["*I consume oatmeal as my breakfast"*] for breakfast.

(3) Health benefits of whole grains

In the in-depth online interview, respondents were asked "what are your thoughts on how whole grains affect your health?", and the most frequent response was that whole grains contain dietary fibre ["*first thing is because of the fibre inside*"] and are good for diabetes ["*My friend is a diabetic patient. He told me the doctors suggested her to consume brown rice as its good for diabetic patients*"]; another response was that whole grains help in weight management ["*I just like to say right, it can reduce my risk of getting obese*"]. Figure 3 displays the responses given by respondents (listed from most to least frequently given) concerning the perceived health benefits associated with consumption of whole grains.

Throughout the in-depth online interview sessions, there were a variety of other different predictions given about the health benefits of whole grains (marked as "other" in Figure 3). For instance, ["*it might boost brain memory power*"] and ["*At a recommended level of consumption, it may be beneficial to health, but excessive consumption may be harmful to one's health*"]. Although a majority of the adults were aware that whole grains are beneficial to their health, most of them were unaware of the particular reasons behind such benefits, which suggests that an increased knowledge towards whole grains is needed ["*I know that it is good for our cardiovascular health but don't know the specific reasons behind it*"].

3.2.2 Behavioural and attitudinal factors: feelings towards whole grain foods.

(1) Personal acceptance/resistance towards whole grain foods

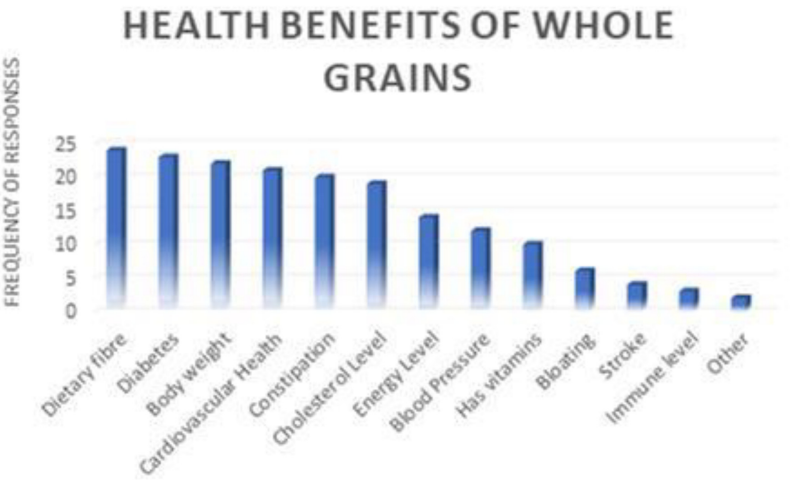

Figure 3.
Respondents' knowledge towards the identification of health benefits provided by whole grains

Participants were asked about their attitudes and acceptance toward whole grain foods. They gave responses to the topic as well as made queries about the health benefits of whole grain foods. All the respondents agreed that whole grain products are healthy, are related to health in some way ($n = 30$, 100%), or are at least "better than soft, white bread" and that "white bread is tastier". [*"In terms of healthiness, I would say whole meal bread is better than the normal bread. It's made of whole meal grains and all that which is more nutrition"*].

Assertion of dislikes towards whole grains were prominent in terms of taste, texture, odour, appearance and cost, with the former being mentioned slightly more frequently than other points [*"Very sticky like that, but if I make the rolled oats like overnight oats then I like it, since it absorbs well, but other like the instant oats, I do not like because its tasteless and dry"*].

Besides that, a third prominent attitude that was recognised was a positive liking towards the sensory aspects of whole grain foods [*"overnight oats are a thumbs up usually"*] and [*"So besides that, I think that whole grain foods are actually more cruncher because I'm person who likes to crunchier things"*].

In a nutshell, participants reported a wide range of opinions and beliefs about whole grains, which also included health-related outcomes. Also, taste and acceptability were depicted to have a stronger influence on their behaviour.

3.2.3 Perceived norm/normative beliefs towards whole grains.

(1) Cultural eating habit

Several components of normative beliefs were identified during the discussion, most notably the concept of "norm" and family influence towards consumption of whole grains. Several participants stated that whole grain foods were unusual or unfamiliar in their everyday lives ($n = 25$, 83.3%). Some participants ($n = 23$, 76.7%) mentioned that [*"As from childhood it has been a habit eating white rice as lunch and dinner. I am not used to eating it, so I will not take it but have to train"*], indicating that amongst Malaysian adults, eating choices are habit driven and that whole grains had never been a component of their diet.

(2) Poorer availability and accessibility of whole grain foods

Additionally, several respondents said that [*"Maybe because we are Asians, we will choose white rice, as its easily available compared to brown rice which will be sold in highly priced restaurants"*] and [*"It isn't the practice of our home to buy specific whole grain food products*

such as quinoa, as they don't know where to buy them"], highlighting the significance of accessibility and availability in moulding intake patterns of whole grain products amongst Malaysian adults.

(3) Family influence

Family influence was notable, which was a barrier mentioned more than half the time when compared to other barriers to whole grain consumption (n = 16, 53.3%). For instance, [*"Our upbringing really plays a main role in our food consumption, I wasn't served these types of foods but I'm not blaming my parents for not giving so as the village people had lesser exposure towards these kind of things"*].

Interestingly, most parents with young kids (n = 10, 33.3%) gave positive responses, such as ["*Throw up only as they don't like the taste, but I'll still include them in their foods"*], demonstrating that they are trying to shape their kids' dietary habits from a young age by inculcating a whole grains diet despite being unsure of the specific health benefits of such a diet and having to deal with their child's "picky eating" habits.

3.2.4 Actual control/control beliefs.

(1) Barriers towards whole grain consumption

The most prevailing barriers toward whole grain consumption were reported to be perceived cost (n = 30, 100%), disliking of the organoleptic properties (taste, texture, appearance and odour) of whole grain foods, with taste being the most prevalent barrier (n = 27, 90%), inadequate knowledge towards whole grain products (n = 25, 83.3%), availability of convenient foods in Malaysia (n = 25, 83.3%), lack of preparation skills (n = 20, 66.7%), low accessibility to whole grain products (n = 18, 60%), various different cultural eating behaviours (n = 17, 56.7%) and parental or family influence (n = 16, 53.3%) amongst all age groups. Furthermore, the longer preparation time needed, medical conditions that necessitate a special diet and social influences were identified as minor barriers towards consumption of whole grains and were marked as "others" in Figure 4.

(2) Perceived cost of whole grain foods

Whole grains were identified by the participants as a costly item when compared to other non-whole grain products. A number of respondents claimed that whole grain products are not cost-friendly, and would therefore inhibit their purchasing of whole grain products unless there are special offers given by stores for these products [*"I will purchase whole grain foods*

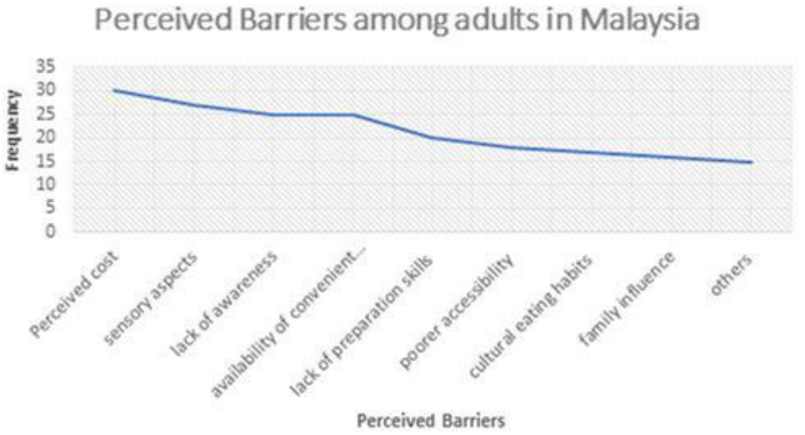

Figure 4.
Perceived barriers towards consumption of whole grains among Malaysian adult population

only when they are in promotions as they cost higher"]. This revealed that the increased price of whole grain products was the most significant barrier towards consumption of whole grains, and that such products are not widely available due to lower demands amongst Malaysians for whole grain foods.

(3) Dislikes towards sensory properties of whole grain foods

Apart from cost-effectiveness, taste was another barrier toward whole grain consumption. A majority of respondents disliked the sensory aspects of whole grains, and indicated their preferences in having whole grain meals together with other more flavourful foods.

(4) Lack of knowledge/awareness towards whole grain foods

Knowledge factors towards whole grains were also discussed, and were a part of the background factors. In addition, respondents stated that ["*Maybe because is not really promoted well"*], which indicates that people consume less whole grain foods due to their notion of ["*not needing to consume it yet*"]; this perception raises the necessity for whole grain products to be more widely advertised and given stronger emphasis.

(5) Availability and accessibility of convenient foods

Nonetheless, a majority of respondents commented that Malaysia has a wide variety of convenient food options, and that whole grain products are not amongst the typical foods that Malaysian adults consume [*"In Malaysia, we have tasty foods like Char Kuey Teow, Tomyam and similar, so whole grain foods doesn't shine among us"*].

(6) Cultural eating habits and family impacts on consumption of whole grain foods

A number of respondents also claimed that they only favoured certain kinds of whole grain products. In addition, several of them responded that they did not buy certain whole grain products due to the unfavourable attitude of family members towards such products. Cultural eating behaviours are also one of the barriers towards whole grain consumption [*"I think maybe is because from childhood it has been a habit like eating white rice as lunch and dinner"*]. Besides that, a few respondents stated that they lack the know-how in preparing good whole grain meals, suggesting the need for the availability of whole grain cookbooks or recipes that cater to the Asian population [*"recipes should be tailored to Asian taste buds"*].

(7) Lack of preparation skills and longer preparation times

Several respondents also reported that time and convenience of whole grain meal preparation were barriers toward whole grain consumption [*"Like for me it's a waste of time when I do the preparation of whole grains because it takes longer time to prepare"*]. A few respondents who were daily consumers of whole grains (n = 8, 26.7%) stated their perceived barriers to be having their meals away from home ["*For my children going to school usually they have their meals in canteen and it is very difficult for me to pack as I'm working*"].

(8) Specific medical diet restrictions

On another note, a few elderly individuals stated that their existing health conditions, such as the need to follow gluten-free diets and having denture issues, limited them from consuming whole grains [*"The reason I have this joint pain also. So, to avoid gluten in it, we have to avoid the oats"*] and [*"I cannot chew it as its very hard"*].

4. Discussion

To the best of our knowledge, this is the first theory-based qualitative study that aimed to investigate the perceived barriers to whole grain consumption amongst the Malaysian adult

population, in which the RAA model was adopted. Formative research evidence has shown that inclusion of whole grains in a diet may prevent the occurrence of several chronic diseases. Despite these recognised health benefits, whole grain intake still falls below the recommended levels in almost all countries worldwide, including Malaysia (Meynier *et al.*, 2020; Foster *et al.*, 2020; Kamar *et al.*, 2016). This scenario highlights the need for developing a better understanding of the perceived barriers to whole grain consumption so as to improve whole grain consumption practices.

4.1 Barriers towards consumption of whole grain foods

The sensory qualities were reported to be the most prevalent of barriers in all studies towards whole grains (Meynier *et al.*, 2020; McMackin *et al.*, 2012; Chea and Mobley, 2019), including the present study. However, the current findings of the study reveal that a number of young adults prefer whole grain products due to their perceived taste and "crunchy" texture, and are willing to pay a higher price for such products. This implies that if sensory characteristics are adequate, cost may not be an issue for some in the population (Foster *et al.*, 2020). Respondents proposed that whole grain foods should be more appetising, flavoursome and have a softer texture. This proposal highlights the importance of the sensory qualities in whole grains.

A majority of the respondents were familiar with the term "whole grain," even if they were unsure of the exact reasons as to why whole grains appear to be good for everyone. However, the barriers to whole grain consumption were still evident, which is in line with a study from Northern Ireland that was conducted amongst an adult population of those between 18–65 years old (McMackin *et al.*, 2012). The present study demonstrated the importance of whole grain knowledge as a practical aid in identifying whole grain foods, which may have an impact in subsequent incorporation of whole grain foods into an individual's diet (Kamar *et al.*, 2016; Chea and Mobley, 2019; Leak *et al.*, 2021). General nutritional guidelines should include the need for intake of a wide variety of foods, such as whole grains, rather than overly emphasising on intake of fruits and vegetables (McMackin *et al.*, 2012). Consumers who are aware of the possible health advantages to whole grain intake would be more likely to consume whole grains regardless of the sensory fixations (Barrett *et al.*, 2020). Increment of whole grain consumption was reported amongst adult populations in the US (Chea and Mobley, 2019), Australia (Foster *et al.*, 2020) and the UK (Kamar *et al.*, 2016), as the citizens are more aware of the health benefits gained from whole grain consumption. This could be attributed to the efforts of health authorities in providing detailed information on the benefits of whole grains, as well as nutritional intervention studies based on the perceived barriers amongst the population (Chea and Mobley, 2019; Foster *et al.*, 2020). Thus, whole grain education is needed to increase awareness amongst Malaysian adults towards whole grains.

Recently, the food industry is making significant progress in incorporating whole grains into an increasing variety of products and manufacturing. This approach may positively impact whole grain intake amongst populations worldwide, including those in Malaysia. However, some of the sensory attributes that people find unacceptable in whole grain foods. Respondents felt that the cost of new whole grain products would be high, and some expressed concern that products marketed as whole grains may also be high in fat and sugar content, as well as calories (McMackin *et al.*, 2012). The challenge then, for food industries globally, would be in producing whole grain products that are more acceptable and have a softer texture without compromising nutritional integrity or incurring additional production costs which may deter consumers from buying such products.

Identification of whole grain foods is indeed a barrier, mainly for young and older adults, as shown in the present study. This could be due to a lack of exposure, such as to advertisements, or a lack of information concerning product packaging which indicate that corn and barley are whole grain products. Individuals may be unable to recognise whole

grain foods based on the wordings/labelling or ingredients listed on the packaging of whole grain food products; instead, they would erroneously identify whole grain foods based on their sensory characteristics, e.g. colour (Leak *et al.*, 2021). Although the majority may display basic reading comprehension when reading the packaging of whole grain food products in order to identify the type of food, there is the tendency of not referring to specific whole grain information (Chea and Mobley, 2019; Leak *et al.*, 2021; Barrett *et al.*, 2020). The present study identified bread, oatmeal and morning cereals to be the most popular whole grain meals, a finding which is in line with several other research studies (AK *et al.*, 2015). This finding reveals that a majority of Malaysian adults prefer to consume whole grains for breakfast. This may be due to the lack in availability of ready-to-eat whole grain meals for lunch and dinner, where options are more limited in hawker stalls such as brown rice (AK *et al.*, 2015). This is in contrast to other findings that examined the influence of determinants on whole grain consumption amongst Malaysian medical students (Subramaniam *et al.*, 2019). In those studies, it was reported that accessibility and availability of whole grain foods had no significant influence on consumption levels.

The present findings revealed the impact of ethnicity or cultural background in influencing whole grain consumption. A majority of the respondents mentioned that consumption of whole grains was not the norm in their cultural eating habits, such as being a religious requirement or part of any festive season. Additionally, a study conducted on whole grain consumption amongst Malaysian medical students aged 19 years and above reported that whole grain intake was substantially greater amongst Chinese medical students as compared to Malay medical students, who had the lowest intake rate (Subramaniam *et al.*, 2019). These findings highlight that the type of food consumed is influenced by one's cultural background and traditions.

Family influence is a dominant factor for whole grain intake amongst young, middle-aged and older adults. Young and middle-aged adults indicated that they did not grow up with a specific diet and that whole grains were not very popular at the time, also adding that whole grains were not readily available and accepted in the Malaysian population due to their different sensory characteristics when compared to traditional Malaysian cuisines. Increased exposure to an uncommon food has been found in several studies to develop and cultivate a child's liking for that food, and such exposure may even decrease resistance to foods that were previously hated (Koo *et al.*, 2020). Despite a majority of the respondents mentioning that they had previously tried whole grain foods, only a handful of them consumed whole grain foods on a regular basis that indicated habitual intake. In view of its nutritional aspects, incorporating whole grains into children's diets as part of a balanced diet is likely to encourage long-term habitual intake of whole grains (Kamar *et al.*, 2016; Leak *et al.*, 2021; Barrett *et al.*, 2020).

For older adults, an additional barrier to consuming whole grain products is their health limitations, such as having difficulty in chewing whole grains as compared to non-whole grain foods. They are also often more reliant on family members who are ultimately responsible towards their food intake. The present findings are consistent with studies that examined the influence of family on whole grain consumption and found that parents regulate the consumption of whole grain as well as refined grain products in the household according to their children's preferences (Burgess *et al.*, 2006); these studies also reported that children, as picky eaters, were a barrier to whole grain intake (Nicklas *et al.*, 2013). In another study, participants reported that spouses were a barrier to consumption of whole grain products in the home, primarily because they disliked such foods in terms of the foods' sensory characteristics (McMackin *et al.*, 2012).

Intestinal discomfort was specifically mentioned as a barrier in an intervention study (Smith *et al.*, 2003). This is in line with the findings of the present study, where the respondents claimed that medical conditions, e.g. gluten intolerance, were a barrier to whole

grain consumption. Medical conditions acting as barriers have also been largely agreed upon by other studies and have been found to be particularly common in elderly individuals (Coffman and Camire, 2017).

The present study has also identified other hurdles to whole grain consumption, including lack of preparation skills, parental influence, accessibility and lifestyle or habits where the intake of foods that are white and not brown is more common. These findings are in line with research studies conducted amongst the adult population in the US (Chea and Mobley, 2019), Northern Ireland (McMackin *et al.*, 2012), Australia (Foster *et al.*, 2020), Sweden (Xiong *et al.*, 2022), as well as amongst the elderly population in the US (Coffman and Camire, 2017).

4.2 Findings in relation to the RAA model

The themes identified are categorised into background factors, behavioural factors, normative beliefs and control beliefs. These themes are used to describe the perceived barriers to whole grain intake amongst Malaysian adults. Most of the primary data generated throughout the sessions could be mapped onto the RAA constructs, although the data did not require for any form of testing on the model's proposed causal pathways. The effectiveness of RAA was mirrored similarly in a prior research study conducted amongst UK adolescents, targeting perceived hurdles to the consumption of whole grains (Kamar *et al.*, 2016).

Several elements in the present study appeared to combine two RAA constructs into one, making it difficult to separate each of these elements as independent components; for instance, general knowledge of whole grains, identification abilities and health benefits awareness are a combination of both background factors and attitudinal factors. Furthermore, parental provision and influence may fall into the latter category of background factors and normative beliefs. The RAA model identifies habit as an independent element, although it was highlighted only in the primary data in association with parental influence.

Several RAA constructs were not particularly dominant in the data. A number of elements within the background factors were not present, namely the influence of mood and emotion, stereotypes and stigma. The other subcomponents of the RAA constructs were highly present in the discussions as it is generally believed that social norms and influences play a key role in shaping adults' dietary behaviour (Chea and Mobley, 2019). These findings are in line with the meta-analysis of the RAA framework conducted by Rosemary *et al.* (2016), which stated that the RAA subcomponents have high utility in predicting and understanding dietary health behaviours. However, these findings were in contrast to the formative study using the RAA model in the UK population (Kamar *et al.*, 2016). Adoption of the RAA model would indeed be helpful for providing valuable insights in the identification of potential barriers to whole grain consumption amongst the Malaysian adult population, and subsequently aid in the development of effective interventions surrounding whole grain consumption.

4.3 Strengths and limitations

In view of the scarcity of relevant research data in Malaysia, as well as Southeast Asia, the present study supplements our understanding of the factors and perceived barriers to whole grain consumption in the Malaysian adult population. Another strength of the study is the use of in-depth interviews, which successfully capture all of the respondents' insights and hurdles towards consumption of whole grain foods. However, information about whole grain consumption and the overall comments related to whole grain intake were self-reported and discussed in a general manner, thus limiting the generalisability of these qualitative findings. Nonetheless, the study makes no attempt to quantify the consumption of whole grains amongst this particular adult population.

5. Conclusion

In a nutshell, the findings of the present study showed that the cost, sensory aspects, poor awareness and lack of knowledge towards whole grain products, availability of convenient foods, lack of preparation skills, limited accessibility, special diets and cultural and family influences were the main barriers towards whole grain consumption amongst the Malaysian adult population. The RAA model effectively reflected factors impacting Malaysian adults' whole grain intake. Outcomes of the study serve as a framework for public health practitioners to develop impactful interventions to improve whole grain intake in the Malaysian population. Quantitative approaches might be further used to investigate the relative importance of and interactions between the various barriers identified, such as the correlation between sensory qualities and perceived cost. This preliminary research will assist in the development of effective programmes to promote whole grain consumption amongst the Malaysian adult population, as well as presents a challenge to the food industry to develop whole grain foods which are easily accepted by consumers.

References

Ajzen, I. (1988), *Attitudes, Personality, and Behaviour*, Dorsey Press, Chicago.

Ajzen, I. (1991), "The theory of planned behavior", *ScienceDirect*, Vol. 50 No. 2, pp. 180-185, doi: 10.1016/0749-5978(91)90020-T.

Ajzen, I. (2011), "The theory of planned behaviour: reactions and reflections", *Psychology and Health*, Vol. 26 No. 9, pp. 1113-1127, doi: 10.1080/08870446.2011.613995.

Ak, N., Koo, H.C., Jm, H.J., Mt, M.N., Tan, S.Y., Appukutty, M., Ar, N., Thielecke, F., Hopkins, S., Ong, M.K., Ning, C. and Tee, E.S. (2015), "Whole grain intakes in the diets of Malaysian children and adolescents – findings from the MyBreakfast study", *Plos One*, Vol. 10 No. 10, e0138247, doi: 10.1371/journal.pone.0138247.

Aune, D., Keum, N., Giovannucci, E., Fadnes, L.T., Boffetta, P., Greenwood, D.C., Tonstad, S., Vatten, L.J., Riboli, E. and Norat, T. (2016), "Whole grain consumption and risk of cardiovascular disease, cancer, and all cause and cause specific mortality: systematic review and dose-response meta-analysis of prospective studies", *BMJ*, Vol. 353, i2716, doi: 10.1136/bmj.i2716.

Australian Dietary Guidelines (2013), available at: https://www.nhmrc.gov.au/adg (accessed 13 September 2021).

Backman, D.R., Haddad, E.H., Lee, J.W., Johnston, P.K. and Hodgkin, G.E. (2002), "Psychosocial predictors of healthful dietary behaviour in adolescents", *Journal of Nutrition Education and Behavior*, Vol. 34 No. 4, pp. 184-193, doi: 10.1016/s1499-4046(06)60092-4.

Barrett, E.M., Foster, S.I. and Beck, E.J. (2020), "Whole grain and high-fibre grain foods: how do knowledge, perceptions and attitudes affect food choice?", *Appetite*, Vol. 149, p. 104630, doi: 10.1016/j.appet.2020.104630.

Braun, V. and Clarke, V. (2006), "Using thematic analysis in psychology", *Qualitative Research in Psychology*, Vol. 3 No. 2, pp. 77-101, doi: 10.1191/1478088706qp063oa.

Burgess, C.T., Marquart, L., Vickers, Z. and Reicks, M. (2006), "Perceptions of children, parents and teachers regarding whole grain foods and implications for a school-based intervention", *Journal of Nutrition Education*, Vol. 38, pp. 230-237.

Canada, H. (2020), "Canada's dietary guidelines", available at: https://food-guide.canada.ca/en/guidelines/ (accessed 13 September 2021).

Chea, M. and Mobley, A.R. (2019), "Factors associated with identification and consumption of whole-grain foods in a low income population", *Current Developments in Nutrition*, Vol. 3 No. 7, doi: 10.1093/cdn/nzz064.

Coffman, M.A. and Camire, M.E. (2017), "Perceived barriers to increased whople grain consumption by older adults in long term care", *Journal of Nutrition in Gerontology and Geriatrics*, Vol. 36 No. 4, pp. 178-188, doi: 10.1080/21551197.2017.1385564.

Coleman, P. (2019), "In-depth interviewing as a research method in healthcare practice and education: value, limitations and considerations", *International Journal of Caring Sciences*, Vol. 12 No. 3, p. 77.

Food (Amendment) (No.4) Regulations (2020), "Attorney general's chambers of Malaysia".

Foster, S., Beck, E., Hughes, J. and Grafenauer, S. (2020), "Whole grains and consumer understanding: investigating consumers' identification, knowledge and attitudes to whole grains", *Nutrients*, Vol. 12 No. 8, p. 2170, doi: 10.3390/nu12082170.

Gray, D. (2018), *Doing Research in the Real World*, 4th ed., Sage. University of Greenwich, London.

Kamar, M., Evans, C. and Hugh-Jones, S. (2016), "Factors influencing adolescent whole grain intake: a theory-based qualitative study", *Appetite*, Vol. 101, pp. 125-133, doi: 10.1016/j.appet.2016.02.154.

Koo, H.C., Poh, B.K. and Ruzita, A.T. (2020), "The great child Trial^{TM}: a quasi-experimental dietary intervention among overweight and obese children", *Nutrients*, Vol. 12 No. 10, p. 2972, doi: 10.3390/nu12102972.

Kyrø, C. and Tjønneland, A. (2016), "Whole grains and public health", *BMJ*, Vol. 353 No. 3046, pp. 55-57, doi: 10.1136/bmj.i3046.

Leak, T.M., Gangrade, N. and Tester, J. (2021), "Facilitators and barriers to preparing and offering whole grains to children diagnosed with prediabetes: qualitative interviews with low-income caregivers", *BMC Public Health*, Vol. 21 No. 1, doi: 10.1186/s12889-021-10915-5.

Mann, K.D., Pearce, M.S., McKevith, B., Thielecke, F. and Seal, C.J. (2015), "Low whole grain intake in the UK: results from the National Diet and Nutrition Survey rolling programme 2008-11", *British Journal of Nutrition*, Vol. 113 No. 10, pp. 1643-1651, doi: 10.1017/s0007114515000422.

McMackin, E., Dean, M., Woodside, J.V. and McKinley, M.C. (2012), "Whole grains and health: attitudes to whole grains against a prevailing background of increased marketing and promotion", *Public Health Nutrition*, Vol. 16 No. 4, pp. 743-751, doi: 10.1017/s1368980012003205.

McRae, M.P. (2017), "Health benefits of dietary whole grains: an umbrella review of meta-analyses", *Journal of Chiropractic Medicine*, Vol. 16 No. 1, pp. 10-18, doi: 10.1016/j.jcm.2016.08.008.

Meynier, A., Chanson-Rollé, A. and Riou, E. (2020), "Main factors influencing whole grain consumption in children and adults-a narrative review", *Nutrients*, Vol. 12 No. 8, p. 2217, doi: 10.3390/nu12082217.

Moghames, P., Hammami, N., Hwalla, N., Yazbeck, N., Shoaib, H., Nasreddine, L. and Naja, F. (2015), "Validity and reliability of a food frequency questionnaire to estimate dietary intake among Lebanese children", *Nutrition Journal*, Vol. 15 No. 1, doi: 10.1186/s12937-015-0121-1.

Murimi, M.W., Chrisman, M., McCollum, H.R. and McDonald, O. (2016), "A qualitative study on factors that influence students' food choices", *Journal of Nutrition and Health*, Vol. 2 No. 1, doi: 10.13188/2469-4185.1000013.

National Coordinating Committee on Food and Nutrition (NCCFN) (2017), *Recommended Nutrient Intakes for Malaysia*, Ministry of Health Malaysia.

National Coordinating Committee on Food and Nutrition (NCCFN) (2021), *Malaysian Dietary Guidelines 2020*, Ministry of Health Malaysia.

Nicklas, T.A., Jahns, L., Bogle, M.L., Chester, D.N., Giovanni, M., Klurfeld, D.M., Laugero, K., Liu, Y., Lopez, S. and Tucker, K.L. (2013), "Barriers and facilitators for consumer adherence to the dietary guidelines for Americans: the HEALTH study", *Journal of the Academy of Nutrition and Dietetics*, Vol. 113 No. 10, pp. 1317-1331, doi: 10.1016/j.jand.2013.05.004.

Rafael, P.E. (2016), "The Mexican dietary and physical activity guidelines: moving public nutrition forward in a globalized world", *The Journal of Nutrition*, Vol. 146 No. 9, p. 1924S-1927S, doi: 10.3945/jn.115.218784.

Rosemary, M., Natalie, T., Reema, H., Rebecca, L., Peter, G. and Mark, C. (2016), "Meta-analysis of the reasoned action approach (RAA) to understanding health behaviours", *Annals of Behavioural Medicine*, Vol. 50 No. 4, pp. 592-612, doi: 10.1007/s12160-016-9798-4.

Seal, C.J., Nugent, A.P., Tee, E.S. and Thielecke, F. (2016), "Whole-grain dietary recommendations: the need for a unified global approach", *British Journal of Nutrition*, Vol. 115 No. 11, pp. 2031-2038, doi: 10.1017/s0007114516001161.

Seal, C.J., Courtin, C.M., Venema, K. and Vries, J. (2021), "Health benefits of whole grain: effects on dietary carbohydrate quality, the gut microbiome, and consequences of processing", *Comprehensive Reviews in Food Science and Food Safety*, Vol. 20, pp. 2742-2768, doi: 10.1111/1541-4337.12728.

Slavin, J., Tucker, M., Harriman, C. and Jonnalagadda, S.S. (2013), "Whole grains: definition, dietary recommendations, and health benefits", *Cereal Foods World*, Vol. 58 No. 4, pp. 191-198, doi: 10.1094/cfw-58-4-0191.

Smith, A.T., Kuznesof, S., Richardson, D.P. and Seal, C.J. (2003), "Behavioural, attitudinal and dietary responses to the consumption of whole grain foods", *Proceedings of the Nutrition Society*, Vol. 62 No. 2, pp. 455-467, doi: 10.1079/pns2003260.

Subramaniam, S., Patil, S.S., Ponnusamy, S., Hasamnis, A.A., Loh, K.Y. and Santosh, N. (2019), "Whole grain consumption and its determinants in Malaysian medical students: a cross sectional study", *Indian Journal of Public Health*, Vol. 63, pp. 220-226.

Xiong, Y., Zhang, P., Warner, R.D., Shen, S. and Fang, Z. (2022), "Cereal grain-based functional beverages: from cereal grain bioactive phytochemicals to beverage processing technologies, health benefits and product features", *Critical Reviews in Food Science and Nutrition*, Vol. 62 No. 9, pp. 2404-2431, doi: 10.1080/10408398.2020.1853037.

Zhang, X.F., Wang, X.K., Tang, Y.J., Guan, X.X., Guo, Y., Fan, J.M. and Cui, L.L. (2020), "Association of whole grains intake and the risk of digestive tract cancer: a systematic review and meta-analysis", *Nutrition Journal*, Vol. 19 No. 1, doi: 10.1186/s12937-020-00556-6.

Corresponding author
Hui Chin Koo can be contacted at: koohc@tarc.edu.my