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Farmers' expenditures associated with children's nutritional status in areas affected by Indonesia's Sinabung eruption

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ABSTRACT

Introduction: During the time of volcano eruptions, farmers have to harvest their crops before the stipulated harvest time, which leads to quality and quantity loss. Besides, farmers also have to continue their farming activities, including purchasing farming necessities. These unaddressed issues of the agricultural restoration could be one of the key factors to malnutrition. Therefore, this study assessed the associations between farmers' expenditures and the nutritional status of children in areas affected by Indonesia's Sinabung eruption. **Methods:** A cross-sectional study was carried out among 444 (158 farmers, 228 farmers cum farm labourers, and 58 farm labourers) households headed by farmers. The questionnaire used for data collection was the Indonesian Family Life Survey questions (IFLS). **Results:** Non-food expenditures had a huge impact on household livelihoods, which was significantly associated with children's nutritional status. Among the three groups of farmers, children of farmers and farmers cum farm labourers were prone to malnutrition. This was because these two groups had to limit food expenditures over their farming necessities and cigarettes expenditure, which took more than half of their income. However, the prevalence of malnutrition was highest in children of farmers. Children of farm labourers had better nutritional status compared to children of the other two groups. **Conclusion:** Children of farmers and farmers cum farm labourers were prone to malnutrition due to limited expenditure on food. This study suggests that policymakers in Indonesia should provide food and nutrition security to children who were impacted by the Sinabung eruption.

Keywords: child nutrition, farmers' expenditures, volcano eruption

INTRODUCTION

Geographically, Indonesia is located on the three active tectonic plates (the Eurasian, Pacific, and Indo-Australian). As a result, the country is prone to various kinds of natural disasters, including volcano eruptions (Guha-Sapir *et al.*, 2014; Hariyono & Liliasari, 2018; Djalante, 2018). Other forms of natural disasters like tsunamis, earthquakes, landslides, droughts, floods, and typhoons typically strike at one point in time, and recovery starts shortly after that. In contrast, volcano eruptions can last for days, weeks, months, or even years and their evolution is relatively unpredictable in the medium to long term (Lebon, Sigmundsson &

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Gislason, 2009). For example, Mount Sinabung in the Karo Regency, North Sumatra Province, Indonesia, has been actively removing its lava and ashes for nine years, from 2010 to 2019, which occurred in August-September 2010, then again from September 2013 to June 2019. Thus, it has erupted episodically, frequently around harvest, leaving farmers uncertain and driving early harvest lest another eruption occurs (Primulyana *et al.,* 2019).

During Sinabung's eruption, over 30,000 citizens were affected by the eruption and needed to be evacuated (Horwell & Baxter, 2006). After they were allowed to return home, socio-economic issues raised as nearly 80 percent of people in the affected areas were heavily dependent on farming (Horwell & Baxter, 2006). During the time of volcano eruptions, farmers have to harvest their crops before the stipulated harvest time, which leads to quality and quantity loss. This situation in turn, causes capital loss for the farmers (Nainggolan *et al.*, 2019). Despite these difficulties, farmers have to continue their farming activities, including purchasing soil fertilisers, pesticides, seeds, and many more. To some extent, they have to manage their expenditures from their limited source of income. Furthermore, there is a lack of programmes from the government explicitly addressing the issues of agricultural restoration (Nainggolan *et al.*, 2019; Fiantis *et al.,* 2019). Hence, these unaddressed issues of agricultural restoration, including soil fertility improvement, could be one of the key factors to severe poverty and malnutrition, especially in children under five years (Bain *et al.,* 2013; Bargout & Raizada, 2013). Besides, there was no previous study that assessed the correlation between farmers' expenditures and the nutritional status of children under five years, specifically in areas affected by volcano eruptions.

Therefore, in this study, we assessed the farmers' expenditures and the nutritional status of children under five years in areas affected by the Sinabung eruption. Specifically, we (1) compared food and other expenditures among different groups of farmers; (2) estimated and compared the prevalence of malnutrition among children under five years according to their parent's occupation; and (3) identified food and other expenditures associated with children's malnutrition between two groups of farmers, namely farmers and farmers cum farm labourers.

METHODS

Study design

A cross-sectional study was carried out to determine the relationship between farmers' expenditures and the nutritional status of children under five years in areas affected by Indonesia's Sinabung eruption. The data was collected from December 2018 to June 2019.

Sampling

We performed a multistage sampling technique in four sub-districts affected by the eruption of Mount Sinabung. We applied purposive sampling technique to select seven villages amongst 15 villages in four sub-districts. Additionally, we used systematic random sampling to choose every 5th household from the sampling frame. We had a sample size of 444 households.

A child was selected by random draw if a household had more than one child aged between 12-59 months. The children were given numbers starting from 1 for the youngest, 2 for the second youngest, and so on. A small box consisting of numbers was used to select a child randomly. For example, if there were three children in the household,

numbers 1-3 were added into the box. The number drawn from the box matched the child.

Data collection

The questionnaire used for data collection in this research was modified from the Indonesian Family Life Survey questions (IFLS). Meanwhile, before using the questionnaire, we adjusted the questions to fit the local people and culture with 30 farmers. Therefore, the questionnaire is applicable only in these specific research areas.

Three enumerators in each study area interviewed the mothers or guardians that had children under five years in the participating households. The community leader accompanied the enumerators during visits to the chosen households for samples of this survey. A structured questionnaire (IFLS) was used to obtain information on socio-economic indicators, household income, and food and non-food expenditures. The enumerators did not collect data on the value of household food stocks consumed and value of gifts consumed.

Household income, other cash resources, and expenditure variables were collected for the last three months with this information recollected from their memory. All cash resources and expenses were recalculated by researchers in Indonesian Rupiah (IDR) as monthly household income, food, and non-food expenditures, then converted into the United States dollar (USD) (using the exchange rate in January 2019, USD1 = IDR14,033) (Exchange rate.org., 2019).

Data collection was mostly done in the morning, right before the farmers left for work and in the afternoon after they have returned home. In this research, the participants were classified into three different groups of farmers as follows:

a. Farmers: people who worked in their own fields.
b. Farmers cum farm labourers: people who owned fields and worked as day labourers in other fields.
c. Farm labourers: people who did not own any field but worked for others as day labourers.

Additionally, there were farmers who worked slightly differently from the above categories, namely "sharecroppers". This group of farmers worked for a certain period on a contract basis. The field owners provided farming necessities, including seeds, soil fertilisers, and pesticides. The profits were shared by calculating the entire income reduced by total capital, and then the rest of the total profit was divided into two (field owner and sharecropper). Thus, the people who worked only as sharecroppers were also considered as farm labourers. But sharecroppers who also owned fields were considered as farmers cum farm labourers. The data of farmers' expenditures collected are as in Box 1.

Anthropometry measures

Prior to fieldwork, we conducted proper training for the three enumerators to perform anthropometry by using the World Health Organization (WHO) training manual on child growth (WHO, 2008). A taring scale was used to measure the children's body weight. The scale was placed on a flat, hard surface. The children were weighed with minimal clothing by undressing them and removing as much clothing as possible. At the same time, the length of children aged 12-23 months old was measured by using a length board that was placed on a flat and stable surface such as a table. The height of children aged 24-60 months old was measured by using a height board mounted at a right angle between a floor and a straight, vertical surface such as a wall. In this study, the enumerators did not measure the

Box 1. Farmers' expenditures

	Description
Food expenditure	
Rice	a. Self-production b. Government aid + purchase c. Purchase
Protein sources: Salted fish, egg, and *tempeh*/tofu	
Vegetables	a. Self-production b. Self-production/tip + purchase c. Purchase
Condiments	
Sugar	
Vegetable Oil	
Snacks	
Non-food expenditures	
Soil fertilisers, pesticides, and seeds	
LPG, electricity, mobile phone bill	
Household items (i.e., soap, washing detergent)	
Gasoline	a. No vehicle b. Has vehicle
Cigarettes	a. No household member who smokes b. Has household member who smokes
*Ngopi**	a. No household member who *ngopi* b. Has household member who *ngopi*
*Nyuntil***	a. No household member who *nyuntil* b. Has house member who *nyuntil*

Note:
**Ngopi* is a socio-cultural habit practised by the Karo tribes by drinking coffee or tea in the morning and/or night time at small stalls. These stalls have functioned as a gathering place where people can have chats and knowledge sharing, including farming topics. It is done by adult men only.
***Nyuntil* is a socio-cultural habit practised by Karonese women, where they chew some herbs such as betel leaves, betel nut, gambier, and tobaccos.

plane of a child's head. The software for Emergency Nutrition Assessment (ENA) was used to measure the children's nutritional status. The ENA software was used to convert age, length/height, and weight into z-scores. Three indices were used in assessing the nutritional status of children: height-for-age z-score (HAZ), weight-for-age z-score (WAZ), and weight-for-height z-score (WHZ), which were calculated by using the WHO growth reference standard (WHO, 2006).

Ethical considerations

Permission to carry out the study was obtained from the Naresuan University Institutional Review Board (NU-IRB), Thailand (IRB Certificate No. 0098/62). Informed consent was obtained from the mothers or guardians before their child was assessed in the study.

Statistical analysis

The USD unit was used for mean expenditure, and percentage (%) unit for mean proportion of expenditure. The proportion (in % unit) was calculated from the expenditures on food and non-food divided by total expenditure multiplied by one hundred. Expenditures on food and non-food of the participants, as well as their children's age, gender, weight and height, and nutritional status, were compared among groups of farmers with the use of chi-square test for categorical variable (gender) and the Welch's analysis of variance (ANOVA) test for continuous variables (children's nutritional status such as HAZ, WAZ, and WHZ). The Welch's ANOVA test was used because the homogeneity of variances assumption was not supported by the Levene's test (Jan & Shieh, 2014).

To analyse the correlation between food and non-food expenditures with the nutritional status of children, we used binomial logistic regression. Researchers did a binomial logistic regression with food expenditures (protein sources, vegetables, condiments, snacks) and non-food expenditures (farming essentials, cigarettes, *nyuntil*, *ngopi*) as continuous variables (independent variables), and nutritional status of children under five years (underweight, stunting, wasting) as a binary (dependent variables). All analyses were conducted using the IBM SPSS, version 17, and $p<0.05$ was considered significant for all statistical tests.

RESULTS

Table 1 shows that the average age of the three groups of participants was statistically different ($p<0.001$), where the mean age of farmers was 31.9 years, followed by the mean age of farm labourers (28.4 years), and farmers cum farm labourers (27.9 years). In contrast, schooling in years had no significant difference ($p=0.305$). The average schooling years of farmers were 9.7 years, farmers cum farm labourers were 9.8 years, and farm labourers were 10.3 years.

Apparently, the participants' marital status was also homogenous,

Table 1. Characteristics of participants in each group

Characteristics	*Farmers* (*n=158*)	*Farmers cum farm labourers* (*n=228*)	*Farm labourers* (*n=58*)	$p^{\dagger}$
Participant				
Age (years)	31.9±6.7	27.9±6.2	28.4±6.7	<0.001
Schooling (years)	9.7±2.5	9.8±2.4	10.3±2.6	0.305
Marital status				
Married	149 (94.3)	221 (96.9)	55 (94.8)	0.427
Single, divorced, or widow	9 (5.7)	7 (3.1)	3 (5.2)	
Households				
Family size	5.7±1.1	4.6±1.1	4.7±1.2	<0.001
Total income per month (USD)	169.7±21.6	153.3±18.7	127.1±19.4	<0.001
Proportion food expenditure (%)	27.1±9.2	42.8±12.9	57.1±18.2	<0.001
Poportion non-food expenditure (%)	72.9±9.2	57.2±12.9	42.9±18.2	<0.001

Data are presented as *n* (%) or mean±*SD*

†Calculated using the chi-square test for categorical variables and the Welch's ANOVA test for continuous variables

USD1 = IDR14,033

as its p-value was 0.427 (p>0.05). This showed that >94% of participants in all groups were mainly married or cohabiting. Furthermore, the participants' household characteristics were significantly different (p<0.001). By family size, farmers had an average family member of 5.7 (5-6 people), while the mean number of family members for farm labourers and farmers cum farm labourers were 4.6 (4-5 people) and 4.7 (4-5 people), respectively.

From the aspect of household income, the mean total income per month showed that farmers earned the highest (169.7 USD) compared to farmer labourers (153.3 USD), and farmers cum farm labourers (127.1 USD). In contrast, farmers allocated less amount for food compared to other groups, which was 27.1% of the total expenditure. Farmers cum farm labourers spent slightly higher (42.8%) and the highest was farm labourers (57.1%). This phenomenon happened as a result of the fact that farmers needed to spend more of their income on non-food expenditures (such as financing farming needs) forced by unfavourable situations during the Sinabung eruption. As shown, the proportions of the amount spent on non-food expenditures by different groups were: farmers as the highest (72.9%), followed by farmers cum farm labourers (57.2%), and farm labourers (42.9%) as the lowest.

Table 2 shows the difference between food expenditure among different groups of farmers in areas affected by the Sinabung eruption. Based on the mean value of expenditure on rice, we found that farmers spent the least (19.9 USD) and farmers cum farm labourers spent 27.8 USD, followed by farm labourers (32.2 USD) with the highest. This could be explained by the percentage of rice access among these three groups, relying on self-production, government aid plus purchase, and purchase only. The data found that most farmers (71.5%) received access from government aid plus purchase, and 10.8% of them met their rice needs by self-production. A total of 64.5% of farmers cum farm labourers and 74.1% of farm labourers must purchase their rice. Therefore, statistically, rice access and rice expenditure were significantly different (p<0.001) among these three groups of farmers, and so was the mean value of the proportion of rice expenditure with its p<0.001.

Interestingly, the p<0.001 shown in the food expenditure of protein sources meant that there were significant differences among the three groups of farmers in protein consumption. The expenditures on protein sources were 9.1 USD by farmers, 13.9 USD and 14.1 USD by farmer cum farm labourers, and farm labourers, respectively. The mean value of the proportion of protein sources expenditure showed a similar trend (5.4% of farmers, 9.0% of farmers cum farm labourers, and 11.2% of farm labourers).

Furthermore, the participants accessed vegetables through self-production, self-production/gift plus purchase, and purchase only. Among the three groups of farmers, the data remained to show a significant difference (p<0.001). The mean proportion of vegetable expenditure showed that farmers spent less (1.3%), farmers cum farm labourers spent a little more (2.1%), and farm labourers spent the largest proportion (2.8%). Thus, the mean of their expenditure was undeniably different (farmers 2.2 USD, farmers cum farm labourers 3.3 USD, and farm labourers 3.5 USD).

Besides the three main food expenditures (rice, protein sources, and vegetables), there were other complementary food sources such as condiments, sugar, vegetable oil, and snacks. The average expenditure for

condiments showed that all three groups of farmers were significantly different, as farmers spent 7.1 USD, while farmers cum farm labourers, and farm labourers spent slightly higher (9.0 USD vs 9.5 USD). Likewise, the proportion of condiments expenditure was seen to be statistically different, with farmers spending the lowest proportion compared to the rest. Similarly, the proportion of sugar and vegetable expenditures showed significant difference (p<0.001) among the three groups. However, interestingly, the average of sugar and vegetable oil expenditures found that farmers and farm labourers spent the same amounts (sugar 1.3 USD, and vegetable oil 1.7 USD). Finally, the expenditure on snacks also showed a significant difference.

In the areas affected by Sinabung's eruption, we found that the participants' non-food expenditures (Table 2) had taken a significant proportion of their income. One of the dominant non-food expenditures was farming necessities (soil fertilisers, pesticides, seeds), with a significant difference among the three groups of farmers. Importantly, farm labourers were free of this expenditure as they were just labourers. In contrast, farmers spent the highest (54.2 USD) for buying farming necessities, even more than half of their total expenditure, and so did its average proportion, at p<0.001.

The expenditure for LPG, electricity, and mobile phone bill was found similar among the groups. Farm labourers spent the most (5.9 USD), while farmers and

Table 2. Expenditures on food and non-food of study participants in each group

	Farmers (n=158)	*Farmers cum farm abourers (n=228)*	*Farm labourers (n=58)*	$p^{\dagger}$
Food expenditures				
Rice access				
a. Self-production	17 (10.8)	21 (9.2)	0 (0.0)	<0.001
b. Government aid + purchase	113 (71.5)	60 (26.3)	15 (25.9)	
c. Purchase	28 (17.7)	147 (64.5)	43 (74.1)	
Rice expenditure (USD)	19.9±9.8	27.8±12.5	32.2±11.3	<0.001
Proportion rice expenditure (%)	11.8±5.9	18.0±7.9	25.6±9.2	<0.001
Protein sources: Salted fish, egg, and *tempeh*/tofu expenditure (USD)	9.1±3.5	13.9±4.4	14.1±4.8	<0.001
Proportion protein salted fish, egg, *tempeh*/tofu expenditure (%)	5.4±2.1	9.0±2.7	11.2±4.0	<0.001
Vegetables access				
a. Self-production	33 (20.9)	14 (6.1)	0 (0.0)	<0.001
b. Self-production/gift + purchase	105 (66.5)	112 (49.1)	25 (43.1)	
c. Purchase	20 (12.7)	102 (44.7)	33 (56.9)	
Vegetables expenditure (USD)	2.2±1.4	3.3±1.3	3.5±1.1	<0.001
Proportion vegetables expenditure (%)	1.3±0.9	2.1±0.9	2.8±0.9	<0.001
Condiments expenditure (USD)	7.1±2.2	9.0±2.8	9.5±2.7	<0.001
Proportion condiments expenditure (%)	4.2±1.3	5.9±1.9	7.6±2.6	<0.001
Sugar expenditure (USD)	1.3±0.2	1.4±0.2	1.3±0.2	<0.001
Proportion sugar expenditure (%)	0.8±0.2	0.9±0.2	1.1±0.3	<0.001
Vegetable oil expenditure (USD)	1.7±0.0	1.7±0.1	1.7±0.0	0.675
Proportion oil expenditure (%)	1.0±0.1	1.1±0.2	1.4±0.2	<0.001
Snacks expenditure (USD)	4.4±3.5	8.8±4.5	9.4±5.0	<0.001
Proportion snacks expenditure (%)	2.6±2.0	5.7±2.9	7.4±2.9	<0.001

Table 2. Expenditures on food and non-food of study participants in each group [Cont'd]

	Farmers (n=158)	*Farmers cum farm abourers (n=228)*	*Farm labourers (n=58)*	*p*†
Non-food expenditures				
Soil fertilisers, pesticide, seeds expenditure (USD)	54.2±7.5	30.6±6.9	0.0±0.0	<0.001‡
Proportion fertiliser expenditure (%)	32.2±4.8	20.3±5.4	0.0±0.0	<0.001‡
LPG, electricity, mobile phone bill expenditure (USD)	5.6±1.0	5.6±1.0	5.9±1.1	0.201
Proportion LPG, electricity, mobile phone bill expenditure (%)	3.4±0.7	3.7±0.8	4.7±1.2	<0.001
Household items (i.e., soap, washing detergent) expenditure (USD)	2.5±0.7	2.6±0.6	2.5±0.7	0.449
Proportion household items (i.e., soap, washing detergent) expenditure (%)	1.5±0.4	1.7±0.5	2.0±0.7	<0.001
Gasoline				
a. No vehicle	21 (13.3)	33 (14.5)	6 (10.3)	0.546
b. Has vehicle	137 (86.7)	195 (85.5)	52 (89.7)	
Gasoline expenditure (USD)	10.5±5.7	10.8±6.1	11.7±5.9	0.710
Proportion gasoline expenditure (%)	6.1±3.3	7.0±3.9	9.2±4.8	0.384
Cigarettes				
a. No household member who smokes	15 (9.5)	43 (18.9)	15 (25.9)	0.060
b. Has household member who smokes	143 (90.5)	185 (81.1)	43 (74.1)	
Cigarettes expenditure (USD)	40.4±17.4	27.3±17.1	27.2±20.6	<0.001
Proportion cigarettes expenditure (%)	23.4±9.5	17.7±10.9	20.7±16.4	<0.001
Ngopi				
a. No household member who *ngopi*	48 (30.4)	84 (36.8)	29 (50.0)	0.028
b. Has household member who *ngopi*	110 (69.6)	144 (63.2)	29 (50.0)	
Ngopi expenditure (USD)	7.5±5.3	6.4±5.3	4.8±5.0	0.003
Proportion *ngopi* expenditure (%)	4.3±3.1	4.1±3.4	3.7±4.1	0.502
Nyuntil				
a. No household member who *nyuntil*	104 (65.8)	136 (59.6)	39 (67.2)	0.354
b. Has house member who *nyuntil*	54 (34.2)	92 (40.4)	19 (32.8)	
Nyuntil expenditure (USD)	3.4±4.9	4.2±5.3	3.4±5.1	0.298
Proportion *nyuntil* expenditure (%)	2.0±2.8	2.7±3.4	2.6±3.9	0.100

Data are presented as n (%) or mean±*SD*
†Calculated using the chi-square test for categorical variables and the Welch's ANOVA test for continuous variables
‡Calculated using the *t*-test
USD1 = IDR14,033

farmer cum farm labourers spent equally (5.6 USD). However, its proportion showed $p<0.001$ due to differences in the monthly total expenditure. Accordingly, the expenditure on household items showed a similar trend; meaning that the average proportion was significantly different, yet its average expenditure was not.

Moreover, for gasoline expenditure, all groups of farmers spent similarly with a $p=0.710$ for expenditure (USD) and a $p=0.380$ for its proportion (%). This showed that most of them owned a personal motorcycle. It was observed that owning a vehicle was essential to escape during the time of Sinabung's eruption. There were non-food expenditures that were spent only by men: cigarettes and *ngopi* expenditures. Additionally, many farmers smoked and did *ngopi* daily. The average proportion was significantly different among the three groups of farmers ($p<0.001$). The highest expenditure spent on cigarettes was farmers (40.4 USD), followed by farmers cum farm labourers, and farm labourers with an equal average of 27.3 USD and 27.2 USD, respectively. In contrast, in the expenditure of *ngopi*, the average value had a significant difference ($p=0.003$). Nonetheless, its proportion was not significantly different ($p=0.502$). Whilst men spent on cigarettes and *ngopi*, *nyuntil* expenditure was another non-food expenditure that was spent only by women. The mean expenditure (USD) and the mean proportion of expenditure (%) for *nyuntil* had no a significant difference. Figure 2 shows the trends of expenditures on foods and non-foods.

Table 3 shows the anthropometry of children under five years with respect to their parent's occupation. The children of farmers, farmers cum farm labourers, and farm labourers showed similar characteristics ($p=0.555$) irrespective of gender. Anthropometric measurements showed that z-scores of weight-for-age, height-for-age, and weight-for-height were statistically different; whereby children of farmers tended to have lower z-scores in each indicator. The prevalences of underweight (32.2% vs. 19.3% vs. 15.5%, $p<0.001$, respectively), stunting (46.8% vs. 33.8% vs. 27.6%, $p=0.070$, respectively), and wasting

Table 3. Anthropometry of children under five years according to parent's occupation

Characteristics and anthropometrics	*Farmers (n=158)*	*Farmers cum farm labourers (n=228)*	*Farm labourers (n=58)*	$p^{\dagger}$
Gender				0.555
Boys	82 (51.9)	112 (49.1)	33 (56.9)	
Girls	76 (48.1)	116 (50.9)	25 (43.1)	
Weight-for-age z-score	-1.34±1.22	0.08±1.55	0.46±1.63	<0.001
Height-for-age z-score	-1.58±1.36	-0.33±1.78	0.03±1.81	<0.001
Weight-for-height z-score	-0.94±1.21	0.51±1.30	0.66±1.46	<0.001
Underweight	51 (32.3)	44 (19.3)	9 (15.5)	
Stunting	74 (46.8)	77 (33.8)	16 (27.6)	
Wasting	26 (16.5)	20 (8.8)	4 (6.9)	

Data are presented as *n* (%) or mean±*SD*

[†]Calculated using the chi-square test for categorical variables and the Welch's ANOVA test for continuous variables

Table 4. Odds ratios (ORs)† of malnutrition (underweight, stunting, and wasting) by farmers' food and non-food expenditures

Expenditures	*Farmers(n=158)*			*Farmers cum farm labourers (n=228)*		
	Underweight	*Stunting*	*Wasting*	*Underweight*	*Stunting*	*Wasting*
	p-value *OR (95% CI)*	*p-value* *OR (95% CI)*	*p-value* *OR (95% CI)*	*p-value* *OR (95% CI)*	*p-value* *OR (95% CI)*	*p-value* *OR (95% CI)*
Rice	0.090 0.95 (0.89, 1.01)	0.003 1.07 (1.02, 1.13)	0.666 1.02 (0.95, 1.09)	0.941 1.00 (0.92, 1.08)	0.110 1.03 (0.99, 1.07)	0.800 1.02 (0.89, 1.16)
Protein sources	0.001 1.47 (1.18, 1.83)	0.103 1.17 (0.97, 1.42)	0.075 1.23 (0.98, 1.56)	0.019 1.74 (1.10, 2.77)	0.517 1.07 (0.86, 1.34)	0.239 1.45 (0.78, 2.68)
Vegetable	0.869 0.97 (0.66, 1.43)	0.058 1.48 (0.99, 2.22)	0.025 1.61 (1.06, 2.43)	0.085 1.82 (0.92, 3.61)	0.037 1.75 (1.03, 2.95)	0.727 1.19 (0.46, 3.09)
Condiments	0.040 1.26 (1.01, 1.56)	0.511 0.93 (0.76, 1.15)	0.292 1.14 (0.89, 1.46)	0.910 0.98 (0.68, 1.42)	0.141 1.17 (0.95, 1.45)	0.723 1.11 (0.63, 1.97)
Snacks	0.233 1.12 (0.93, 1.35)	0.988 1.00 (0.85, 1.17)	0.021 1.53 (1.06, 2.20)	0.129 1.38 (0.91, 2.10)	0.306 1.09 (0.92, 1.28)	0.202 1.60 (0.78, 3.30)
Fertiliser, pesticide, seeds	0.440 1.38 (1.03, 1.83)	0.011 1.53 (1.39, 1.98)	0.159 1.36 (1.10, 1.62)	0.267 1.01 (0.96, 1.38)	0.046 1.03 (1.00, 1.40)	0.237 1.01 (0.92, 1.23)
Cigarettes	0.253 1.09 (1.04, 1.13)	0.011 1.04 (1.01, 1.06)	0.744 1.01 (0.97, 1.04)	0.245 0.97 (0.91, 1.02)	0.046 0.97 (0.94, 1.00)	0.579 0.98 (0.90, 1.06)
Nyuntil	0.264 0.96 (0.88, 1.03)	0.317 0.96 (0.89, 1.04)	0.118 0.93 (0.86, 1.02)	0.726 0.97 (0.84, 1.13)	0.899 1.00 (0.93, 1.08)	0.164 0.87 (0.71, 1.06)
Ngopi	0.246 1.04 (0.97, 1.12)	0.640 0.98 (0.92, 1.05)	0.624 1.02 (0.94, 1.11)	0.812 1.02 (0.88, 1.18)	0.944 1.00 (0.93, 1.07)	0.908 1.01 (0.83, 1.23)

†Odds ratios (ORs) have been adjusted by age and sex of the children

(16.5% vs. 8.8% vs. 6.9%, $p<0.001$, respectively) were higher in children of farmers.

Table 4 shows that food expenditures especially rice, protein sources, and condiments of farmers had a significant association with underweight children. While children with stunting were significantly associated with only rice expenditure. In the case of wasting, we found that expenditures on vegetables and snacks were significantly correlated. The non-food expenditures of farmers showed that farming necessities and cigarettes expenditure were associated considerably with children with stunting. Among children of farmers cum farm labourers, underweight was related to the expenditure on protein sources, while vegetables expenditure was correlated with stunting cases. Additionally, the correlation of children's malnutrition case with non-food expenditures showed that the expenditures on farming necessities and cigarettes were also significantly associated with stunting in children.

DISCUSSION

We found that rice expenditure of the three groups of farmers was significantly different. The people whose occupation was farmer, tended to utilise rice from the government aid in order to allocate their income for other expenditures. Having free rice during post-Sinabung eruption was financially helpful; however, this type of rice was problematic due to its low quality in smell and taste. The low quality of rice was due to long time storage in the Bureau of Logistics (BULOG) (United States International Trade Commission, 2015). As a result, this rice was less likely edible as most people hardly ate them. Children showed less interest to eat this rice, which then leads to inadequate carbohydrate intakes (Naylor, 2014). Referring to Block *et al.*, (2004) low quality rice had an impact towards fewer calories intake and could affect malnutrition, especially in children under five years during Indonesia's crisis.

The farmers group had the lowest average expenditure on protein sources (9.1 USD). Consequently, children were prone to have inadequate protein intakes in their daily meals. Similarly, the study showed that in comparison to other groups, farmers spent the least part of their income on vegetables, which are sources of vitamins and minerals. This was partially caused by the higher need on non-food expenditures of the farmers (Figure 2). Children need an adequate amount of food intake, including protein, vitamins and minerals for optimal growth. In the case of children who consume less nutrition, they tend to acquire a high risk of chronic malnutrition (Steyn *et al.*, 2006; WHO, 2013). Besides food expenditures, as farming activities in the areas were affected by Sinabung's eruption, the study found that non-food expenditures of households had taken their income in a larger proportion. Households who were working as farmers only generally spent approximately >54% of their total income to purchase farming necessities, such as soil fertilisers, pesticides, seeds etc. They then tended to reduce their food expenditures so that they could fund their farming activities in the upcoming seasons. Moreover, under the circumstances of natural disasters, especially volcanic eruptions, farming activities require even higher amounts of capital. The results published by Bargout & Raizada showed that no or very little attention has been given to improve soil fertility, which led to poverty and chronic malnutrition in children (Bargout & Raizada, 2013).

For households who had extra jobs apart from working as farmers only, they were able to earn additional income. As

they were not working as farmer only, they indirectly received benefits for having lower percentages of expenditures on farming necessities. Apart from that, we found that households working as farmers only tended to smoke more compared to farm labourers. By observation, we figured out that the different types of workloads explained this. Farm labourers had to spend more time working in the field, which made them smoke only during resting time. In contrast, farmers with fewer workloads found plenty of time for smoking. In the aspect of non-food expenditures, both farming necessities and cigarettes have therefore taken a huge portion of their income. Accordingly, these led to reduction on food expenditures. Therefore, children with parents working as farmers who lived in areas affected by the Sinabung eruption tended to have a higher risk of malnutrition.

Under these circumstances, the occupation as farm labourers had a better opportunity to have children with good nutritional status, given the reason that most of them earned incomes without the need to spend on farming activities. Consequently, they could allocate their income to provide for their daily household needs, including food. A study in Madagascar in areas affected by cyclones had also found that >50% of the farmers having a temporary outside job had effective coping strategies to earn income to provide for daily needs, including food (Rakotobe *et al.,* 2016).

Conducting research in areas affected by natural disasters (especially volcano eruptions) has indeed brought some challenges and limitations. We admit that we faced either technical or non-technical problems in the field. For example, during the data collection process, we struggled to have an appointment with the participants at the appropriate time, specifically with groups of farm labourers who mostly go to work early in the morning and returned only in the late afternoon. Sometimes, we had to stay overnight with them after interviews as it was quite hard to travel at night in those areas. Additionally, many of the mothers or guardians that were interviewed barely focused during the session, as they were distracted by household activities, including childcare. Hence, we even had to reschedule our appointments for interviews.

Furthermore, we expected that both fathers and mothers (or guardians) could provide information on household expenditures together at the time of the interview, but the data collected were mostly from mothers or guardians only, which may affect the imbalance of information on non-food expenditures. This was caused by the socio-cultural aspect where men (fathers) tended to go out often for *ngopi* either in the morning before work or/and in the evening after returning from work. Therefore, for future research, we strongly suggest that researchers find appropriate ways to solve these challenges so that they will be able to do data collection with both fathers and mothers at the same time to gain deeper and more balanced information.

CONCLUSION

Non-food expenditures had a huge impact on household livelihoods, which was significantly associated with children's nutritional status. Among the three groups of farmers, children of farmers and farmers cum farm labourers were prone to malnutrition. This was because these two groups had to limit food expenditures over their farming necessities (soil fertilisers, pesticides, and seeds) and cigarettes expenditure, which took more than half of their income. However, the prevalence of malnutrition among children was highest in children of farmers.

Children of farm labourers had better nutritional status compared to the other two groups. Although this group earned less than the rest of the groups, they allocated more on food expenditures. The other two groups had major non-food expenditures, especially farming necessities, but working as farm labourers only had an advantage of zero expenditure on farming necessities. Even though their job as farm labourers only was insufficient in the time of Sinabung's eruption, they could meet the needs of nutrition for their children.

It is suggested that the policymakers should provide accessible loans for farmers to fund their farming activities during unpredictable circumstances like the Sinabung eruption, given that the farmers were unable to access private loans from banks or any other financial institutions. Additionally, policymakers in Indonesia should provide food and nutrition security to children who were impacted by the Sinabung eruption.

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Authors' contributions

SG, principal investigator, conceptualised and designed the study, led the data collection, data analysis and interpretation, and prepared the draft of the manuscript; NK, advised on the study design, data analysis, interpretation, and reviewed the manuscript; SM, advised on data analysis and interpretation, and reviewed the manuscript.

Conflict of interest

The authors reported no potential conflict of interest.

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Association of household food security and dietary diversity of mother-child pairs in the Philippines

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ABSTRACT

Introduction: The majority of Filipino households experience food insecurity. Mothers and children are among the population groups suffering from poor diet quality. This study aimed to determine the extent of the association of household food security (HFS) to mothers' and children's dietary diversity score (DDS), and to identify the significant factors associated with meeting the DDS of these vulnerable groups. **Methods:** The study was a cross-sectional, population-based study utilising secondary data from the 2015 Updating Survey. From a total of 6,692 mother-child pairs, the association between HFS and meeting the DDS of mothers and children, as well as the potential predictors for meeting the DDS were tested using descriptive and logistic regression analyses. **Results:** The findings showed that HFS was significantly associated with meeting the DDS of mothers and children aged 6-36 months (p<0.001). The proportion of meeting the DDS among mothers and children was significantly higher in food-secure than in food-insecure households (20.7% vs. 14.4%). Furthermore, meeting the DDS decreased with increasing levels of food insecurity. Household food security status, education background, employment, child's age, and wealth status were significantly associated with meeting the DDS. **Conclusion:** This study showed the extent of how food security was associated with meeting the DDS of mothers, children, and mother-child pairs, and the factors associated with meeting the DDS. Results can be used to strengthen the formulation of appropriate, evidence-based policies to address household food insecurity and low DDS among mothers and young children.

Keywords: dietary diversity, household food security, mother-child pairs, NNS, Philippines

INTRODUCTION

Pregnant and lactating mothers and children under five are nutritionally vulnerable because of additional energy and micronutrient requirements for their physiological needs. According to the latest estimate, maternal and child malnutrition is responsible for 45% of mortality among children under the age of five (FAO *et al.*, 2019). The substantial reduction of maternal and child mortality is a global priority as embodied in Sustainable Development Goal (SDG) No. 3 (Brizuela & Tunçalp, 2017). Food-based interventions that focus on a healthy diet among children

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and women of child-bearing age is one of the established interventions to meet additional energy and micronutrient requirements for their physiological needs during the first 1000 days (Keats *et al.*, 2021).

Despite the global and local priority accorded to maternal and child health and nutrition programmes, the results of the 2018-2019 Expanded National Nutrition Survey (ENNS) released by the Department of Science and Technology – Food and Nutrition Research Institute (DOST-FNRI) in May 2021 showed the lack of diversity in the diets of mothers and children (DOST-FNRI, 2021). Among infants aged 6-11 months, the majority of one-day food intake came from only two food groups; rice as the major source of carbohydrates at 43.6%, and milk and milk products as important sources of protein at 46.6%. Among children aged 1-2 years old, rice comprised 40.8% of the diet and 47.2% among those 3-5 years old. Across these age groups of children, intakes of fruits and vegetables, eggs, dried beans accounted for <5% of the diet, while it was also noted that children aged 1-2 years old and 3-5 years old have an intake of sugar and sugar products at 3.4 % and 5.4% of the diet, respectively.

Among pregnant women and lactating mothers, more than half of one day's food intake was from rice at 51.5% and 58.3%, respectively. Both pregnant women and lactating mothers consumed milk and milk products, starchy roots and tubers, fats and oils, eggs, dried beans, nuts and seeds in less significant amounts of about one to two percent of total intake per day, while sugars and syrups were at about 5% per day. Based on the same survey data, mean energy intakes versus the Philippine Dietary Reference Intakes (PDRI) were low for infants aged 6-11 months (446 kcal vs. 675 kcal), 1-2 years old (728 kcal vs. 960 kcal), and 3-5 years old (889 kcal vs. 1305 kcal). The same result was noted among pregnant women (1502 kcal vs. 2200 kcal) and lactating mothers (1632 kcal vs. 2400 kcal). Based on the acceptable macronutrient distribution ranges, the majority of the diet of children six months to five years old was from carbohydrates at 63.3%, 13.3% from protein, and 23.4% from fats. For pregnant women, the distribution was 70.0% from carbohydrates, 13.5% from protein, and 16.6% from fats. For lactating mothers, the distribution was 72.8% from carbohydrates, 12.9% from protein, and 14.2% from fats. The higher limit for carbohydrates, but lower than recommended distribution ranges for fats and protein were noted for children and pregnant and lactating mothers.

The available data on protein adequacy showed that 70.8% of children six months to five years old were meeting protein adequacy, but only 17.2% and 19.0% among pregnant women and lactating mothers were. For Vitamin A, 68.2% of infants aged 6-11 months and about half of those aged 1-2 years old and 3-5 years old have inadequate intakes. For dietary iron, about 80% of these children have inadequate intakes. Among pregnant women and lactating mothers, 70.5% and 72.7%, respectively, have inadequate Vitamin A intakes and 100% inadequacy for iron. Proportions with inadequate intakes of calcium, thiamine, and riboflavin were at about 90%.

The 2019 ENNS also showed that children, pregnant women and lactating mothers were suffering from micronutrient deficiencies. Anaemia was of severe public health concern among infants aged 6–11 months at 43.1%, and moderate public health significance among pregnant women at 23.0%. Vitamin A deficiency (VAD) among ages 6–59 months at 15.5% was of moderate public health significance. Iodine deficiency was also present

among pregnant women (21.1%) and lactating mothers (22.0%) based on median urinary iodine concentration. The very high rates of anaemia among infants under one year possibly reflect insufficient maternal stores due to poor dietary intake during pregnancy and inadequate micronutrient contents, particularly iron and Vitamin A of complementary foods given to children in the first and second years of life (Mbuya *et al*, 2021).

In addition to the diversity of the diet, another key element in shaping the nutritional environment in the household is the degree to which the household experiences food insecurity. Food insecurity is related to the limited or lack of economic and physical access to adequate food (Pérez-Escamilla, 2017). The 2018-2019 ENNS results showed that using the Household Food Insecurity Access Scale (HFIAS) tool, more than half (56.0%) of the households were food insecure, with 29.8% suffering from a moderate form of food insecurity. The December 2019 non-commissioned survey of the Social Weather Stations (SWS) also showed that 54% of Filipino families considered themselves poor and 35% also described themselves as food-poor during the last quarter of 2019. A self-rated poor family means that the head of the household rated the family as poor or food-poor, respectively, based on the situational questions asked (SWS, 2020).

The high prevalence of food insecurity among Filipinos can be traced to a combination of low incomes, poor choices, and high prices of nutritious foods, such as vegetables and fruits (Mbuya *et al.*, 2021). Based on the Philippine Statistics Authority, the 2018 proportion of Filipino families living below the poverty threshold, or the proportion whose per capita income was not sufficient to meet their basic food and non-food needs was 16.6%, or 17.6 million Filipinos, while poor families at 12.3% were estimated at three million (PSA, 2019). In a recent iPrice study in September 2021, findings showed that Manila has one of the most expensive cost of living and the lowest average salary compared with other Southeast Asian Countries. In addition to limited purchasing power, the price per calorie for vitamin A-rich fruits and vegetables, dark green leafy vegetables, other vegetables, other fruits, and nuts are higher in the Philippines than in lower-middle-income countries and Southeast Asia (Mbuya *et al.*, 2021; iPrice Group, 2021). In contrast, sugary drinks, such as soft drinks and juices, and sugary snacks are all cheaper in the Philippines than in other countries including low- and middle-income countries and Southeast Asia (Mbuya *et al.*, 2021). Poor food choices were consistent with the study conducted by Lopez-Madrid *et al.* in 2018, which showed that Filipino meal planners' awareness of and adherence to Food-based Dietary Guidelines were low (Lopez-Madrid *et al.*, 2018).

Although food insecurity and lack of dietary diversity are widespread in the Philippines, they are insufficiently examined and assessed for risk factors among mothers and young children, the two important life stages that are crucial to prevent malnutrition. Research findings suggest that household with moderate to severe food insecurity has lower dietary diversity scores compared to food-secure households (Chandrasekhar *et al.*, 2017). The degree to which households experience food insecurity and how it is reflected on the diversity of foods consumed by mothers, children, and mother-child pairs in the Philippine situation merits an investigation. To date, most studies on food insecurity and or dietary diversity in low- and middle-income countries have dealt with understanding its association with nutritional status (Dinku,

Mekonnen & Adilu, 2020), but scant on studies looking at the association of food security and dietary diversity scores (DDS) among mothers and children. DDS is correlated with nutrient adequacy (Daniels *et al.*, 2009) and is a proxy measure of the micronutrient adequacy of complementary foods provided to infants and young children, as well as the diet of mothers (FAO & FHI 360, 2016). Furthermore, counting the dietary diversity is one of the means of measuring food quality vis-à-vis socioeconomic status and malnutrition among children (UNICEF, 2019) and mothers (FAO, 2021).

This study was therefore conducted to fill this research gap to determine the association of HFS and meeting the DDS of mothers, children, and mother-child pairs. Specifically, it aimed to determine the proportion of mothers, children aged 6 to 36 months, and mother-child pairs meeting the DDS by food insecurity levels, and to determine the factors associated with meeting the DDS of these population groups. Looking at both the HFS, which measures food adequacy, and the DDS of mothers and children as a proxy measure of nutrient adequacy of their diet will provide a broader understanding of their nutritional well-being. The results of this study will also strengthen the development of evidence-based policies to target the severely and moderately food-insecure households with mothers and young children with less diverse diets in the country.

MATERIALS AND METHODS

Study design and participants

This study was a cross-sectional study utilising secondary data from the 2015 Updating Survey. Prior to the conduct of the ENNS in 2018-2020, the Updating Survey was being conducted every 3-5 years nationwide by the DOST-FNRI as a designated statistical activity that aimed to generate nutrition and health statistics of the Filipino citizenry. The 2015 Updating Survey was conducted from July-November 2015 covering all 17 regions and 80 of 81 provinces, excluding Batanes.

The 2015 Updating Survey adopted the 2003 Master Sample (MS) developed by the Philippine Statistics Authority (PSA). It used a three-stage sampling design where the first stage was the selection of Primary Sampling Units (PSUs), consisting of one barangay or a combination of contiguous barangays with at least 500 households each (Figure 1). Enumeration areas consisting of 150-200 households from these PSUs were identified, from which housing units were randomly selected. The last stage was the random selection of the households, which was the ultimate sampling unit (DOST-FNRI, 2016).

From the PSA list of 48,178 households eligible for interviews, a total of 42,310 households participated in the 2015 Updating Survey. From these, households with both mothers and children aged 6-36 months were 7,528. Upon exclusion of mother-child pairs with missing information, the households with mother-child pairs included in the study were 6,692.

Data collection

Data were obtained by trained field researchers using face-to-face interviews among mothers with children aged 6-36 months with a questionnaire developed and pre-tested by the DOST-FNRI. The questionnaire was uploaded in the electronic Data Collection System (eDCS) to collect all relevant information on households, mothers, and children. Questionnaires were written in English with translations in Filipino and other major dialects. In survey areas where Filipino was not the spoken language, deliberate hiring of local researchers

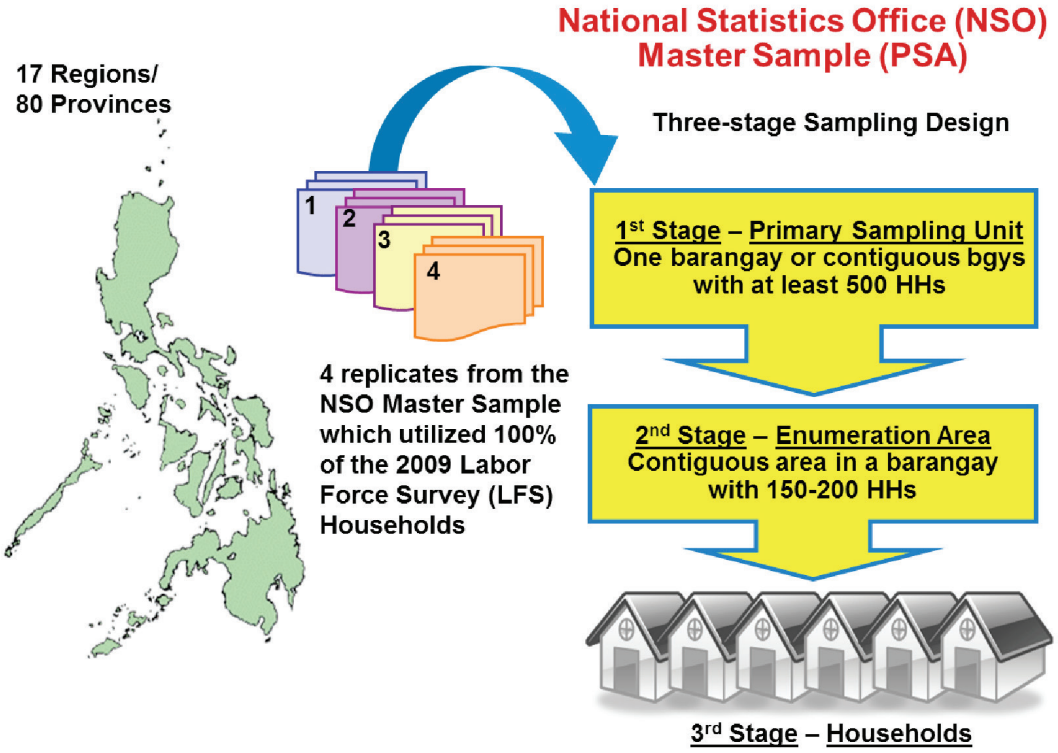

Figure 1. Sampling design of the 2015 Updating of Nutritional Status of Filipino Population

from these areas who can speak the local dialects was done. In addition, the survey team also sought the help of hired local aides in the survey area to act as interpreters during the interview.

Household food security status was determined using the HFIAS assessment tool adapted from the United States Agency for International Development (USAID) Food and Nutrition Technical Assistance (FANTA) Project (Coates, Swindale & Bilinsky, 2007). The HFIAS is a nine-item questionnaire regarding difficulties experienced in securing food needs for the past month from the date of the interview. The nine questions or experiences were the following: 1) worry about food, 2) unable to eat preferred foods, 3) eat just a few kinds of foods, 4) eat foods they do not want to eat, 5) eat a smaller meal, 6) eat fewer meals in a day, 7) no food of any kind in the household, 8) go to sleep hungry, and 9) go a whole day and night without eating.

The dietary diversity of mothers and their children aged 6-36 months were obtained from the mother's and child's one-day food intake through a 24-hour food recall using a paper-based questionnaire and measuring tools. The mother was asked about her and her child's complete food intake from the time of waking up until at night before going to sleep. Selected socio-demographic, socioeconomic, and reproductive characteristics of mothers, children, and households were also obtained using face-to-face interviews.

Study variables

The dependent variables or the outcomes of interest of the study included the

mothers, children, and mother-child pairs meeting the DDS.

1. Mothers meeting the DDS - a mother who consumed food items from at least five out of ten food groups (FAO, 2010) that were identified from their 24-food recall interview.
2. Children meeting the DDS - a child who consumed food items from at least four out of seven food groups that were identified from their 24-food recall interview.
3. Mother and child pair meeting the DDS - the mother who consumed food items from at least five out of ten food groups, while the child who consumed food items from at least four out of seven food groups.

The independent variable was household food security; maternal, child, and household characteristics were included as covariates in the study.

1. Household Food Security – using HFIAS, a household was food secure if it never experienced the occurrence of any of the nine food insecurity questions. Otherwise, the household was food insecure if it experienced any of the nine food insecurity questions. By frequency of occurrence of the nine food insecurity questions, the household was classified as mildly food insecure, moderate food insecure, and severely food insecure.
2. Maternal variables - included age (<20 and ≥20 years); educational attainment (primary level or less, secondary level, tertiary and above), employment status (employed, not employed), and the number of children (one child, 2-3 children, 4-5 children, ≥6 children).
3. Child variables - included age in months (6-11 months, 12-23 months, 24-36 months); sex (male or female); and current breastfeeding status (breastfed or not breastfed).
4. Household variables - included sex of household head (male or female); household size (2-4 members, 5-6 members, 7-8 members, ≥9 members); place of residence (rural or urban); and wealth quintile (1st quintile-poorest, 2nd quintile-poor, 3rd quintile-middle, 4th quintile-rich, 5th quintile-richest). Wealth quintile served as a proxy indicator for wealth status of households derived using data collected from the socio-economic component of the 2015 Updating Survey using Principal Component Analysis (PCA).

Computation of dietary diversity scores of mothers and children

The DDS was calculated by adding up the number of groups consumed by the mother and the child in the previous 24 hours. For maternal DDS, the food groups were categorised into ten groups classified according to the Food and Agriculture Organization (FAO) groupings such as 1) starchy staples, 2) beans and peas, 3) nuts and seeds, 4) dairy, 5) flesh foods, 6) eggs, 7) vitamin A-rich dark green leafy vegetables, 8) other vitamin A-rich vegetables and fruits, 9) other vegetables, and 10) other fruits. If at least one food item was consumed from a food group, that group was given a score of one. All positive scores were then added together to give the mother a final DDS ranging from 0 to 10 (FAO & FHI 360, 2016).

For child DDS, the food items were categorised into seven food groups, namely: 1) grains, roots, and tubers,

2) legumes and nuts, 3) milk and milk products, 4) flesh foods including meat, fish, poultry, and liver/organ meats, 5) eggs, 6) vitamin A-rich fruits and vegetables, and 7) other fruits and vegetables, using a scoring system adopted from the World Health Organization (WHO). Breast milk was not included in the DDS computation. Similarly, if at least one food item was consumed by the child from a food group, that group was given a score of one. All positive scores were then added together for the child's final DDS.

A mother who consumed food items from at least five out of ten food groups (FAO, 2010) and a child who consumed food items from at least four out of seven food groups were considered to have a high quality diet, thus meeting dietary diversity (WHO, UNICEF, IFPRI, UC, FANTA AED & USAID, 2008). A mother-child pair meeting the DDS was considered when both mother and child met their respective DDS.

Computation of household food security

The household's food security score from HFIAS varied from zero (food secure) to 27 (maximum food insecurity) based on the frequency of occurrence of the nine questions being asked. For each question, a score of zero was given if the situation never occurred, one if the situation occurred rarely (one to two times per month), two if the situation occurred sometimes (three to ten times a month), and three if the situation occurred frequently (>10 times a month) (Coates *et al.,* 2007). Based on the responses, the study computed the level of household food security as food secure, mildly food insecure, moderate food insecure, and severely food insecure, as well as by dichotomous classification of food secure and food insecure by combining mildly food insecure, moderate food insecure, and severely food insecure as food insecure.

Data processing and analysis

Descriptive statistical analysis included estimation of frequencies, weighted means, and proportions. Bivariate analysis was conducted and chi-square test was used to test the significance of the association between the dependent and independent variables. All variables with significant associations with meeting DDS of mothers, children, and mother-child pairs were entered into the multivariate logistic regression analysis. The level of significance was set at $p<0.05$ for all tests performed. Analyses were done using Stata version 15 (StataCorp LLC, Texas, USA).

Ethical considerations

The 2015 Updating Survey was approved by the Food and Nutrition Research Institute's Institutional Ethics Review Committee (FIERC) under the protocol code FIERC-2015-006. Oral and written consent was obtained from the respondents before actual data collection, which included information on the different components of the 2015 Updating Survey, detailed data collection procedures, and non-disclosure of information for anonymity and confidentiality purposes. The content of the consent form has been published elsewhere (DOST-FNRI, 2016).

RESULTS

Sample characteristics

Socio-demographic characteristics of the study population are shown in Table 1. By maternal characteristics, almost all mothers (95.1%) were 20 years old and above. The majority of them had secondary level education (51.0%) and were not employed (76%). Nearly half of the mothers had 2-3 children

Table 1. Socio-demographic and socio-economic characteristics of households, mothers, and children: Philippines, 2015 *(n*=6,692)

Characteristics	*n*	*Proportion (%)*	*SE*
Maternal characteristics			
Age			
<20 years old	319	4.9	0.3
≥20 years old	6,373	95.1	0.3
Education background			
Primary level or less	1470	20.3	0.6
Secondary level	3,360	51.0	0.8
Tertiary and above	1,862	28.8	0.7
Employment status			
Employed	1,521	23.7	0.6
Not employed	5,171	76.3	0.6
Parity			
1 child	1,583	24.4	0.6
2-3 children	2,888	43.8	0.7
4-5 children	1,338	19.5	0.5
≥6 children	883	12.3	0.5
Child characteristics			
Age			
6-11 months old	1,454	21.8	0.5
12-23 months old	2,595	39.1	0.6
24-36 months old	2,643	39.2	0.6
Sex			
Male	3,369	49.9	0.7
Female	3,323	50.1	0.7
Breastfeeding status			
Breastfed	3,956	59.8	0.7
Not breastfed	2,736	40.2	0.7
Household characteristics			
Sex of household head			
Male	5,798	86.0	0.5
Female	894	14.0	0.5
Household size			
2-4 members	1,223	18.6	0.6
5-6 members	2,326	34.2	0.7
7-8 members	1,763	26.2	0.6
≥9 members	1,380	21.1	0.7
Type of residence			
Rural	4,015	52.5	1.0
Urban	2,677	47.5	1.0
Wealth quintile			
Poorest	1,940	25.0	0.7
Poor	1,575	21.7	0.6
Middle	1,272	20.2	0.6
Rich	1,060	18.1	0.6
Richest	845	15.0	0.6
Food security status			
Food secure	1,418	21.9	0.7
Food insecure	5,274	78.1	0.7
Food security levels			
Mild food insecure	840	12.9	0.5
Moderate food insecure	2,632	38.2	0.8
Severe food insecure	1,802	27.0	0.7

Table 1. Socio-demographic and socio-economic characteristics of households, mothers, and children: Philippines, 2015 (*n*=6,692) [Cont'd]

Characteristics	*n*	*Proportion (%)*	*SE*
Dietary diversity score: Mothers			
Not meeting DDS	4,693	69.5	0.7
Meeting DDS	1,999	30.5	0.7
Dietary diversity score: Children			
Not meeting DDS	4,200	62.4	0.7
Meeting DDS	2,492	37.6	0.7
Dietary diversity score: Mother-Child			
Not meeting DDS	5,636	84.2	0.5
Meeting DDS	1,056	15.8	0.5

(44%). An almost equal proportion of children belonged to the age groups of 12-23 months and 24-36 months at 39.1% and 39.2%, respectively. By sex, males and females had almost equal representations. Most of the children were breastfed (59.8%). By household characteristics, the majority of mother-child pairs' households were headed by a male and with 5-6 household members. More than half were living in rural (52.5%) areas, while higher proportions were from the poorest (25.0%) and food-insecure households (78.1%). Among the food insecure households, the majority were experiencing moderate food insecurity at 38.2%, while 27.0% were experiencing severe food insecurity. About one-third of the mothers (30.5%) and a little over one-third of the children (37.6%) met the DDS. However, when combined as mother-child pairs, only 15.8% met the DDS.

Meeting dietary diversity score of mothers, children, and mother-child pairs by household food security status

Table 2 shows the percentage distribution of meeting and not meeting the DDS among mothers, children, and mother-child pairs by household food

Table 2. Percentage distribution of meeting and not meeting the DDS among mothers, children, and mothers and children by household food security status (*n*=6,692)

Household food security status	*Mother**		*Child**		*Mother and child**	
	Not meeting DDS	*Meeting DDS*	*Not meeting DDS*	*Meeting DDS*	*Not meeting DDS*	*Meeting DDS*
Food secure	60.7	39.3	58.1	41.9	79.3	20.7
Food insecure	72.0	28.0	63.6	36.4	85.6	14.4
Food insecurity level						
Mild food insecure	60.7	35.0	58.1	42.6	79.3	19.7
Moderate food insecure	65.0	29.4	57.4	37.7	80.4	15.1
Severe food insecure	70.6	22.6	62.4	31.8	84.9	10.9

**p*<0.001

Table 3. Multivariate logistic regression model showing the determinants of meeting the DDS among mothers, children aged 6-36 months old, and both mothers and children aged 6-36 months old: Philippines, 2015 (n=6,692)

Characteristics	*Meeting the DDS*								
	Mother			*Child*			*Mothers and children*		
	Adjusted OR†	*95% CI*‡ *LL*	*UL*	*Adjusted OR*†	*95% CI*‡ *LL*	*UL*	*Adjusted OR*†	*95% CI*‡ *LL*	*UL*
Food security status									
Food secure	reference category			reference category			reference category		
Mild food insecure	1.00	0.81	1.24	1.06	0.85	1.31	1.06	0.82	1.37
Moderate food insecure	0.93	0.78	1.12	0.96	0.81	1.14	0.90	0.72	1.12
Severe food insecure	0.73***	0.59	0.89	0.77**	0.63	0.93	0.67**	0.52	0.87
Maternal characteristics									
Education background									
Primary level or less	reference category			-			reference category		
Secondary level	1.24*	1.03	1.50				1.33*	1.05	1.69
Tertiary and above	1.55***	1.25	1.92				1.64**	1.24	2.15
Employment status									
Employed	reference category			-			reference category		
Not employed	0.79**	0.69	0.92				0.79*	0.67	0.94
Child characteristics									
Age									
6-11 months old	-			reference category			reference category		
12-23 months old				4.70***	3.85	5.74	3.35***	2.54	4.42
24-36 months old				7.01***	5.71	8.59	4.88***	3.74	6.37
Breastfeeding status									
Not breastfed	-			reference category			-		
Breastfed			-	0.58***	0.51	0.66			

Table 3. Multivariate logistic regression model showing the determinants of meeting the DDS among mothers, children aged 6-36 months old, and both mothers and children aged 6-36 months old: Philippines, 2015 (*n*=6,692) [Cont'd]

Characteristics	*Meeting the DDS*									
	Mother			*Child*			*Mothers and children*			
	Adjusted OR†	*95% CI*‡ *LL*	*UL*	*Adjusted OR*†	*95% CI*‡ *LL*	*UL*	*Adjusted OR*†	*95% CI*‡ *LL*	*UL*
Household Characteristics										
Wealth Quintile										
Poorest	reference category			reference category			reference category			
Poor	1.66***	1.37	2.00	1.72***	1.46	2.02	1.48**	1.17	1.87
Middle	1.92***	1.56	2.36	2.19***	1.84	2.62	1.82***	1.42	2.33
Rich	1.80***	1.44	2.25	2.00***	1.65	2.44	1.62***	1.24	2.11
Richest	2.66***	2.06	3.43	2.06***	1.64	2.59	2.20***	1.62	2.98

*p<0.05, **p<0.01, ***p<0.001
†Odds ratio
‡95% confidence interval; lower limit (LL); upper limit (UL)
Covariates: education background, employment status of mothers, child's age, child's breastfeeding status, wealth quintile

security status. Among mothers, the proportion of meeting the DDS was higher among food secure (39.3%) than food insecure (28.0%) households. Similarly, among children, the proportion meeting the DDS was higher among food secure (41.9%) than food insecure (36.4%) households. Among mother-child pairs, only 14.4% met the DDS in food-insecure households, while 20.7% met the DDS in food-secure households. The proportion of meeting the DDS decreased as the levels of household food insecurity increased.

Factors associated with meeting dietary diversity score of mothers, children, and mother-child pairs

After controlling for the effects of other variables, the final model of factors significantly associated with meeting the DDS of mothers, children, and mother-child pairs are presented in Table 3. For mothers, the factors were household food security, education background, employment status, and wealth quintile; while for children, the factors were household food security, age, breastfeeding status, and wealth quintile. Among mother-child pairs, factors significantly associated with meeting DDS were household food security, education background, employment status of mothers, age of the child, breastfeeding status, and wealth quintile.

Results showed that mothers who experienced severe food insecurity were 27% less likely to meet DDS than mothers in food-secure households. Mothers with secondary level education and had

at least tertiary education were 24% and 55% more likely, respectively, to meet the DDS than those with primary level or less. Unemployed mothers were 21% less likely to meet the DDS than their employed counterparts. Wealth quintile was also found to be significantly associated with DDS, wherein those in the richest quintile were 2.66 times more likely to meet DDS than those in the poorest quintile. The likelihood of meeting DDS increased as wealth status improved.

Children with severe food-insecure households were 23% less likely to meet the DDS than mothers in food-secure households. Children aged 12-23 months old were 4.70 times more likely to meet the DDS compared to the reference group. Moreover, those in the 24-36 months old age group were 7.01 times more likely to meet the DDS compared to the reference group. Similar to mothers, the likelihood of meeting DDS among children generally increased with the improvement of wealth status.

Among mother-child pairs, there was a decreased likelihood of meeting the DDS as the household experienced severe food insecurity. The likelihood of meeting the DDS was 64% more likely among mothers with at least tertiary education compared to those with no grades completed. The likelihood of meeting the DDS increased as education level increased. Unemployment decreased the likelihood of meeting the DDS by 21%. In terms of child characteristics, those in the 12-23 months old age group were 3.35 times more likely to meet the DDS, and those in the 24-36 months old age group were 4.88 times more likely to meet the DDS than their younger counterparts. The likelihood of meeting DDS increased as wealth status improved among mother-child pairs.

DISCUSSION

Household food security status in association with meeting the minimum DDS of mothers and children aged 6-36 months

The study revealed the widespread problem of HFS in the country. Findings of the study showed that meeting the DDS for both mothers and children aged 6-36 months and when combined as mother-child pairs was significantly associated with their level of household food security status. Mothers and children belonging to food-secure households were more likely to meet their minimum DDS than those belonging to food-insecure households. Furthermore, the likelihood of not meeting the DDS increased with the increasing severity of household food insecurity. The results are consistent with a study in Northern Albania, in which it was found that the more severe the food insecurity in the household, the less varied the women's diets were (MDGF & UN Albania, 2012). Another study done in Bangladesh, Vietnam, and Ethiopia reported that food security was positively associated with maternal dietary diversity (Nguyen *et al.*, 2013). Women, especially mothers, are the gatekeepers of their family's diet and are entrusted with the major responsibility of selecting, preparing, and serving nutritious foods to support families and households. However, the diets of women and mothers are often overlooked, along with the potential impacts of poor diets on women and their families. Furthermore, mothers are likely to reduce their intakes to secure those of infants and small children.

A significant association of meeting the minimum DDS and household food security among children was also found in other studies. It was reported in studies in Nicaragua and Northern Ghana that improved household food

security was associated with meeting children's dietary diversity (Agbadi, Urke & Mittelmark 2017). Another study in Nepal reported the same finding which stated that more children from food-secure households received the recommended dietary diversity compared to children from food-insecure households (Hellen Keller International, 2010).

Factors on meeting the DDS among mothers

Meeting the minimum DDS of five food groups among mothers was found to be significantly associated with their household food security, educational attainment, employment status, and household wealth status. Those with at least a tertiary level education and in the richest quintile were more likely to meet the DDS, while those who were unemployed were less likely to meet DDS. Mothers in food-secure households were significantly more likely to meet DDS than those in food-insecure households.

Of the three most commonly used indicators i.e., educational level, income, and occupation, educational level is the strongest and most consistent in predicting health behaviours (Winkleby *et al.*, 1992). Parents with lower educational attainment experience difficulties, such as lack of knowledge, skills, time, money, and other resources, to create healthy home environments and model healthy behaviours for their children. In the context of this study, women with higher education might have acquired essential information on appropriate feeding practices (Kiboi, Kimiywe & Chege, 2017). On the other hand, mothers who were not employed had lower odds of meeting the minimum DDS than employed mothers. The same result was reported in the same study, wherein more employed women attained minimum dietary diversity as compared to the non-employed. This can be explained by the fact that women who are employed have a regular income, which increases their chances of access to food.

By wealth status, mothers in the higher wealth quintiles were more likely to meet the minimum DDS compared to those in the lower wealth quintiles. In a study by Hatloy *et al.* (2000), it has been demonstrated that as income rises, households tend to diversify their diets, which in turn increases their micronutrient intakes and improves their nutrient adequacy. Also, people living in poverty or extreme poverty have limited purchasing power, which directly affects their ability to buy a variety of foods.

Factors on meeting the minimum DDS among children aged 6-36 months

Meeting the DDS of at least four food groups among children aged 6-36 months was associated with their household food security, age, breastfeeding status, and household wealth status. A higher proportion of older children (12-23 months and 24-36 months) had significantly higher odds of meeting their minimum DDS as compared to younger children aged 6-11 months. Similar studies have also found an association between the age of a child and minimum dietary diversity (Amugsi, Mittelmark & Oduro, 2015; Nguyen *et al.*, 2013). This is expected because children gradually consume a greater variety and quantity of foods from six months onwards and in developing countries, they are likely to transition to family foods during their second year (Nguyen *et al.*, 2013). Younger children <9 months old had lower odds of meeting the DDS and this could be due to the late introduction of complementary foods to infants or if the mother had introduced complementary

feeding on time, they only included milk or cereal products like gruel. Another reason could be due to the mother's perception that the younger the child, the poorer the ability of the child's intestine to digest solid foods (Beyene, Worku & Wassie, 2015).

Breastfed children were less likely to meet their minimum DDS than non-breastfed children. One possible reason would be that the breastfed children were not introduced to complementary foods in a timely manner and their mothers were not aware of or were not knowledgeable on the importance of adequate dietary diversity in meeting their children's nutritional needs.

Children in the richer wealth quintiles had greater chances of meeting their minimum DDS than those in the poorer wealth quintiles. This is consistent with the finding in another study, which stated that the child's dietary diversity was positively associated with wealth index (Amugsi *et al.*, 2015). Higher economic status is associated with improved access to material resources including foods. Direct access to food may allow households to provide their children greater amounts of food and a more diversified diet that is richer in micronutrients.

In light of this finding, it is critically important that interventions that are to be designed and implemented should address the food insecurity issues of economically disadvantaged households and their dietary modification towards a healthier and more diverse diet. Social and behavioural change interventions that target maternal and child dietary diversity are also recommended to emphasise the importance of feeding the child nutritious family foods and as timely as suggested. In addition, the promotion of women empowerment is also encouraged to improve not only the infant and young child feeding practices, but also the dietary diversity of every household member.

Strengths and limitations

One of the strengths of the study was the large, nationally representative sample size of the data set. The rich dataset has information on the DDS of both mothers and their children, as well as household food security that allowed the authors to determine in one study the association of household food security with DDS of mothers and children, and identify the risk factors for meeting the DDS among these population groups. The findings, however, can be affected by recall bias since the survey tools used – the 24-hour food recall and the HFIAS were dependent on the memory of the mothers to recall past events. The study design, being cross-sectional, also limited the causal relationships of the risk factors identified.

CONCLUSION

The findings showed that HFS was significantly associated with meeting the DDS of mothers, children aged 6-36 months, and mother-child pairs. The severity of household food insecurity further decreased the mothers' and children's likelihood of meeting the DDS. Among mothers, meeting the DDS of at least five food groups was significantly associated with their level of food security, education background, employment status, and wealth status. Among children, meeting the DDS of at least four food groups was significantly associated with their level of food security, age, breastfeeding status, and wealth status. For mother-child pairs, the factors significantly associated with meeting the DDS were household food security status, education background, employment, child's age, and wealth status. The results of this study

provided evidence on how the level of household food security was associated with meeting the DDS of mothers, children, and mother-child pairs, and the need to support the 1st 1000 days of life. Results can be used as a basis to formulate appropriate policies to address the widespread food insecurity among Filipinos, which impacts the most vulnerable population groups of mothers and children.

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Authors' contributions

MOG, principal investigator, conceptualised and designed the study, prepared the draft of the manuscript and reviewed the manuscript; MLVM, conducted the data analysis and interpretation of the study, assisted in drafting the manuscript, and reviewed the manuscript; CGM, assisted on the data interpretation and reviewed the manuscript.

Conflict of interest

The authors declare that they have no competing interests.

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Exploring the norms of eating-out practice among adults in Malaysia

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ABSTRACT

Introduction: Eating-out is common in almost all countries, including Malaysia, but this frequent practice may affect human health. In Malaysia, data on eating-out is limited. This study aimed to assess the proportion of eating-out, to assess the association between socio-demographic factors and eating patterns, and to compare energy and nutrient intakes between people eating-out and eating-in. **Methods:** This cross-sectional study was conducted among 100 adults aged 30 to 70 years old. Three-day food diaries were used to collect data on dietary intake. Eating-out was defined as eating foods prepared outside the home. Respondents who ate outside for at least one meal per day, for two or three days per week were considered as those who frequently practised eating-out. **Results:** A total of 84% of respondents who ate out had significantly higher sodium intake than those who ate at home (2934 mg/day vs. 2165 mg/day, p=0.025). Foods and drinks that were most commonly consumed outside were *nasi lemak*, *roti canai*, rice, *ayam masak kicap*, vegetable soup, *tomyam*, rice vermicelli soup (*mee-hoon soup*), hot *teh-o*, iced tea, and orange juice. Occupation (p=0.004) and location type (p=0.001) were associated with eating-out. Government and semi-government workers (61%) and urban population (57%) had higher percentage of eating-out compared to eating at home (19% and 12%, respectively). **Conclusion:** More than two-thirds of our respondents ate out and this habit was related to poor diet quality with excessive intake of sodium. Interventions are needed to improve the diet quality of the overall eating-out behaviour among targeted population.

Keywords: eating pattern, eating-out, factors, Malaysia, nutrients

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INTRODUCTION

In recent decades, people around the world were found to have significant shifts in their eating patterns or behaviours. The trend of people eating-out has been increasing as compared to eating at home (eating-in) (Seguin *et al.*, 2016). Eating-out frequently may affect human health. For example, meals purchased outside were found to be a risk factor for cardiovascular diseases due to higher intakes of energy and fat, and malnutrition from the low micronutrient contents (Lachat *et al.,* 2012; Goffe *et al.*, 2017; Kim & Ahn, 2020). Moreover, the nutritional contents in meals from independent takeaway outlets are inconsistent with national dietary recommendations (Goffe *et al.*, 2017). Mills *et al.* (2020) have discovered that lesser time spent cooking at home was paralleled with diet-related non-communicable diseases including diabetes mellitus and obesity. In addition, a recent study found that late-night supper could increase the risk of gastroesophageal reflux, especially among obese individuals (Deraman *et al.*, 2020).

Many factors can influence eating-out habit. Socio-economic and demographic factors such as high income and smaller urban household size are part of the determinants of eating-out. Independent of these factors, the urban effect was found to affect the consumption of food away from home. Urbanisation has increased the financial accessibility and availability of various food outlets, which exposes consumers to new dietary options (d'Amour *et al.*, 2020). The increasing number of women in the labour force has also changed the role of women in food provision. Women's employment and a decline in the prevalence of cooking at home have driven an increase in eating food away from home (Kim & Ahn, 2020). Ready-to-eat foods consumed from outlets, namely cafes, food stalls, food courts, restaurants, and convenience stores are common (Goffe *et al.*, 2017). A study in the United Kingdom (UK) showed that adults and children had a takeaway meal at home on a weekly basis, proving that higher takeaway food intake is related to increased exposure to takeaway outlets (Goffe *et al.*, 2017).

As a developing nation, Malaysia is also experiencing a rapid modernisation process with expansive urbanisation programme and rural withdrawal (Fournier *et al.*, 2016), and the growing economy is associated with an increase in income. The increase in income allows more purchase and food consumption including eating-out. The Malaysian Adult Nutrition Survey (MANS, 2014) has highlighted a high frequency of eating outside linked with urbanisation. The growth of urbanisation results in the development of a food environment with a high density of outlets, thus increases the opportunity for Malaysians to eat outside (Poulain *et al.,* 2020). Other factors include working mothers who have no time to cook at home and the expansion of premises serving a variety of foods, both of which have ignited the recent practice of eating-out in Malaysia (Ali & Abdullah, 2012).

Secondary data from several states in Malaysia including Selangor, Kedah and Johor revealed that the habits of eating-out among students, workers and families were due to the unavailability of foods at home or they could not go home to eat (Ali & Abdullah, 2012). An earlier study on the eating patterns in Malaysia had discussed the patterns and implications of eating-out (Ali & Abdullah, 2012), while another study explored the issue of body mass index (BMI) with socio-demographic and the link between eating-out and obesity (Fournier *et al.*, 2016). However,

many issues remain unclear, and the information is limited, especially on the latest rates, associated factors, energy intakes, and nutrient intakes. Therefore, the current study aimed to assess the proportion of eating-out, to assess the association between socio-demographic factors and eating patterns, and to compare energy and nutrient intakes between people eating-out and eating-in.

MATERIALS AND METHODS

Definition of eating-out

There has been various definitions of eating-out applied in various populations (Gorgulho, Fisberg & Marchioni, 2014; Llanaj *et al.*, 2018; Zang *et al.*, 2018). For the current study, eating-out was defined as eating foods prepared outside of the home, such as in restaurants, food courts, fast food joints, hawker stalls etc., and including takeaway or delivery services (e.g., Food Panda, Grab Food etc.) for home, office or indoor consumption (NCCFN, 2019). In addition, we have a quantitative definition for eating-out of at least one meal over two or three days. Respondents who did not meet the above definitions were considered as eating-in.

Study design

This cross-sectional study was conducted from December 2019 to March 2020 in two cities of Peninsular Malaysia, which were Kuala Lumpur (KL) and Kota Bharu, and they represented the urban and suburban areas, respectively. KL is in Klang Valley, with a population density of 7802 per square kilometre, while Kota Bharu is located in Kelantan, in the north-east of Peninsular Malaysia, with a population density of 1511 per square kilometre according to the Department of Statistics Malaysia, 2019. The sample size was calculated based on single proportion estimation with an expected proportion of 0.24 (Gorgulho *et al.*, 2014) and a precision of 0.09. The estimated sample size with 10% dropout was 96 respondents.

Respondents were recruited using the convenience sampling method. The inclusion criteria included individuals aged 30 years and above who did not practise any diet regime [e.g., intermittent fasting, Atkins diet, low–fermentable oligo-, di-, monosaccharide and polyol (FODMAP) etc.]. The study procedure was reviewed and approved by the Human Research Ethics Committee of Universiti Sains Malaysia (USM/JEPeM/19060354) and Universiti Kebangsaan Malaysia's Research Ethics Committee (UKMREC; FF-2020-005). The respondents were recruited into the study after they have provided informed consent.

Dietary data collection

Dietary information was assessed using three-day food diaries. The three-day food diary included two weekdays and one weekend day per week. As the quantitative definition of eating-out was those who ate outside for at least one meal per day, for two or three days in a week, the multiple recalls or three repeat recalls covering two weekdays and one weekend was the most suitable option to assess the proportion of eating-out. In addition, multiple recalls provided a better capture of the variation in energy and nutrient intakes, as well as episodically-consumed foods between individuals who were eating-out and eating-in. Nevertheless, it is noteworthy that each food assessment method has its strengths and limitations. The three-day food diary included pictures of household measurements, such as tablespoon, teaspoon, cup, glass etc., to aid in the estimation of portion sizes. Other variables included the time of meals, place of eating, types of food and beverages, and the total price for two weekdays and one weekend. Nutritionist

Pro™ Diet Analysis Software version 7.8.0 (Axxya Systems, version 2020, Redmond, USA) was used to analyse the dietary data. Recipes and foods were selected from the reference list of Nutrient Composition of Malaysian Foods in the Nutritionist Pro™ database. Recipes that were not listed in the reference list were added to the database. Portion sizes were calculated based on standard recipe sizes, for example per serving size and total serving. Weight of foods or ingredients to make the recipes were referred from the Nutrient Composition of Malaysian Foods (Tee *et al.*, 1997), Atlas of Food Exchanges & Portion Sizes (Suzana *et al.*, 2009), *Album Makanan Malaysia* (IPH, 2011), and Malaysian Food Composition Database (MyFCD, 2020). The nutrition information of food product was obtained from its packaging or MyFCD and was inserted into the database.

Statistical analysis

Statistical analysis was carried out using IBM SPSS Statistics, Version 22.0 (Chicago, IL, USA). Categorical data were presented as frequencies and percentages. Continuous data with a normal distribution were presented as mean and standard deviation, while skewed data were presented as median and interquartile range. Results of eating-out and eating-in were grouped or tabled according to gender, age, occupation, monthly household income, and location type. The occupation groups of housewife, pensioner, and the unemployed were regrouped into one group, i.e. housewife and not working group, due to small sample size. Differences between the two groups were analysed using Pearson chi-square or Fisher's exact test. Comparisons of energy and nutrient intakes between eating-out and eating-in were analysed using an independent *t*-test or Mann-Whitney U test.

RESULTS

Table 1 shows the socio-demographic characteristics of the study population. A total of 100 respondents (38 men and 62 women) participated in the study. The majority of the respondents were 45-59 years old (66%), Malays (70%), married (85%), had secondary level education (51%), worked in the government and semi-government sectors (54%), had a household member of between 1-5 (82%), and had a monthly household income of not more than RM 3860, equivalent to USD 953 (75%), which was classified as the bottom 40% of household income group (EPU, 2015). Half of the respondents lived in urban areas, while the other half in suburban locations.

The overall proportion of eating-out was 84% (Table 2). Eating-out vs. eating-in was significantly associated with occupation (p=0.004) and location (p=0.001). With regards to occupation, we found a higher proportion of eating-out vs. eating-in in the government and semi-government sectors (61% vs. 19%), while a lower proportion was observed in the non-government sectors (18% vs. 44%), as well as the housewife and not working category (21% vs. 37%). Furthermore, a higher proportion of eating-out vs. eating-in was observed in the urban areas (57% vs. 12%), but a lower proportion was observed in the suburban (43% vs. 88%) areas.

Figure 1 shows the percentages of eating-out according to meals. The highest proportion of eating-out was observed during lunch time (57%), followed by breakfast time (46%), and the least during dinner time (26%). There was a significant association between gender and the frequency of eating-out during lunch time (p=0.026). A higher proportion of eating-out during lunch time vs. eating-in was observed in men (71% vs. 29%), whilst a lower proportion

Table 1. Characteristics of respondents (*n*=100)[†]

Characteristics	*Men (n=38)* *n (%)*	*Women (n=62)* *n (%)*	*Overall (n=100)* *n (%)*
Age groups (years)			
30-44	4 (11)	15 (24)	19 (19)
45-59	27 (71)	39 (63)	66 (66)
≥ 60	7 (18)	8 (13)	15 (15)
Race			
Malay	24 (63)	46 (74)	70 (70)
Chinese	6 (16)	11 (18)	17 (17)
Indian	8 (21)	5 (8)	13 (13)
Marital status			
Single	1 (3)	6 (10)	7 (7)
Married	36 (94)	49 (79)	85 (85)
Widower/Widow	1 (3)	6 (10)	7 (7)
Divorced	0 (0)	1 (1)	1 (1)
Educational level			
Primary school	1 (3)	9 (14)	10 (10)
Secondary school	22 (58)	29 (47)	51 (51)
University	14 (36)	24 (39)	38 (38)
Unschooling	1 (3)	0 (0)	1 (1)
Occupation			
Government and semi-government	22 (58)	32 (52)	54 (54)
Private	3 (8)	6 (10)	9 (9)
Self-employed/own business	6 (16)	7 (11)	13 (13)
Housewife	0 (0)	10 (16)	10 (10)
Unemployed	2 (5)	4 (6)	6 (6)
Pensioner	5 (13)	3 (5)	8 (8)
Household number			
1-5	32 (84)	49 (80)	81 (82)
6-10	5 (13)	8 (13)	13 (13)
≥ 11	1 (3)	4 (7)	5 (5)
Monthly household income (RM)[‡]			
< 3860	27 (71)	48 (77)	75 (75)
3860-8319	10 (26)	11 (18)	21 (21)
≥ 8320	1 (3)	3 (5)	4 (4)
Living location			
Urban	25 (66)	25 (40)	50 (50)
Suburban	13 (34)	37 (60)	50 (50)

[†]Sample size was not always n=100 due to missing values
[‡]Based on the cut-offs of the Eleventh Malaysia Plan (2015)

of eating-out during lunch time vs. eating-in was observed in women (48% vs. 52%).

Table 3 shows the energy and nutrient intakes of eating-out and eating-in. Overall, the level of sodium was significantly higher in participants who were eating-out compared to eating-in (2934 vs. 2165, p=0.025). However, there were no significant differences in

Table 2. Percentage of eating-out and eating-in among respondents: by gender, age groups, occupation, monthly household income, and location type (*n*=100)

Variables	*Out of home n (%)*	*At home n (%)*	*p-value*[†]
Gender			0.083
Men	35 (42)	3 (19)	
Women	49 (58)	13 (81)	
Age groups (years)[b]			0.275
30-44	14 (17)	5 (31)	
45-59	58 (69)	8 (50)	
≥ 60	12 (14)	3 (19)	
Occupation[‡]			0.004*
Government and semi-government	51 (61)	3 (19)	
Non-government	15 (18)	7 (44)	
Housewife and not working	18 (21)	6 (37)	
Monthly household income (RM) [‡,¶]			0.481
< 3860	62 (74)	13 (81)	
3860-8319	19 (23)	2 (13)	
≥ 8320	3 (3)	1 (6)	
Location type			0.001*
Urban	48 (57)	2 (12)	
Suburban	36 (43)	14 (88)	
Overall percentage	84	16	

[†]Chi-square test
[‡]Fisher's exact test
[¶]Based on the cut-offs of the Eleventh Malaysia Plan (2015)
*p<0.05

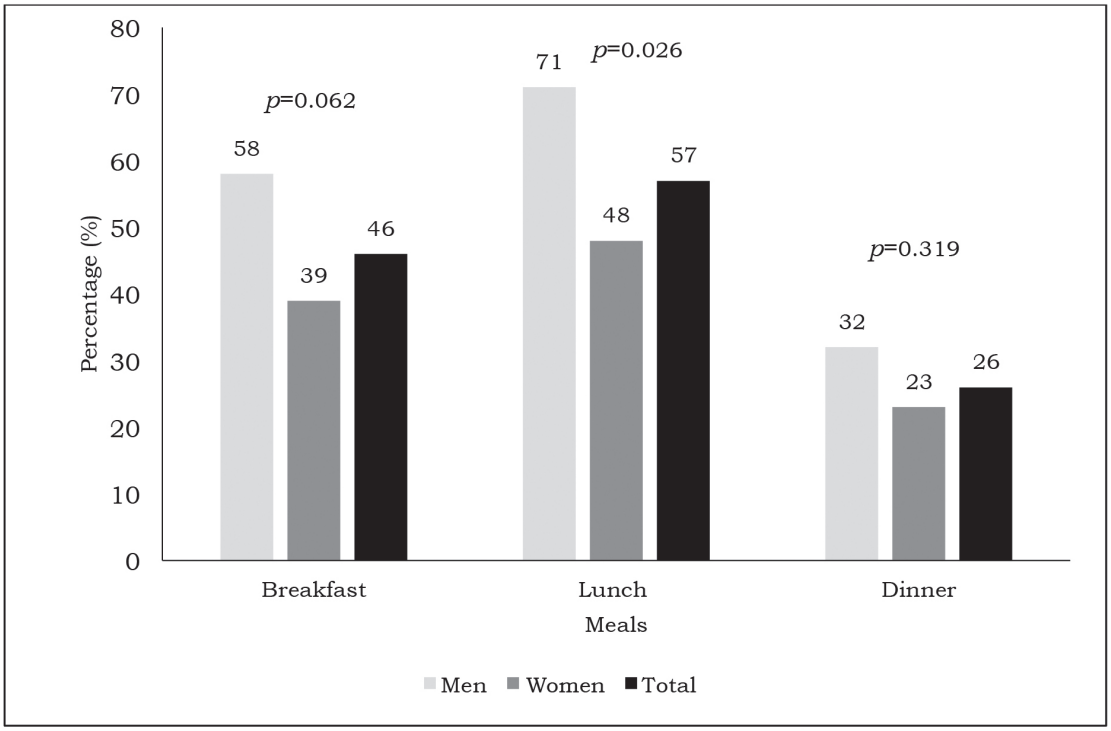
total energy, protein, carbohydrate, fat, dietary fibre, and sugar between those eating-out and eating-in.

The list of preferred foods and drinks that study participants consumed outside during breakfast were *nasi lemak*, *roti canai,* and hot *teh-o*. During lunch time, people liked to eat rice, *ayam masak kicap*, vegetable soup, and iced tea; during dinner, the preferred foods were rice, *tomyam*, rice vermicelli soup (*mee-hoon soup*), and orange juice. Most people liked to eat curry puff, *jemput pisang,* and popcorn chicken (*ayam gunting*) as snacks.

The list of commonly consumed foods and drinks at home during breakfast were fried noodles (*mee goreng*), white bread, butter, biscuits, hot *teh-o*, oat, and low-fat milk powder. During lunch, people mostly consumed rice, *ayam masak kicap,* and fried vegetables (*sayur goreng*). For dinner, study participants tended to eat fried noodles.

DISCUSSION

We found that more than two-thirds (84%) of our respondents ate out, mostly during lunch and breakfast. More people are eating-out as a result of the growing number of hawkers, who typically open from 10 a.m. to midnight and offer a wide range of dishes. This pattern was consistent with a previous study conducted in Shanghai, China



Note. The *p*-values are based on Pearson Chi-square test

Figure 1. Percentage of eating-out among men, women and total respondents according to mealtime

(Zang *et al.*, 2018), though our data found a slightly higher prevalence of eating out. Zang *et al.* (2018) found that in their study population, slightly more than half (56%) of their respondents ate out mostly during lunch (47%). Our proportion rate was closer to a report from Singapore with an eating-out rate of 77% (Naidoo *et al.*, 2017). In contrast, in the Singapore study, lunch and dinner were the more common eating-out occasions. The demand increases as the government subsidises hawkers' rental leases, allowing them to sell cooked foods at lower rates (Naidoo *et al.* 2017). In Metropolis, Brazil, the rate of eating-out was much lower than in Malaysia at 24% (Gorgulho *et al.*, 2014). Different research designs might have caused differences in research findings. Gorgulho *et al.* (2014) defined eating-out mainly based on the place of eating-out only, excluding take-away foods. This different approach used to define eating-out resulted in different prevalence.

In this present study, the proportion of eating-out during lunch was significantly higher among men as compared to women. This observation is consistent with a previous study in which men were found to consume outside foods more frequently compared to women (Zang *et al.,* 2018). The norm of men engaging in more social activities, usually taking place in restaurants, may lead to a higher frequency of eating-out (Du *et al.,* 2014). A previous study also found that this trend was more pronounced among male employees with working wives, whereby they tended to eat out and consumed processed foods more often than those whose wives did

Table 3. Comparison of energy and nutrient intakes between eating-out and eating-in (n=91)

Variables	*Out of home Mean±SE*	*At home Mean±SE*	*p-value*[†]
Energy (kcal)	1794±155	1367±116	0.269
Protein (g)	68.9±2.8	56.0±5.8	0.074
Carbohydrate (g)	256.3±31.9	190.1±14.7	0.403
Fat (g)	55.2±2.9	42.3±5.2	0.084
Dietary fibre, total (g)	5.05±1.43	2.98±0.42	0.448
Sugar, total (g)	47.6±18.5	26.5±4.0	0.644
Sodium (mg)[‡]	2934±1311	2165±1476	0.025*

[†]*p*-values were based on independent *t*-test, unless otherwise indicated
[‡]Mann-Whitney U test, median±interquartile range was reported
*$p<0.05$

not work (Park *et al.,* 2017). The higher proportion of those who can cook and prepare meals at home might be a determinant factor of a lower prevalence of eating-out.

From our results, eating-out and eating-in were influenced by the occupation and location of respondents. A lower proportion of eating-out (18%) than eating-in (44%) was observed in non-government sectors, as well as in the housewife and not working category (eating-out 21% vs. eating-in 37%). Interestingly, government and semi-government sectors had the highest proportion of eating-out than eating-in (61% vs. 19%). The exact reasons are unclear; however, a more secure and fixed salary job in the government and semi-government sectors could be a reason since the respondents were less worried about spending their money outside. According to Ali & Nath (2013), being employed was one of the factors that may influence eating away from home among Indian population in Uttar Pradesh.

Location wise, Kuala Lumpur (urban) reported greater rates of eating-out than eating-in (57% vs. 12%), while Kota Bharu (suburban) reported otherwise. Rapid urbanisation in the Kuala Lumpur city has resulted in a great increase of its population, but also services including transportation, social services, and food outlets such as restaurants, western fast food restaurants, food courts, *warung, mamak,* hawker stalls, food trucks, etc. These premises are often within a short distance from offices or homes where many are opened around the clock and are often competitive in their pricing. This suggests an association between purchasing power and the accessibility of food stores (d'Amour *et al.*, 2020). These characteristics of food premises in Malaysia may promote eating-out behaviour, and a similar observation was reported by Tian *et al.* (2016). Tian *et al.* (2016) reported that populations residing in urban China tended to eat outside more frequently than their rural counterparts and the reason for this difference was thought to be due to lifestyle factors. Ma *et al.* (2015) reported that the frequency of eating-out among the Chinese population, especially in urban locations, had increased because people were unable to spend much time on food preparation and cooking.

A significantly higher sodium intake was observed among those who consumed outside foods compared to those eating at home. The greater sodium intake is in line with the data obtained by Ruiz *et al.* (2020), where 80% of the recommended

daily sodium intake could be contributed by a single meal outside of the home. This might be due to the misperception of individuals about sodium contents in outside foods. Consumers had poor estimation of sodium in different types of foods. The savoury foods were thought to have high sodium, whilst baked goods were perceived as being lower in sodium. However, research has found that commercial bakeries contained more than 20% of the recommended daily sodium limit (Moran, Ramirez & Block, 2017). Interestingly, the present study found comparable energy, protein, carbohydrate, fat, dietary fibre, and sugar intakes between those who consumed foods outside and those who ate at home. This discrepancy might be due to the small sample size. Nevertheless, the trend showed a slightly higher mean intake of these nutrients associated with eating outside.

The possible reasons for high energy and fat intakes when dining outside might be due to the frequent consumption of *nasi lemak* and *roti canai*, which are widely available as a local traditional cuisine in Malaysia. Foods away from home are energy-dense, high in total fat and sugar, and have been found to be associated with poor diet quality (Lachat *et al.*, 2012). A study among the Shanghai population indicated that the daily intakes of total energy, protein, carbohydrate, fat, and iron were increased in people who were dining both at restaurants and company/school, while the intakes of vitamin B1, zinc, and sodium were increased only in those who ate at restaurants (Zang *et al.*, 2018). A study conducted in 10 European countries found that generally, the levels of vitamin C and calcium intakes were lower compared with other water-soluble vitamins and minerals among those people who eat outside (Orfanos *et al.*, 2009). Women consuming foods outside had more total fat than protein and carbohydrate intakes, and both men and women who ate outside, especially in southern Europe, had more sugar and starch intakes and lesser total fibre (Orfanos *et al.*, 2009).

The high level of dietary fibre among respondents who practised frequent eating-out might be because they liked to consume vegetables obtained from vegetable soup, *tomyam*, and *mee-hoon* soup. The data showed that these foods were cooked and prepared with a variety of vegetables including carrot, mustard green (*sawi*), cabbage, baby corn, and bean sprouts. In terms of beverages, people dining outside preferred ordering sweet drinks, such as hot *teh-o,* iced tea, and orange juice, which may promote increased sugar intake in their diet. Dan & Keke (2016) stated that high amounts of sodium, sugar, and cooking oil, as well as the frying cooking method applied to the preparation of foods away from home, were purposely done to improve the taste, flavour and colour of foods.

Making healthy decisions when eating-out would improve an individual's diet quality. The United States Department of Agriculture (USDA) recommendations include choosing plain water over sugar-sweetened beverages, opting for small or medium portions, and choosing dishes with healthy cooking methods, such as steamed, grilled or broiled, versus fried or sautéed. At fast food restaurants, it is recommended for individuals to use available nutrition information to make decisions and passing on "super-sizing" (Seguin *et al.,* 2016). Thus, the present study suggests that effective strategies are needed to encourage individuals to prepare foods at home whenever possible and educate them on healthy food choices when eating-out. The government and agencies should also pay more attention to the dietary quality of the government cafeteria.

More engaging promotional activities on nutrition and health knowledge among workers and the public might help to encourage them in choosing healthier options when eating away from home and to improve their diet quality.

This study has its limitations. Firstly, the cross-sectional design and questionnaire-based methodology did not allow the explanation of factors associated with eating-out habits. Secondly, the findings may not be generalised to all Malaysians due to the non-random sampling method, small sample size, and the incomplete coverage in terms of geographical areas.

CONCLUSION

In conclusion, the dietary composition of respondents who practised frequent eating-out habits was higher in sodium. Furthermore, being government and semi-government servants and living in urban areas promoted the practice of eating-out. Therefore, the promotion of a healthy diet should be intervened among these groups immediately.

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Authors' contributions

LSA, designed the study, conducted data collection in the suburban area, data entry, data analysis, and prepared the draft of the manuscript; AAAR, led the data collection in the suburban area, data entry, and prepared the draft of the manuscript; SMR, conceptualised the study, advised on data analysis, and reviewed the manuscript; LYY, reviewed the manuscript; YCK, advised on data analysis and interpretation, and reviewed the manuscript; AHBN, participated in data entry, assisted in data analysis, and assisted in drafting of the manuscript; NHS, led the data collection in the urban area and data entry; RARA, conceptualised the study and reviewed the manuscript; HJJM, conceptualised the study and reviewed the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

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Sociodemographic factors associated with consumption of high-sodium foods: Evidence from Malaysia

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ABSTRACT

Introduction: The objective of the present study was to investigate the influences of sociodemographic factors on consumption of high-sodium foods among adults in Malaysia. **Methods:** Data were extracted from the Malaysian Community Salt Survey (MyCoSS) (*n*=1046). A seemingly unrelated regression (SUR) was utilised to assess factors associated with the number of servings of high-sodium foods (*nasi lemak*, *roti canai*, fried rice, fried noodles, and fried vermicelli) consumed per week. The independent variables were sociodemographic factors. **Results:** Younger individuals consumed more high-sodium foods than their older counterparts. Adults with secondary level education consumed more high-sodium foods compared with those with tertiary level education. Consumption of high-sodium foods was higher among males and Malays compared to females and non-Malays. **Conclusion:** Consumption of high-sodium foods was common in the population. Sociodemographic factors, such as age, education level, gender, and ethnicity, play an important role in influencing the decisions of people to consume high-sodium foods.

Keywords: age, food, gender, Malaysia, population study, salt, sodium

INTRODUCTION

Sodium is important for human health and it improves the tastiness of foods. However, in today's hectic lifestyle, people tend to consume too much sodium. Excessive consumption of sodium can lead to hypertension, which is one of the main factors causing chronic kidney disease and cardiovascular diseases, such as stroke and coronary heart disease (Morrison & Ness, 2011; Aburto *et al.*, 2013). These diseases are responsible for millions of deaths across the globe (WHO, 2021).

In Malaysia, the prevalence of chronic kidney disease had increased from 9.1% in 2011 to 15.5% in 2018 (Saminathan *et al.*, 2020), and the prevalence of known hypertension had risen from 12.8% in 2011 to 15.9% in 2019 (IPH, 2020). From 2011 to 2016, the total number of patients undergoing dialysis had increased by 11404 (Wong & Goh, 2018). Moreover, nearly forty thousand dialysis patients required renal replacement therapy in 2016, and this contributed to a large amount of national health expenditure (Saminathan *et al.*, 2020).

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Despite the negative impacts of excessive sodium intake on health, the consumption of high-sodium foods among Malaysian adults remains very high (IPH, 2019). On average, a Malaysian adult consumes about 3.17 grams of sodium per day, which is 1.17 grams higher compared to the amount recommended by the World Health Organization (IPH, 2019). Only 55.4% of Malaysian adults control their intake of sodium regularly, while approximately 47.7% have the habit of adding excessive salt to foods (IPH, 2019).

The objective of the present study was to examine the influences of sociodemographic factors on consumption of high-sodium foods among adults in Malaysia. To our knowledge, the present study was the first to use a rigorous methodological approach to explore this topic. With our findings, we were able to understand which group of population consumed more or less high-sodium foods. Thereby, a more effective policy directed towards reducing sodium intake in the Malaysian population can be formulated.

METHODS

Data

The present study conducted secondary analyses on data from the Malaysian Community Salt Survey (MyCoSS) (IPH, 2019). The survey period was between October 2017 and March 2018. A stratified cluster sampling approach was adopted in order to ensure that the collected data were nationally representative. Sample size was determined based on the number of populations in each of the states in Malaysia. In the first stage of sampling, Enumeration Blocks (EBs) were selected. Then, living quarters (LQs) were chosen in each selected EB using random probability sampling. Lastly, only one of the eligible household members in the selected LQs was surveyed. Inclusion criteria were individuals aged 18 years and above across genders and ethnicities. Validated and pre-tested structured questionnaires were used by trained staffs to interview the respondents (face-to-face) (IPH, 2019). The respondents were asked to report their daily and weekly intake of foods with high sodium content (≥0.1 gram sodium per serving). A total of 104 high-sodium foods accompanied by images were presented in order to assist the respondents in answering the questionnaire. The survey found that fried vegetables, wholemeal bread, omelette, fried chicken with spice, fried rice, *nasi lemak*, *roti canai*, fried vermicelli, fried noodles, and chicken curry were the top ten high-sodium foods most consumed by Malaysian adults. Written consent was obtained from the respondents prior to the interview. Ethical approval was sought from the Medical Research and Ethics Committee, Ministry of Health Malaysia (NMRR-17-423-34969). The permission to use MyCoSS for secondary analyses and to publish this research article was given by the Ministry of Health Malaysia. Data use agreement was duly signed by the authors and the Ministry of Health Malaysia.

Variables

Consumption of high-sodium foods was used as the dependent variable. Its value was measured as number of servings consumed in a week. The high-sodium foods examined in the present study were *nasi lemak* (fragrant rice cooked with coconut milk and *pandan* leaf), *roti canai* (fried unleavened bread), fried rice, fried noodles, and fried vermicelli. These five food items are the most common, calorie-dense and unhealthy foods frequently consumed by Malaysian adults of all ethnicities. Based on the Food Frequency Questionnaire (FFQ), these food items were identified as five of the top ten high-sodium foods most

consumed by Malaysians (IPH, 2019). According to the FFQ, the means of sodium intake for *nasi lemak*, *roti canai*, fried rice, fried noodles, and fried vermicelli were 88mg/day, 99.3mg/day, 95.4mg/day, 82.8mg/day, and 53.7mg/day, respectively. Not all high-sodium foods found in the MyCoSS, including the top five, were assessed in the present study because some of them, such as fried vegetables, wholemeal bread, and omelette, are somewhat healthier and less energy-dense compared with others.

Sociodemographic characteristics were used as independent variables. They were selected in light of the findings from previous studies (Sarmugam, Worsley & Wang, 2013; Mestral *et al.*, 2017; Miyagawa *et al.*, 2018; Souza, Lima & Horta, 2019). Age was categorised into six categories (18-24, 25-34, 35-44, 35-54, 55-64, and ≥65 years), while monthly individual income [in Ringgit Malaysia (RM)] was grouped into five categories (≤RM999, RM1000-1999, RM2000-2999, RM3000-3999, and ≥RM4000). Education level was categorised as no formal, primary, secondary, and tertiary. Ethnic variable was categorised into four groups [Malay, Chinese, Indian, and other ethnicities (Others)]. Employment status was grouped into employed and unemployed (e.g., retirees, housewives and students). Marital status comprised three categories: married, divorced/widowed, and single. Household locality was categorised as urban and rural areas.

Statistical analyses

A total of 1046 respondents were used for statistical analyses. The present study used a seemingly unrelated regression (SUR), i.e., a linear system of equations, to analyse consumption of each high-sodium food.[1] The regression was estimated using feasible generalised least squares. In general, consumption models, such as the model developed in the present study, may consist of several equations because consumers may consume a number of related goods in a given period of time. Hence, the errors of equation could be correlated, and the use of ordinary least-squares linear regression to estimate each equation separately was inappropriate because it assumed that the errors were independent of one another. As such, a SUR that allowed errors in all the equations to be correlated must be used for jointly estimating the equations. Given that the present study had five dependent variables (*nasi lemak*, *roti canai*, fried rice, fried noodles, fried vermicelli), there were therefore five equations in the SUR. The residuals between these equations were expected to be correlated. This was because the same unobservable factors, such as health variables, that affected consumption of *nasi lemak*, may also affect consumption of *roti canai*, fried rice, fried noodles, and fried vermicelli. For example, individuals with heart diseases tend to consume less *nasi lemak*, and may also consume less *roti canai*, fried rice, fried noodles, and fried vermicelli than those without heart diseases because they are more aware of their health. Therefore, using a separate linear regression for each dependent variable may seem inappropriate. In order to confirm that the residuals between these five equations were correlated, we computed the correlation matrix of residuals and performed the Breusch-Pagan test of independence. Specifically, Breusch & Pagan (1980) used Lagrange multiplier to test whether residuals of two or more equations were uncorrelated, which was the null hypothesis of the Breusch-Pagan test. The 5% level of significance was selected. The Stata statistical software was used to perform all the analyses.

[1]Stata example dataset: use https://www.stata-press.com/data/r16/auto. Stata command: sureg (price foreign length) (weight foreign length), corr

RESULTS

Results of the Breusch-Pagan test supported the use of SUR as the residuals were significantly correlated with each other. Individuals aged 18-24, 25-34, and 35-44 years consumed 0.442-0.751 and 0.386-1.217 servings more *nasi lemak* and fried rice, respectively, than those aged ≥65 years. Having secondary level education instead of tertiary level education increased the consumption of *nasi lemak* and fried noodles by 0.279 and 0.164 servings, respectively. Males consumed 0.264, 0.760, and 0.132 servings more *nasi lemak*, *roti canai*, and fried noodles, respectively, relative to females. Chinese and Others (other ethnicities) consumed 0.537-0.676, 0.703-0.738, and 0.376-0.737 servings less *nasi lemak*, *roti canai*, and fried rice, respectively, than Malays. While Indians consumed 0.450 serving less fried rice than Malays, they consumed 0.311 serving more fried vermicelli (Table 1 & 2).

DISCUSSION

Using data from the MyCoSS, we found that age, education level, gender, and ethnicity were significantly associated with the consumption of high-sodium foods. Surprisingly, however, there were no income, employment status, marital status, and household locality differences in the consumption of high-sodium foods. This implied that not all sociodemographic factors play an important role in affecting the decisions of people to consume high-sodium foods.

Findings of the present study showed that younger individuals consumed more high-sodium foods than older individuals, which lent support to previous studies that age was inversely associated with sodium intake (Sarmugam *et al.*, 2013; Souza *et al.*, 2019). Similar findings were also shared by Abdul Aziz *et al.* (2021) and Salleh *et al.* (2021), who found that young adults consumed more sodium compared to the elderly. This is simply because older people are more aware of their health and tend to eat more home-cooked foods than their younger peers (Souza *et al.*, 2019; Abdul Aziz *et al.*, 2021; Salleh *et al.*, 2021).

As past studies suggested, education improves health awareness and socio-economic status, thus reducing sodium intake (Mestral *et al.*, 2017; Miyagawa *et al.*, 2018). This is especially true if healthy foods are expensive. However, our findings did not show a strong relationship between education level and consumption of high-sodium foods as the differences in consumption between tertiary and primary level education were insignificant. It appeared that only secondary level education was related to an increased consumption of high-sodium foods. However, interestingly, findings of Salleh *et al.* (2021) suggested otherwise; well-educated people consumed more sodium than less educated people because they have less time for cooking and ate more food-away-from-home.

Previous studies have found that men consumed more sodium than women (Meneton *et al.*, 2009; Sarmugam *et al.*, 2013; Souza *et al.*, 2019). Two Malaysian studies also suggested men to have a higher intake of sodium than women (Abdul Aziz *et al.*, 2021; Salleh *et al.*, 2021). Similar finding was evidenced in the present study, which showed that the consumption of high-sodium foods was higher among males than females. A plausible explanation for this outcome is that women are more concerned about their diet compared to men and consequently, more likely to opt for healthy foods (Souza *et al.*, 2019; Abdul Aziz *et al.*, 2021; Salleh *et al.*, 2021). Moreover, men in general, tend to eat more foods than women because of different physical structure (Abdul Aziz *et al.*, 2021).

The present study offered an important finding that there were ethnic differences in the consumption of high-

Table 1. Descriptive statistics of dependent and independent variables (*n*=1046)

Variables	*Mean/Frequency*	*Standard deviation/Percent*
Dependent		
Nasi lemak	0.8	1.5
Roti canai	0.8	1.5
Fried rice	1.0	1.7
Fried noodles	0.5	1.0
Fried vermicelli	0.5	1.0
Independent		
Age (years)		
18-24	77	7.4
25-34	155	14.8
35-44	176	16.8
45-54	215	20.6
55-64	244	23.3
≥65	179	17.1
Income (RM)		
≤999	557	53.3
1000-1999	234	22.4
2000-2999	98	9.4
3000-3999	63	6.0
≥4000	94	9.0
Education		
No formal	96	9.2
Primary	220	21.0
Secondary	502	48.0
Tertiary	228	21.1
Gender		
Male	428	40.9
Female	618	59.1
Ethnicity		
Malay	662	63.3
Chinese	115	11.0
Indian	63	6
Others	206	19.7
Employment		
Employed	549	52.5
Unemployed	497	47.5
Marital status		
Married	760	72.7
Divorced/widowed	153	14.6
Single	133	12.7
Locality		
Urban	433	41.4
Rural	613	58.6

Note: For dependent variables, the values refer to mean and standard deviation. For independent variables, the values refer to frequency and percent.
Source: MyCoSS (IPH, 2019)

Table 2. Estimated SUR models for consumption of *nasi lemak*, *roti canai*, fried rice, fried noodles, and fried vermicelli (*n*=1046)

Variables	*Nasi Lemak*	*Roti canai*	*Fried rice*	*Fried noodles*	*Fried vermicelli*
Constant	0.332	0.649*	0.572	0.348	0.805*
	(0.296)	(0.298)	(0.334)	(0.206)	(0.195)
Age (years)					
18-24	0.751*	0.111	1.217*	0.140	-0.237
	(0.248)	(0.250)	(0.280)	(0.172)	(0.163)
25-34	0.611*	0.270	0.816*	0.139	-0.115
	(0.187)	(0.188)	(0.211)	(0.130)	(0.123)
35-44	0.442*	0.098	0.386*	0.085	-0.050
	(0.174)	(0.175)	(0.197)	(0.121)	(0.115)
45-54	0.201	0.083	0.271	0.045	-0.035
	(0.164)	(0.165)	(0.185)	(0.114)	(0.108)
55-64	0.108	0.004	-0.057	0.039	0.039
	(0.147)	(0.148)	(0.166)	(0.102)	(0.097)
≥65	Ref.	Ref.	Ref.	Ref.	Ref.
Income (RM)					
≤999	-0.189	-0.261	-0.079	-0.164	-0.105
	(0.190)	(0.191)	(0.215)	(0.132)	(0.125)
1000-1999	-0.206	-0.213	-0.117	-0.186	-0.145
	(0.190)	(0.192)	(0.215)	(0.132)	(0.125)
2000-2999	-0.344	0.021	0.113	-0.101	0.019
	(0.212)	(0.214)	(0.240)	(0.148)	(0.140)
3000-3999	-0.071	-0.142	-0.378	-0.316	-0.190
	(0.235)	(0.237)	(0.266)	(0.164)	(0.155)
≥4000	Ref.	Ref.	Ref.	Ref.	Ref.
Education					
No formal	0.211	-0.068	-0.079	0.136	-0.105
	(0.202)	(0.204)	(0.229)	(0.141)	(0.133)
Primary	0.191	0.026	0.320	0.142	-0.072
	(0.161)	(0.163)	(0.183)	(0.112)	(0.106)
Secondary	0.279*	0.086	0.110	0.164*	-0.057
	(0.127)	(0.128)	(0.144)	(0.089)	(0.084)
Tertiary	Ref.	Ref.	Ref.	Ref.	Ref.
Gender					
Male	0.264*	0.760*	0.116	0.132*	-0.074
	(0.103)	(0.103)	(0.116)	(0.071)	(0.068)
Female	Ref.	Ref.	Ref.	Ref.	Ref.
Ethnicity					
Malay	Ref.	Ref.	Ref.	Ref.	Ref.
Chinese	-0.537*	-0.703*	-0.737*	-0.036	0.072
	(0.147)	(0.148)	(0.166)	(0.102)	(0.097)
Indian	-0.296	-0.242	-0.450*	-0.018	0.311*
	(0.191)	(0.193)	(0.216)	(0.133)	(0.126)
Others	-0.676*	-0.738*	-0.376*	0.369*	-0.078
	(0.118)	(0.119)	(0.133)	(0.102	(0.078)

Table 2. Estimated SUR models for consumption of *nasi lemak*, *roti canai*, fried rice, fried noodles, and fried vermicelli (n=1046) [Cont'd]

Variables	*Nasi Lemak*	*Roti canai*	*Fried rice*	*Fried noodles*	*Fried vermicelli*
Employment					
Employed	0.130	-0.006	-0.119	0.016	0.041
	(0.111)	(0.112)	(0.125)	(0.077)	(0.073)
Unemployed	Ref.	Ref.	Ref.	Ref.	Ref.
Marital status					
Married	0.229	0.148	0.318	0.020	-0.104
	(0.168)	(0.170)	(0.190)	(0.117)	(0.111)
Divorced/widowed	0.113	0.121	0.349	0.125	-0.169
	(0.212)	(0.214)	(0.240)	(0.148)	(0.140)
Single	Ref.	Ref.	Ref.	Ref.	Ref.
Locality					
Urban	0.024	0.003	-0.004	0.010	0.019
	(0.095)	(0.096)	(0.107)	(0.066)	(0.063)
Rural	Ref.	Ref.	Ref.	Ref.	Ref.
Chi-squared[†]	221.988*				

Note: The values refer to Beta coefficients and are interpreted as number of servings consumed in a week. Standard errors are shown in parentheses. Ref. refers to reference category.
*p<0.05
[†]Breusch-Pagan test of independence between the residuals. Since there are five equations in SUR (five dependent variables), five columns for the food items are presented separately.
Source: MyCoSS (IPH, 2019)

sodium foods. The study by Salleh *et al.* (2021) also found ethnic variations in sodium intake because different ethnicities have different dietary practices. Our finding led to a conclusion that cultural factor plays an important role in dietary behaviour. Culture could be seen as a mediator for ethnicity and food consumption. An in-depth qualitative study is therefore needed to supplement a better understanding of the independent effects of culture and ethnicity on the demand for high-sodium foods.

Although an evaluation of food policy is not within the scope of the present study, some policy implications of our findings are noteworthy. Firstly, an intervention measure aimed at reducing the consumption of high-sodium foods could pay special attention to young adults with a focus on those aged 18-44 years. Secondly, while educating people about the adverse effects of excessive intake of sodium is mandatory, the government must bear in mind that having considerable knowledge may not be able to reduce one's consumption of high-sodium foods. Thirdly, it may be worthwhile for policy makers to make a concerted effort to discourage specific groups, especially men and Malays, from consuming high-sodium foods, especially *nasi lemak* and *roti canai*.

One of the limitations of the present study was that the causal relationships between sociodemographic factors and consumption of high-sodium foods could not be well-identified because of cross-sectional data. Furthermore, some health variables that may affect the consumption of high-sodium foods were omitted from analyses due to data limitation. Moreover, the sample size was not large enough. Otherwise, analysis stratified by ethnic groups could be conducted. Another limitation was that condiments used in cooking

and other food items that have high-sodium content, such as salted fishes and anchovies, were not considered in the present study. Also, there was no complex sample analysis for the SUR. Otherwise, the SUR could be estimated based on three stages of sampling: 1) enumeration blocks; 2) living quarters; 3) members of households.

CONCLUSION

Sociodemographic factors, such as age, education level, gender and ethnicity, are associated with consumption of high-sodium foods. In particular, adults are more likely to consume high-sodium foods if they are younger, less-educated, male or Malay. These sociodemographic differences need to be recognised in policy formulation.

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Authors' contributions

CYK, conceptualisation, funding acquisition, methodology, validation, formal analysis, investigation, writing of original draft, reviewing & editing manuscript, visualisation and supervision; SASN, methodology and validation; KCC, reviewing & editing manuscript; LHK, reviewing & editing manuscript; OMA, methodology and validation.

Conflict of interest

The authors have no competing interests to declare.

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Anaemia and its associated factors among pregnant women in Malaysia

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ABSTRACT

Introduction: Despite remarkable improvement in maternal health, anaemia during pregnancy remains a significant public health threat to Malaysian women. This study aimed to determine the prevalence, severity, and associated factors of anaemia in pregnancy among pregnant mothers in Seremban, Negeri Sembilan. **Methods:** A total of 482 pregnant mothers were recruited using cluster sampling. Data were collected using a validated and pre-tested self-administered questionnaire consisting of four sections, namely socio-demographic and socio-economic details, obstetric history, nutritional factors, and iron supplementation status. In this study, anaemia in pregnancy was defined as haemoglobin (Hb) <11.0 g/dL, which was based on blood test taken during the first trimester. The data were analysed using IBM SPSS version 23.0. Multiple logistic regression analysis was conducted to determine the predictive model for anaemia during pregnancy among the respondents. **Results:** The prevalence of anaemia in pregnancy among the respondents was 22.0%, with 95.3% respondents mildly anaemic. Respondents with an intake of iron supplementation of once daily (AOR=0.191, 95% CI: 0.074-0.914), more than once daily (AOR=0.149, 95%CI: 0.091-0.248), and low intake of seafood (AOR=0.320, 95% CI: 0.187-0.526) were less likely to develop anaemia during pregnancy. **Conclusion:** The findings revealed moderate level of anaemia in pregnancy, which was dominated by those in the mild category, with increased risk predicted among young mothers. Iron supplementation (once daily or more) and low intake of seafood protected mothers from developing anaemia during pregnancy.

Keywords: anaemia, maternal health, pregnancy

INTRODUCTION

Anaemia during pregnancy remains a public health concern globally, particularly in developing countries. It is associated with maternal and foetal adverse outcomes. According to the World Health Organization (WHO, 2001), anaemia is considered to be of a public health significance or problem if the prevalence is 5.0% or higher, while a prevalence of more than 40% in a population is classified by WHO (2008) as a severe public health problem. High prevalence of anaemia has been reported among pregnant women in low- and middle-income countries (LMIC), with the highest in Sub-Saharan Africa (SSA) (57%), followed by Southeast Asia (48%), and lowest prevalence (24.1%) found in South America (WHO, 2008). In general,

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Pasricha & Drakesmith (2016) assumed that 50% of the cases of anaemia are due to iron deficiency, in which WHO (2015) reported iron deficiency anaemia (IDA) being one of the top ten contributors to global burden of disease. Pregnancy is associated with increased iron demand and therefore increases the risk of iron deficiency anaemia.

According to Milman (2008), women who become pregnant require favourable iron status to ensure good well-being of the mother, development of the foetus, and maturity of the newborn infant. In another study, Milman (2015) also reported the various negative impacts of IDA on the foetus and newborn, which include impaired brain development, premature birth, low birth weight for gestational age, and birth complications.

High prevalence of anaemia in pregnancy was previously reported in Malaysia, with 38% of pregnant women having anaemia according to the WHO survey (McLean *et al.*, 2009). Additionally, a frequency of 35% to 42% in Selangor, Johor and Kelantan, respectively, were reported in previous research, in both urban and rural areas (Hassan, Abdullah & Nik Hussain, 2005; Haniff *et al.*, 2007; Thirukkanesh & Zahara, 2010). Furthermore, the prevalence of anaemia was also reported to increase with increasing gestational age, being 12% in the first, 32% in the second, and 43% in the third trimester (Haniff *et al.*, 2007). Meanwhile, in a survey conducted by the Malaysian Institute of Public Health (IPH), a prevalence of 29.3% was reported, with 8.3% of pregnant women aged 15 to 49 years having associated medical conditions (Thirukkanesh & Zahara, 2010). This study aimed to determine the prevalence and associated factors of anaemia among pregnant mothers in Seremban, Negeri Sembilan. Negeri Sembilan was noted to have the highest prevalence of anaemia at 29.7%, compared to all other states in Malaysia in the National Health and Morbidity Survey 2015 (IPH, 2020).

MATERIALS AND METHODS

Study design and sampling

A cross-sectional study was conducted among antenatal mothers in the Seremban district. Cluster sampling was employed to randomly sample five health clinics from a total of 12 in the district of Seremban. Based on the calculated cluster size, which was calculated using the estimated attendance of antenatal women per month of 2504 in the 12 health clinics, the estimated sample size was 548. The inclusion criteria were Malaysian and pregnant women who were 18 years old and above. Those who were known to have thalassaemia, sickle cell anaemia, Southeast Asian ovalocytosis, myeloma, sideroblastic anaemia, aplastic anaemia, anaemia secondary to chronic diseases, chronic kidney disease and hypothyroidism, parasitic infestation causing anaemia, and anaemia of any causes before pregnancy were excluded.

Study instrument

The data were collected using a reliable and validated self-administrated questionnaire with Cronbach's alpha and kappa agreement coefficients ranging between 0.686 and 0.843, respectively. Content and face validity were conducted, with the content of the questionnaire assessed by two expert panel members - a Family Medicine Specialist and a Nutritionist. A pre-test involving 55 respondents (10% of estimated *N*) of similar background was conducted to check for face validity. All changes were addressed accordingly based on inputs given by the expert panelists, as well as the respondents involved in the pre-test. Back-to-back translation was also conducted to ensure accuracy of information in both

the Malay and English versions of the questionnaire.

There were 4 sections in this questionnaire, socio-demographic and socio-economic details, obstetric history, nutritional factors, and iron supplementation status. Anaemia in pregnancy was defined as haemoglobin (Hb) <11.0 g/dL, with mild, moderate and severe anaemia in pregnancy refer to Hb levels of 10.0 to 10.9, 7.0 to 9.9 and <7.0 g/dL respectively (WHO, 2011). Daily nutritional history was collected using a list of animal protein (6 items), vegetables (11 items), fruits (11 items), cereals (8 items), and seafood (6 items), as well as consumption of black tea (1 cup/day, >1 cup/day). All items were measured using a 5-point Likert scale ranging from 0 to 4, in which 0 = never consume, 1 = once monthly, 2 = once weekly, 3 = 2-3 times a day, and 4 = daily intake. As for iron supplementation status, a history related to the frequency of intake, supplier, and method of consumption were also obtained.

Data analysis

Data were analysed using IBM SPSS version 22.0. The cut-off points for high intake of vegetables, fruits, cereals, meat, and seafood were decided based on their mean scores. The association between two categorical data was determined by Chi-square test, and a significant association was taken at $p<0.05$ with 95% CI. Meanwhile, multiple logistic regression was used to determine the predictors for anaemia during pregnancy.

Ethical approval

Approvals were obtained from the Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia, and Ethics Committee of Universiti Putra Malaysia prior to the study. Individual consent was also obtained prior to distribution of questionnaire.

RESULTS

Prevalence of anaemia in pregnancy

The prevalence of anaemia among the respondents is shown in Table 1, with 22% of them having anaemia during pregnancy, of which more than 90% were of mild severity.

Table 1. Prevalence of anaemia in pregnancy among respondents

Characteristics	*n*	*%*
Anaemia status		
No	376	78.0
Yes	106	22.0
Mild	101	95.3
Moderate	4	3.8
Severe	1	0.9

Characteristics of respondents

Meanwhile, the general characteristics of the respondents are shown in Table 2. Mean age of the respondents was 29.8±4.8 years old, which were dominated by Malays (74.4%), those with tertiary education (76.6%), unemployed (56.2%), had a household income of >RM 5000 (31.5%), multigravida (56.4%), in the 3rd trimester of pregnancy (61.4%), singleton foetus (99.6%), no history of antepartum haemorrhage (95.2%) and miscarriages (79.9%), had a child spacing of 2 years or more (57.1%), non-obese (85.3%), and non-smoker (99.8%). Majority of the respondents were also non-vegetarian (99.4%), with low consumption of black tea (97.5%), and taking iron supplementation (88.8%) on a daily basis (79.4%) with plain water or fruit juices (98.4%).

Factors associated with anaemia in pregnancy

Significant associations ($p<0.05$) were found between anaemia and maternal education, gravidity, pregnancy trimester, child spacing, seafood intake, intake of iron supplementation, frequency

Table 2. Characteristics of the respondents

Characteristics	*n*	%
Sociodemographic factors		
Age (Years) [mean±*SD*]	29.8±4.8	
Ethnicity		
Malay	360	74.7
Chinese	57	11.8
Indian	57	11.8
Others	8	1.7
Residential area		
Urban	239	49.6
Rural	243	50.4
Maternal education		
Primary	14	2.9
Secondary	99	20.5
Tertiary	369	76.6
Maternal employment status		
Employed	271	43.8
Unemployed	211	56.2
Household income		
< RM 1000	2	0.4
RM 1000 – RM1999	56	11.6
RM 2000 – RM2999	92	19.1
RM 3000 – RM3999	106	22.0
RM 4000 – RM4999	74	15.4
> RM 5000	152	31.5
Marital status		
Married	476	98.8
Unmarried	6	1.2
Obstetric history		
Gravidity		
Primigravida	158	32.8
Multigravida	272	56.4
Grand-multigravida	52	10.8
Pregnancy trimester		
1st trimester	17	3.5
2nd trimester	169	35.1
3rd trimester	296	61.4
Number of foetus		
Singleton	480	99.6
Twins or more	2	0.4
History of antepartum haemorrhage (APH)		
Yes	23	4.8
No	459	95.2
History of miscarriages		
Yes	97	20.1
No	385	79.9
Child spacing (years)†		
< 2 years	139	42.9
≥ 2 years	185	57.1

Table 2. Characteristics of the respondents [Cont'd]

Characteristics	*n*	*%*
Co-morbidities history		
Obesity status		
Obese	71	14.7
Non-obese	411	85.3
Smoking status		
No	481	99.8
Yes	1	0.2
Nutritional status		
Vegetarian		
Yes	3	0.6
No	479	99.4
Vegetables intake		
High intake (≥mean score 18.01)	229	47.5
Low intake (<mean score 18.01)	253	52.5
Fruits intake		
High intake (≥mean score 20.82)	243	50.4
Low intake (<mean score 20.82)	239	49.6
Cereals intake		
High intake (≥mean score 7.95)	215	44.5
Low intake (<mean score 7.95)	267	55.5
Meat intake		
High intake (≥mean score 10.10)	209	43.4
Low intake (<mean score 10.10)	273	56.6
Seafood intake		
High intake (≥mean score 11.20)	232	48.1
Low intake (<mean score 11.20)	250	51.9
Black tea		
≤1 cup a day	470	97.5
>1 cup a day	12	2.5
Iron supplementation history		
Intake of iron supplementation		
Yes	428	88.8
No	54	11.2
Frequency of intake (*n*=428)		
Daily	340	79.4
Twice a day	67	15.7
Thrice a day	5	1.2
Every other day	7	1.6
Weekly	9	2.1
Method of consumption (*n*=428)		
With plain water or fruit juices	421	98.4
Other beverages (e.g. milk, carbonated drinks, caffeinated drinks and cordial)	7	1.6

[†]Not applicable for 158 respondents who were primigravida

of intake, and consumption methods (Table 3).

Predictors of anaemia in pregnancy

Table 4 shows the factors that predicted anaemia in pregnancy. The risk of anaemia in pregnancy was found to be 2.9 times higher among young mothers aged <20 years old (AOR=2.941, 95% CI: 0.404-12.316). Meanwhile, pregnant women with an intake of iron supplementation of once daily (AOR=0.191, 95% CI:0.074-0.914), more than once daily (AOR=0.149, 95%CI: 0.091-0.248), and low intake of seafood (AOR=0.320, 95% CI: 0.187-0.526) were less likely to develop anaemia during pregnancy.

DISCUSSION

Severe anaemia in pregnancy among women in Malaysia had been previously reported in other studies, with prevalence

Table 3. Factors associated with anaemia in pregnancy

Characteristics	*Anaemia in pregnancy*		*Statistical findings*		
	Yes n (%)	*No n (%)*	*χ^2/ Fisher exact test*	*df*	*p-value*
Maternal education			11.889	1	0.003
Primary	4(28.6)	10(71.4)			
Secondary	34((34.3)	65(65.7)			
Tertiary	68(18.4)	301(81.6)			
Gravidity			6.510	2	0.039
Primigravida	28(17.7)	130(82.3)			
Multigravida	60(22.1)	212(77.9)			
Grand-multigravida	18(34.5)	34(65.4)			
Pregnancy trimester			10.752	2	0.005
1st Trimester	4(23.5)	13(76.5)			
2nd Trimester	23(13.6)	146(86.4)			
3rd Trimester	79(26.7)	217(73.3)			
Child spacing (years)			6.589	2	0.037
≥ 2years	52(28.1)	133(81.3)			
< 2years	26(18.7)	113(81.3)			
Not applicable	28(17.7)	130(82.3)			
Seafood intake			16.542	1	<0.001
High (≥mean score 11.2)	70(30.2)	162(69.8)			
Low (<mean score 11.2)	36(14.4)	214(85.6)			
Intake of iron supplementation			7.540	1	0.006
Yes	102(23.8)	326(76.2)			
No	4(7.4)	50(92.6)			
Intake frequency (*n*=428)			48.523	2	<0.001
Less than once daily	4(25.0)	12(75.0)			
Daily	58(17.1)	282(82.9)			
More than once daily	40(55.6)	32(44.4)			
Consumption method (*n*=428)					0.218†
Plain water and fresh juice	99(23.5)	322(76.5)			
Others	3(42.9)	4(57.1)			

†Fisher's exact test

Table 4. Predictors of anaemia in pregnancy

Characteristics	*β*	*SE*	*Wald*	*p-value*	*AOR*	*95% CI*	
						Lower	*upper*
Maternal age							
<20years	1.079	0.921	1.372	0.024*	2.941	0.404	12.316
20-34years	-0.391	0.921	1.158	0.282	0.676	0.084	1.558
≥35years (ref)							
Iron supplement intake frequency							
>once daily	-1.905	0.331	33.14	<0.001**	0.149	0.091	0.248
Once daily	-1.655	0.731	5.124	0.024*	0.191	0.074	0.914
<once daily (ref)							
Seafood intake							
Low intake	-1.140	0.319	12.79	<0.001**	0.320	0.187	0.526
High intake (ref)							
Period of amenorrhea†							
Constant	1.436	0.876	2.876	0.101	4.204		

*Significant at $p<0.05$
**Significant at $p<0.001$
†Period of amenorrhea was controlled as confounder
Nagelkerke R square value=0.281

ranging between 38 to 43.8 percent (Tee *et al.*, 1984; Ahmad *et al.*, 1997; Thaneemali & Jamiyah, 2005; Mclean *et al.*, 2009; Milman, 2015). In comparison with the present study, a slightly higher prevalence of 29.3% was also reported in the National Health and Morbidity Survey (NHMS) 2015 (IPH, 2015). Although this study showed a lower prevalence of anaemia in pregnancy among the antenatal mothers who participated in this study, generalisation of this finding among antenatal mothers in Malaysia must be done with caution in view of the potential unequal chance for all eligible respondents to be selected for the study due to the use of cluster sampling.

Based on the WHO (2011) classification of public health importance, the prevalence of anaemia during pregnancy in this study was considered as moderate and was dominated by those of mild severity. However, the mild level of anaemia among majority of the respondents may be related to iron supplementation, which was evident by the high proportion of respondents being prescribed this supplement during the conduct of this study, indicating underlying IDA as a potential cause. Anaemia in pregnancy is frequently reported among women in developing countries, indicating inadequate pre-existing iron stores and insufficient physiological adaptations to pregnancy to meet increased requirements (Osungbade & Oladunjoye, 2012).

According to a review by Santoyo-Sánchez *et al.* (2015), regardless of age, iron intake requirements reach a peak in pregnant women at 27mg/day, with iron deficiency being the most frequent cause of anaemia in women of reproductive age and pregnant women (Milman, 2015). IDA during pregnancy is reported to be associated with impaired brain development of the foetus or newborn, premature birth, a low birth weight for gestational age, and birth complications (Milman, 2015).

Anaemia in pregnancy remains a significant public health problem, particularly issues related to compliance towards iron supplementation and awareness related to its potential detrimental impacts. Oral iron supplementation is cheap, safe, and effective at correcting IDA, which is the second most common cause of anaemia during pregnancy, after physiologic anaemia of pregnancy. However, iron supplement may not be tolerated by some patients, which probably explains the once daily intake among most respondents in the current study.

The higher burden of anaemia in developing countries, particularly among women of reproductive age and children, are mainly related to malnutrition and low bioavailability of micronutrients commonly resulting from poor dietary habits and inadequate intake of foods rich in micronutrients, such as fresh fruits and vegetables (Ghose & Yaya, 2018). According to the WHO recommendations, fruits and vegetables intake of ≥5 servings/day is considered adequate, with anything less as inadequate (Ghose & Yaya, 2018). Compared to women who consumed at least five servings of fruits and vegetables, those who consumed less than five servings of fruits and vegetables had higher odds of suffering from severe and moderate anaemia (Ghose & Yaya, 2018). Despite the important role of dietary intake of fruits and vegetables in the prevention of anaemia, a non-significant relationship was demonstrated in this study with minimal differences observed between those with low and high intake of fruits and vegetables.

The finding of this study also reflected the role of teenage pregnancies or being pregnant at a younger age of <20 years old on the risk of developing anaemia in pregnancy. The association between young age and development of anaemia in pregnancy had been reflected by the high prevalence of anaemia in pregnancy among teenage mothers in previous research. A very high prevalence of 53.1% (95% CI: 46.0, 60.0) was reported in a local study conducted by Nazirah, Tengku Alina & Aziah (2015) in Northwestern Malaysia. The study found that gestational age at booking was strongly associated with anaemia among teenage pregnancy, in which late bookers had 16 times higher odds of getting anaemia compared to early bookers (AOR=16.33; 95% CI: 6.51–40.99). This is because the risk of anaemia in pregnancy increases with the progression of pregnancy. Furthermore, a study involving 458 pregnant adolescents with a mean age of 16 years old in Brazil by Pinho-Pompeu *et al.* (2017) reported a prevalence of 41.27%, which was significantly associated with preterm labour (p=0.003), gestational age at birth of <37 weeks (p=0.036), and stillbirth (p=0.004). Similarly, another study in Western Jamaica reported that younger mothers aged 18 to 24 years old were more likely to be anaemic compared to those ≥35 years old (odds ratio: 3.44; 95% CI: 1.07–11.06) (Wright *et al.*, 2017).

Meanwhile, the findings of this study also revealed that daily or more iron supplementation and low intake of seafood were protective towards anaemia during pregnancy. However, a systematic review on prophylactic iron supplementation in pregnancy concluded many arguments regarding its impact on maternal and infant outcomes (Friedrisch & Friedrisch, 2017). The review suggested considering other factors such as culture, geography, social and economic status, lifestyle, nutritional status, and all issues that determine health conditions in pregnancy and infancy in order to clarify the real impact of prophylactic iron

supplementation during pregnancy, especially in developing countries (Friedrisch & Friedrisch, 2017). Oral iron is an effective, cheap and safe way to replace iron store, with ferrous salts being preferred to ferric salts due to the poorer absorption and bioavailability of the latter (Nagpal & Choudhury, 2004). The National Guidelines in Malaysia recommends iron supplementation of 100 mg/day for pregnant women and the Malaysian Perinatal Care Manual advocates 100 mg elemental iron/day for prophylaxis in pregnant women (Milman, 2015). However, more recent studies have suggested some advantages from lower doses or intermittent supplementation (Pena-Rosas *et al.,* 2015), with better absorption reported with intake of 40-80 mg once a day or alternate days and avoiding twice daily dosing among iron depleted young non-pregnant women (Moretti *et al.,* 2015). Higher doses potentially increase side effects due to excess unabsorbed iron remaining in the gastrointestinal tract (Pavord *et al.,* 2020).

Contrary to the findings from this study, the protective effect of seafood, such as fish, on the development of anaemia during pregnancy has been reported in a previous study. In a related study by Anlaakuu & Anto (2017) among antenatal attendants at the Sunyani Municipal Hospital, Ghana, they reported that consumption of fish/snails was found to be significantly associated with anaemia among pregnant women. Pregnant women who consumed fish or snails regularly were less likely to become anaemic compared to those who never consumed fish or snails (Anlaakuu & Anto, 2017). Although intake of red meat, particularly beef and liver, has been frequently reported as a good source of iron-rich food, it is also linked with the development of cancer, diabetes, cardiovascular diseases, and an increased risk of premature death in adults (Agarwal, 2013). Hence, intake of seafood, such as fish and shellfish as an alternative iron-rich food should be considered. The non-significant association between intake of meat and anaemia in pregnancy may be related to the significantly higher proportion of those without anaemia.

Additionally, it is crucially important to have knowledge on the enhancers and inhibitors of iron absorption, such as ascorbic acid, which can significantly increase iron absorption, as well as phytate and calcium that may inhibit iron absorption (Shah *et al.,* 2003). However, many studies on the relationship between iron absorption and intake of certain types of drinks have been mainly conducted among children, with iron being well absorbed from a meal that includes either orange or apple juice (Shah *et al.,* 2003). At risk individuals who are being prescribed with iron supplementation either for prevention or treatment of anaemia should be consulted on its effective consumption methods.

CONCLUSION

The moderately high prevalence of anaemia during pregnancy in this study suggested its role as an ongoing public health concern among pregnant women in Malaysia. Education and awareness on the detrimental impacts of anaemia on pregnant mothers and the foetus, as well as the protective role of an iron-rich diet, such as seafood, in replacement of red meat and iron supplementation are crucial, with special attention on young pregnant mothers urgently needed.

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Authors' contributions

HSM, principal investigator, conceptualised and designed the study, prepared the draft of the manuscript and reviewed the manuscript; PT, led the data collection and analysis, and assisted in drafting of the manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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Evaluation of *in vitro* lipid-lowering properties of 'Saba' banana [*Musa acuminata x balbisiana* (BBB group) 'Saba'] peel pectin from different extraction methods

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ABSTRACT

Introduction: This study was conducted to investigate the *in-vitro* lipid-lowering properties of 'Saba' banana peel pectin (SBP) extracted using three methods for its possible use as a dietary fibre ingredient. **Methods:** Pectin from 'Saba' banana peels were extracted using acid extraction (citric acid), enzymatic extraction (cellulase), and microwave-assisted extraction. *In-vitro* lipid-lowering assays were performed using spectrophotometry for pancreatic lipase inhibition and cholesterol binding, while liquid chromatography was used for bile acid-binding capacity. **Results:** Results revealed that all SBPs were not able to inhibit pancreatic lipase activity. However, all SBPs can notably bind to cholesterol and bile acids, taurocholate, and glycocholate. Acid-extracted pectin had the highest binding capacity to cholesterol (51.36%–55.07%) and glycocholate (27.37%), whereas all SBPs were similarly bound to taurocholate. **Conclusion:** The results of this study showed that acid-extracted SBPs can significantly bind to cholesterol and bile acids, glycocholate and taurocholate, thereby indicating a possible reduction in lipid metabolism.

Keywords: bile acid binding capacity, cholesterol-binding capacity, pancreatic lipase inhibition, pectin, saba

INTRODUCTION

Obesity and weight gain in this generation has become a global concern. According to the World Health Organization (WHO), the prevalence of overweight was 22.3%, while obesity was 4.7% in the Philippines in 2016. These may lead to the development of non-communicable diseases, such as diabetes and cardiovascular problems. Drugs have been developed to treat obesity, but some were withdrawn from the market because of various side effects (Kang & Park, 2012).

There is immense interest in the field of 'natural' products, such as dietary fibres, for the prevention of obesity and weight gain. Dietary fibre has been

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known to reduce the absorption of fat and produce a feeling of satiety, thereby reducing caloric intake (Bordicchia *et al.*, 2014).

Pectin is a soluble fibre that has a wide function as a food ingredient. Its lipid-lowering activities and possible mechanisms had also been studied. Pectin influences satiety because of its high viscosity and ability to form gels in aqueous environments. Its action on pancreatic lipase and binding of bile acid and cholesterol has been shown, thus lowering absorbed fats and increasing cholesterol and fat in faecal excretion (Adam, 2015).

Commercial pectin powders are sourced from citrus and apple pomace. In the Philippines, 'Saba' banana peel was found to be a good source. It has high pectin content and a relatively high yield (Castillo-Israel *et al.*, 2015).

'Saba' banana is second in terms of varietal production in the country, contributing to 28.2% of total banana production during the second quarter of 2020 according to the Philippine Statistics Authority. 'Saba' banana is utilised for domestic consumption and processed into chips and catsup. Banana peels constitute around 40% of the banana fruit, which is discarded as waste. This study focuses on the use of 'Saba' banana peel pectin as a natural lipid-lowering agent. As one of the many stabilisers used in the food industry, pectin can have more advantages over others because of its potential lipid-lowering property, contributing to possible actions against obesity and weight gain.

This study evaluated the *in-vitro* lipid-lowering properties of pectin extracted from 'Saba' banana peel wastes for its possible use as a dietary fibre ingredient. Specifically, it aimed to evaluate and compare pectin from 'Saba' banana peels extracted by acid (citric acid), enzyme (cellulase), and microwave in terms of *in-vitro* lipid-lowering properties, such as pancreatic lipase inhibition, cholesterol-binding capacity, and bile acid-binding capacity.

The study was only limited to the three indicators of lipid-lowering mentioned. In the bile acid binding assays, only two bile acids were used, namely sodium taurocholate and sodium glycocholate. The pectins were not subjected to *in vitro* digestion prior to analyses of the lipid-lowering properties. The pectins were extracted from unripe 'Saba' banana peels generated from a banana chips processing plant where the unripe form was used.

MATERIALS AND METHODS

'Saba' banana peel pectin extraction

Preparation of 'Saba' banana peel powder followed the methods of Castillo-Israel *et al.* (2015). Peels of green mature unripe 'Saba' banana were sliced into approximately 2 x 2 cm pieces and soaked in 0.05% sodium metabisulfite for 1 hour. The peels were oven-dried at 55°C for 24 hours, cooled at ambient temperature, and ground into flour until it can pass through a no. 80 mesh, then stored in polyethylene bags.

Acid extraction

Ten grams of the dried 'Saba' banana peels were mixed with 250 mL distilled water, and 0.50 N hydrochloric acid (HCl) was added until pH of 1.5 was reached. The mixture was heated with continuous stirring at 90±5°C in a stirring hot plate for 4 hours. The solution was filtered using a 1-mm mesh screen with two layers of cheesecloth. The filtrate was added with absolute ethanol at 1:2 (v/v). The precipitate was filtered through a miracloth. The collected residue (pectin) was washed with aqueous ethanol (75%), followed by absolute ethanol, then oven-dried for 5 hours at 50°C.

Enzymatic extraction
The powder was swelled using distilled water (8.0 mL/g 'Saba' banana peel powder) at room temperature. For the enzyme solution, cellulase, with an initial concentration of 200 to 400 U/mL was used to extract pectin. One hundred mL of the enzyme was diluted with 50 mL distilled water. Then, 100 mL of the diluted sample was added with distilled water to a final volume of 600 mL to make the enzyme solution.

Extraction of pectin
Enzyme solution was added to the swollen sample at 8.0 mL/g peel powder and extracted at 41–50°C for 3 hours. The solution was filtered using cheesecloth, then the filtrate was collected and weighed. The filtrate was heated to 50°C for 1 hour to deactivate the enzyme. Pectin was precipitated by slowly adding absolute ethanol to the filtrate at a ratio of 1:2 (v/v) with stirring for 1 hour. After standing, the precipitate was washed with 95% ethanol. Pectin was then collected and oven-dried at 50°C for 5 hours.

Microwave-assisted extraction
'Saba' banana peel powder was weighed and placed in a 250-mL beaker. Diluted HCl solution with pH 3.0 was added to the powder in a solid-liquid ratio of 8.0%. The mixture was then placed in a rotating disc of the microwave digester (Ethos UP, High-Performance Microwave Digestion System, Torre Boldone, Italy) and heated to 195°C for 60 seconds. Microwave power was set at 1,000 W. The mixture was cooled to room temperature and filtered using a Grade 1 qualitative filter paper (11 μm). The filtered extract was slowly added with an equal volume of 95% (v/v) ethanol with continuous mixing. The mixture was allowed to stand for 2 hours at 4°C. The coagulated pectin mass was filtered and washed twice with 95% (v/v) ethanol. The residue was oven-dried at 40°C until constant weight.

Pectin yield
Pectin yield was calculated for each extraction method using the formula:

$$\text{Pectin yield (\%), dry basis} = P/Bi \times 100$$

Where, P = extracted pectin, g
Bi = weight of alcohol-insoluble-residue, g

***In-vitro* assays for the lipid-lowering activity of pectin**
All sample preparations were done at the Institute of Food Science and Technology, University of the Philippines Los Baños (UPLB), while analyses were done at the Institute of Chemistry, UPLB. All chemicals and reagents were analytical reagent grade and purchased from Thermo Fisher Scientific, USA.

Pancreatic lipase inhibition assay
Methods of Chedda *et al.* (2016) with modifications were used.

Sample preparation
Pectin powders (0.05 g) from different extraction methods were dissolved in 30 mL 100 mM phosphate buffer with pH of 7.2 in a 50-mL beaker. The pectin solution was heated to 50°C with continuous stirring for 30 minutes. After heating, the pectin solution was transferred to a 50-mL volumetric flask and added with 100 mM phosphate buffer to a volume of 50 mL. This served as the stock solution (1000 μg/mL). Concentrations of 20, 40, and 60 μg/mL were prepared from the stock solution.

The positive controls were commercial citrus pectin and Orlistat. Exactly 0.05 g of citrus pectin was dissolved in 50 mL 100 mM phosphate buffer as the stock solution. For the Orlistat, 0.05 g was dissolved in 50 mL dimethyl sulfoxide (DMSO).

Buffer solution
100 mM phosphate buffer was prepared with 0.5% (v/v) of Triton-X-100. The solution pH was adjusted to 7.2.

Enzyme solution
The porcine pancreatic lipase enzyme solution was prepared by dissolving 6 mg porcine pancreatic lipase in 10 mL 100 mM phosphate buffer by gentle vortexing.

Substrate solution
The substrate used was *p*-nitrophenylbutyrate (PNPB). PNPB working solution was prepared using 8.493 µL of PNPB. The solution was made up to 10 mL with acetonitrile.

In-vitro pancreatic lipase inhibition assay
The total assay volume was 200 µL. Approximately 25 µL of test solution or positive control was added with 50 µL of the enzyme solution, 100 µL of the buffer solution, and 25 µL of PNPB solution in a 96-well microplate and mixed thoroughly. Blank was made by substituting the test solution with 100 mM phosphate buffer. The reaction was allowed to stand for 30 minutes at 37°C. Lipase activity was determined by measuring the hydrolysis of PNPB to *p*-nitrophenol at 400 nm using a microplate plate reader (Multiskan™ GO, Waltham, MA, USA). Percent inhibition was calculated using the formula:

$$\% \text{ inhibition} = \frac{|\text{Absorbance of blank} - \text{absorbance of test}|}{\text{Absorbance of blank}} \times 100$$

Cholesterol-binding capacity
Methods of Boungoura, Wenshui & Jiali (2009) were employed with modifications.

Sample preparation
Pectin powders (0.05 g) from different extraction methods were dissolved in 30 mL 15 mM phosphate buffer with pH of 7.4 in a 50-mL beaker. The pectin solution was heated to 50°C with continuous stirring for 30 minutes. After heating, the pectin solution was transferred to a 50-mL volumetric flask and added with 15 mM phosphate buffer to a volume of 50 mL. This pectin solution (1000 µg/mL) was used as the stock solution from which 20, 40, 60, 80, and 100 µg/mL were prepared.

The positive controls were commercial citrus pectin and cholestyramine. Citrus pectin (0.05 g) and cholestyramine (0.05 g) were dissolved in 50 mL 15 mM phosphate buffer as the stock solution.

Cholesterol micellar solution
Reagents used were analytical grade bought from Sigma-Aldrich (St. Louis, MO, USA). Cholesterol micellar solution containing 10 mM sodium taurocholate, 0.4 mM cholesterol, 1 mM oleic acid, 132 mM NaCl, and 15 mM phosphate buffer (pH 7.4) was sonicated for 20 minutes.

In-vitro cholesterol micellar solubility inhibition assay
Approximately 450 µL of the cholesterol micellar solution was added with 450 µL of sample. The solutions were incubated at 37°C for 24 hours. Then, the solutions were centrifuged for 10 minutes. The supernatant was collected and used for cholesterol concentration determination.

From the supernatant, 80 µL of each sample was pipetted into a 96-well microplate. Then, 100 µL of glacial acetic acid was added, followed by 120 µL Zak's reagent and mixed thoroughly. For the control, 80 µL of cholesterol micellar solution was added instead of the sample. The solution was further incubated for 15 minutes at room temperature, and absorbance was measured at 560 nm using a microplate reader.

Standard calibration curve
Cholesterol standards in glacial acetic acid with the following concentrations: 20, 25, 30, 35, 40, and 45 µg/mL were

prepared and absorbance was read at 560 nm.

Bile acid binding assay

Bile acid binding was performed according to the methods of Kongo-Dia-Moukala *et al.* (2011) with modifications.

Sample preparation

Pectin powders (0.002 g) from different extraction methods were dissolved in 60 mL 50 mM phosphate buffer with pH of 6.5 in a 50-mL beaker. The pectin solutions were heated to 50°C with continuous stirring for 30 minutes. After heating, the pectin solutions were transferred to a 100-mL volumetric flask and added with 50 mM phosphate buffer to a volume of 100 mL. The positive controls used were commercial citrus pectin and cholestyramine. Positive controls were prepared by dissolving 0.002 g of the powder in 100 mL 50 mM phosphate buffer.

Bile acid solution

The bile acids used for this assay were sodium taurocholate and sodium glycocholate. Two millimolar of each bile acid was prepared in 50 mM phosphate buffer of pH 6.5. The control that was used to calculate bound bile acid was 2 mM bile acid without sample.

In-vitro bile acid binding assay

Solutions of 1 mL of 2 mM bile acid solution and 1 mL of each sample were prepared. The solution was incubated for 1 hour at 37°C in an oven incubator. The solution was centrifuged for 20 minutes. The supernatant was collected, filtered with a 0.45-micron filter, and transferred into UPLC vials. After the reaction, unbound taurocholate and glycocholate were measured using Ultra Performance Liquid Chromatographic (UPLC) with a BEH C18 column (2.1 x 50mm, 1.7 µm) (ACQUITY H Class UPLC System, Prague, Czech Republic).

Standard calibration curve

Bile acid solutions with the following concentrations: 0, 0.4, 0.8, 1.2, 1.6, and 2.0 mM were prepared. Peak area at 210 nm was recorded using UPLC. Assays using taurocholate and glycocholate were performed in separate experiments.

Ultra-Performance Liquid Chromatography (UPLC)

Three injections of 3 µL of the sample supernatant or bile acid standard (sodium taurocholate or sodium glycocholate) were injected into the UPLC. The sample was eluted with methanol: 0.4% KH_2PO_4 (65:35) at a flow rate of 0.15 mL/min for three minutes. Peak area at 210 nm was recorded and used to calculate the concentration of unbound bile acids. The concentration of unbound bile acids was calculated from the standard calibration curve. Percent bound bile acids were calculated:

$$\% \text{ bound bile acid} = \frac{Cc\text{-}Cs}{Cc} \times 100,$$

where C_c = concentration of bile acid in control

C_s = concentration of bile acid in the samples

Statistical analysis

All data obtained were expressed in mean±standard deviation (*SD*) and were subjected to one-way analysis of variance (ANOVA) at $p \leq 0.05$, followed by Tukey's Honest Significant Difference (HSD) test at $p \leq 0.05$. Statistical analyses were performed using SPSS Version 25.0 (SPSS, Chicago, IL, USA).

RESULTS

Acid extraction of pectin produced the highest yield at 20.02%, followed by microwave-assisted extraction (14.22%), while enzymatic extraction had the lowest yield (6.18%). All pectins were fine powders and of the same brown

colour (Figure 1) with a distinct smell after drying and grinding, which was similar to pectins extracted using acids by Castillo-Israel *et al.* (2015) from 'Saba' banana peel.

The action of 'Saba' banana peel pectin (SBPs) extracted using different methods, citrus pectin (CP), and Orlistat (OS) was investigated using the UV-Visible spectrophotometry method (Chedda *et al.*, 2016). The substrate, *p*-nitrophenylbutyrate, was reacted with porcine pancreatic lipase and pectin at 37°C. The activity of lipase was measured by the absorbance of the hydrolysis product, *p*-nitrophenol, at 400 nm. Pancreatic lipase inhibition was measured by percent difference in absorbance of reaction without pectin.

All SBPs showed lower inhibition compared to CP and OS at all concentration levels (Figure 2). At 20 µg/mL, SBP inhibited lipase activity in the range of 11.43%–14.19%. CP and OS had a peak percent inhibition of 57.52% and 46.10%, respectively, which were not significantly different ($p \leq 0.05$). On the basis of concentration, there was no trend in the inhibition of lipase activity among SBPs. In contrast, the inhibition action of CP and OS were decreasing as concentration increased.

For cholesterol-binding capacity, SBPs were incubated with the cholesterol micellar solution composed of cholesterol, bile acid, fatty acid, and buffer at pH 7.4. Cholesterol-binding capacity was measured by the percent difference of cholesterol concentration from cholesterol micellar solution alone and that incubated with pectin. Generally, the effect of concentration varied among different SBPs, CP, and cholestyramine (CH). For the standard CH, comparable binding was observed at concentrations of 20, 60, 80, and 100 µg/mL, whereas binding was slightly lower at 40 µg/mL (Table 1). For CP, at 60 µg/mL, binding was slightly lower compared to the rest of the concentration levels. For AP, similar binding was observed at 40–80 µg/mL, and slightly lower binding at 20 and 100 µg/mL. For EP, all concentration levels showed no significant difference in binding. Lastly, for MP, slightly lower binding was observed at 40 and 60 µg/mL ($p \leq 0.05$).

The comparison of binding activity among different SBPs, CP, and CH is also shown in Table 1. AP had the highest cholesterol-binding activity (51.36%–55.07%), which was statistically comparable to CP (49.06%–53.02%) and CH (45.65%–52.43%). EP (41.69%–45.82%) and MP (39.93%–45.01%) showed similar binding, but were significantly lower than AP ($p \leq 0.05$). Nevertheless, the binding action of SBPs

Figure 1. Pectin samples extracted from 'Saba' banana peels using various extraction methods. (L-R: acid-extracted, enzyme-extracted, microwave-assisted extracted pectin)

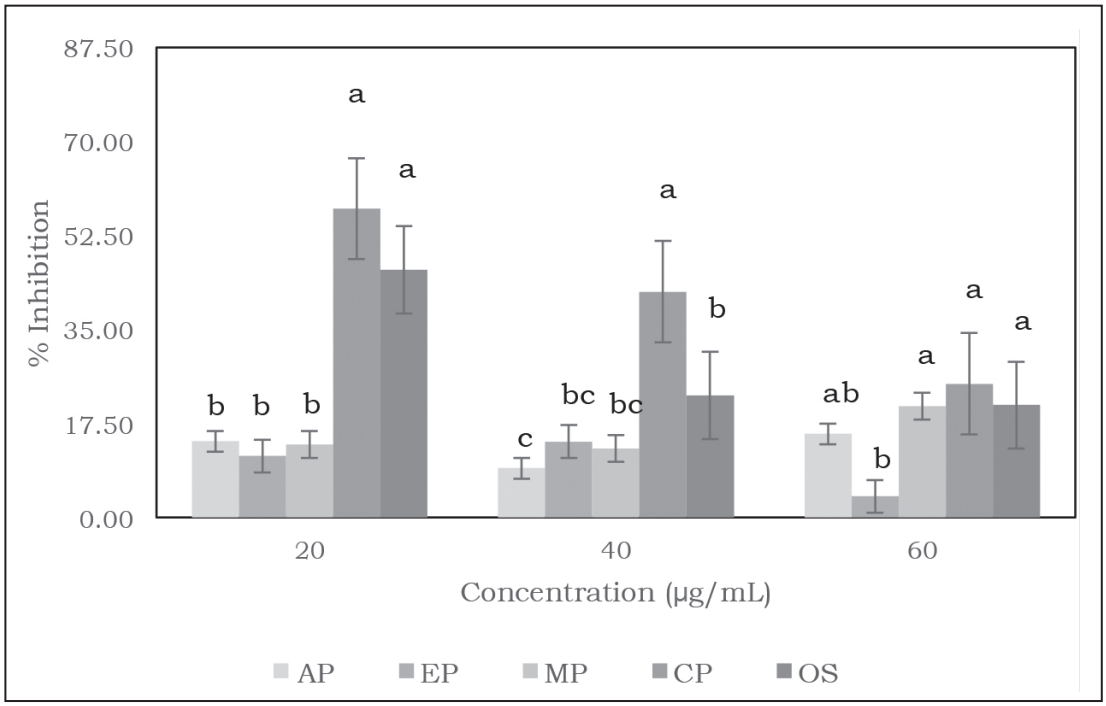

Figure 2. Pancreatic lipase inhibition of 'Saba' banana peel pectin extracted using three different methods. AP=acid extraction; EP=enzymatic extraction; MP=microwave-assisted extraction; CP=commercial citrus pectin; OS=Orlistat

on cholesterol was comparable to CP or CH.

The capacity of SBPs to bind to two bile acids, namely taurocholic and glycocholic acids, in comparison to commercial pectin and cholestyramine was examined. Figure 3 shows that all SBPs, CP, and CH were able to bind bile acids at concentration of 20 µg/mL. Further, taurocholate bound to pectin better than glycocholate. For taurocholate binding, CH had the highest

Table 1. Cholesterol binding capacity of 'Saba' banana peel pectin extracted using different methods at varying concentrations

Samples†	*Cholesterol binding capacity (%)*‡				
	20 µg/*mL*	*40* µg/*mL*	*60* µg/*mL*	*80* µg/*mL*	*100* µg/*mL*
AP	$52.48^{B,a}$±1.10	$53.26^{AB,a}$±1.18	$54.77^{A,a}$±0.93	$55.07^{A,a}$±1.31	$51.36^{B,a}$±1.43
EP	$44.13^{A,b}$±4.98	$41.69^{A,b}$±2.81	$43.28^{A,bc}$±0.65	$45.82^{A,cd}$±1.70	$45.55^{A,b}$±1.28
MP	$45.01^{A,b}$±2.02	$39.93^{B,b}$±1.34	$40.42^{B,c}$±2.15	$41.69^{AB,d}$±2.09	$41.79^{AB,b}$±2.09
CP	$51.16^{AB,ab}$±0.80	$53.02^{A,a}$±1.00	$49.06^{B,abc}$±1.17	$50.04^{AB,b}$±3.61	$49.99^{AB,a}$±1.80
CH	$48.33^{AB,ab}$±6.43	$45.65^{B,ab}$±3.59	$51.65^{AB,ab}$±2.33	$48.82^{AB,bc}$±2.38	$52.43^{A,a}$±2.78

†AP=acid-extracted pectin; EP=enzyme-extracted pectin; MP=microwave-assisted-extracted pectin

‡Means with the same uppercase letter within rows are not significantly different based on Tukey's HSD at 5% level of significance; means with the same lowercase letter within columns are not significantly different based on Tukey's HSD at 5% level of significance

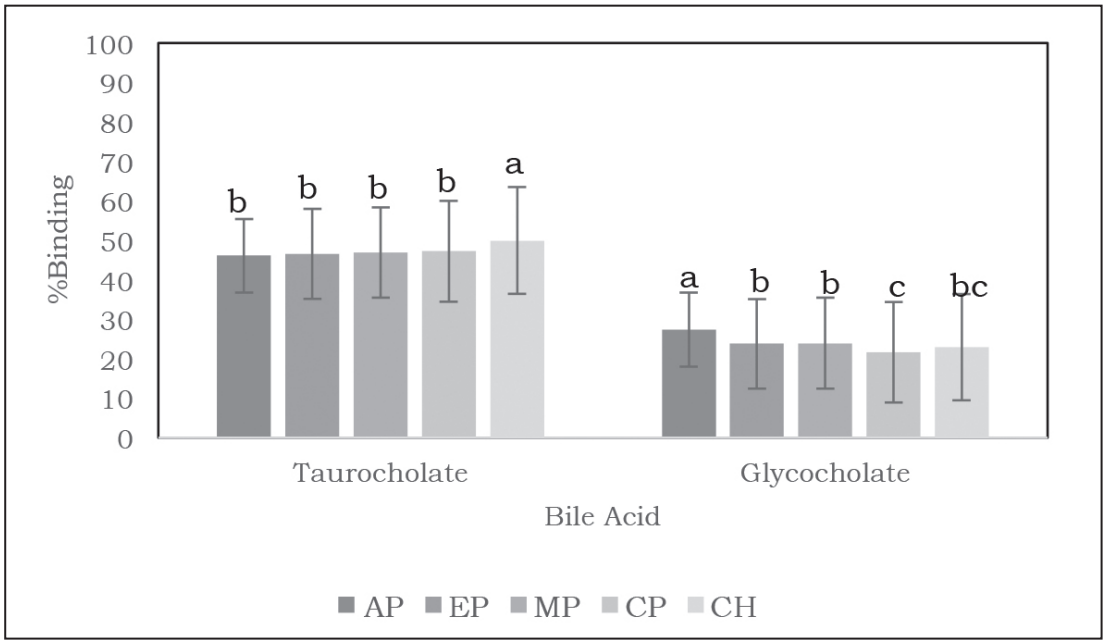

Figure 3. Taurocholate (L) and glycocholate (R) binding of Saba banana peel pectin extracted using three different methods. AP=acid extraction; EP=enzymatic extraction; MP=microwave-assisted extraction; CP=commercial citrus pectin; CH=cholestyramine

binding at 49.95%. All SBPs and CP showed similar binding to taurocholate ($p \leq 0.05$). SBP taurocholate binding was in the range of 46.10%–46.90%, which was not much difference with CH binding. On the other hand, AP had the highest binding capacity to glycocholate at 27.37%. EP, MP, and CH then followed with comparable binding at 23.81%, 23.93%, and 22.95%, respectively. These results suggested that SBP, regardless of extraction methods, could bind effectively to taurocholate and glycocholate, with more affinity of binding to taurocholate.

DISCUSSION

The pectins extracted using different methods were compared in terms of yield and lipid-lowering parameters. Previous research on the extraction of pectin from banana peel using HCl showed 16.54% (Castillo-Israel *et al.,* 2015) and 11% yields (Maneerat *et al.,* 2017). Meanwhile, using citric acid had pectin yields of 14.23% (Oliviera *et al.,* 2015) and 24.08% (Khamsucharit *et al.*, 2018). Microwave-assisted extraction of pectin from banana had previously produced pectin with a 2.58% yield (Swamy & Muthukumarappan, 2017), whereas an enzymatic extraction generated 9.33% (Hui *et al.,* 2013). Thus, acid extraction of pectin from banana peels produced the highest yield compared to other extraction methods. As expected, among the pectins, AP had the highest yield. This is due to the harsh conditions of acid extraction and temperature, which involves hydrolysis of protopectin to pectin and subsequent precipitation by ethanol, that were able to destroy the cell walls and expose the pectins. The milder extraction methods, namely enzyme and microwave-assisted extractions,

were less efficient as shown by the lower yields. These milder extractions require penetration of plant cell walls via microwave radiation or swelling by hydration (Sandarani, 2017). Swelling by water to rupture plant cell walls may not be efficiently completed considering the mild conditions of these extraction methods.

Pancreatic lipase inhibition by all pectins were relatively low compared with commercial pectins and the positive control Orlistat, and was much lesser in this study compared to previous studies. Isaksson *et al.* (1982) reported 65% and 90% lipase inhibition for low and high methoxyl pectin, where lipase inhibition seemed to be less pronounced in buffer systems than when performed in duodenal juice. Tsujita *et al.* (2003) also reported 40%–50% of lipase activity reduction at 1–5 mg/mL level of citrus pectin. A more recent study reported low methoxyl pectin extracted from apple pomace using citric acid to have 94.30% inhibition of lipase activity *in-vitro*. The lipase activity inhibition of pectin was attributed to a competitive mechanism where pectin forms a complex with lipase. The –COOH groups of pectin protonates histidine and possibly the hydroxyl group of serine at the active serine-histidine-aspartic/glutamic acid triad of lipase (Kumar & Chauhan, 2010). Furthermore, the action of pectin on lipase activity inhibition could be enhanced by high molecular weight, viscosity, and purity (Edashige, Murakami & Tsujita, 2008).

Inhibition of lipase activity by pectin is concentration-dependent. However, this study observed no trend in terms of the concentration of pectin and pancreatic lipase inhibition. Pectin levels that are commonly explored are at 0.1 to 5.0 mg/mL (Isaksson *et al.*, 1982; Tsujita *et al.*, 2003; Edashige *et al.*, 2008). Meanwhile, pectin concentrations in this study were only at 20–60 µg/mL, as permitted by the assay (Cheddah *et al.*, 2016). As the concentration used in this study was much lower, this could also be a possible reason for the observed results. This may imply that the mechanism for the possible lipid-lowering action of pectin is not by pancreatic lipase inhibition. Since the extracted SBPs were crude, the actual concentrations of pectin used in the reaction could be lower. Other components in the extracted SBPs could also interfere with the action of pectin as a lipase inhibitor.

Cholesterol-binding capacity results varied with different pectin concentrations. AP had the highest binding with cholesterol, which was comparable with commercial pectins and the positive control cholestyramine. Cholesterol-binding activity of pectin is affected mainly by pectin source and type, which includes degree of esterification and molecular weight. All the pectins in this study had high degree of esterification (>50%), which could be the reason for its high binding with cholesterol, thereby reducing cholesterol absorption by the body. Moreover, the viscosity of pectin also indirectly influences cholesterol binding (Brouns *et al.*, 2012). The concentration of pectin affects its viscosity in solution (Kar & Arslan, 1999), which suggests that increased concentration should correspond to increased viscosity. In this study, concentration effects were not apparent as shown by varying effects among samples. Furthermore, differences in cholesterol-binding capacity between concentrations were minimal. In EP and MP, concentrations as low as 20 µg/mL showed similar binding with the highest concentration, parallel to positive controls AP and CH. AP, on the other hand, had slightly lower binding at 20 and 100 µg/mL. Nevertheless, these slight differences

were still considered as significant binding of pectins to cholesterol, implying that the concentrations utilised in this study were not a substantial factor in the samples' cholesterol-binding capacity.

Studies on cholesterol-lowering capacity of pectin usually investigate the effect on mice, rats, and humans fed with high-cholesterol diets and either taking pectin alone or incorporating it in the subjects' diets. In a study by Soh, Kim & Lee (2003), an *in-vitro* experiment on pectin at a concentration of 0.1% showed that it had the highest absorbance with 2.88 mg/dL capacity (90% of total cholesterol). More recent studies on the cholesterol-lowering action of pectin that focused on *in-vivo* set-ups had proposed possible mechanisms on pectin's cholesterol-lowering action. The action of pectin on cholesterol *in-vivo* is influenced by the degree of esterification, molecular weight, and viscosity. Pectins with a high degree of esterification have shown more reduction of total cholesterol in humans (Brouns *et al.*, 2012). In animal models, highly esterified pectins also showed considerable total cholesterol reduction (Trautwein, Kunath-Rau & Erbersdobler, 1998; Dongowski & Lorenz, 2004). Moreover, pectins with low molecular weight, low viscosity, and high solubility were found to be less effective in lowering total cholesterol (Yamaguchi *et al.*, 1995). However, in this study, AP, which has a relatively intermediate degree of esterification of 51.09% and lower equivalent weight showed greater cholesterol reduction than pectins with high degree of esterification and equivalent weight - EP and MP. This effect could be attributed to the viscosity of AP. Upon dissolving the pectins in a buffer, the AP solution was more viscous than EP and MP. Furthermore, AP has an anhydrourinic acid content of 50.85%, indicating that it had much higher purity than EP and MP. The presence of other molecules could affect the action of pectin on cholesterol binding.

The capacity of SBPs to bind to cholesterol solubilised in cholesterol micellar solubility (CMS) is an important parameter in measuring the lipid-lowering capability of SBPs. CMS created for the assay mimics the micelle, which is composed of bile acids, fatty acids, and monoglycerides that are supposedly liberated from triacylglyceride hydrolysis by lipase and dietary cholesterol (Lehninger, Nelson & Cox, 2008). This study showed significant binding of cholesterol, which prevents it from being soluble in the micelle. These micelles are vital to lipid metabolism because they serve as carriers of both dietary cholesterol and fatty acids for absorption in the intestines. Once cholesterol is not solubilised in the micelle, it forms a separate oil phase in the intestinal lumen and becomes unavailable for absorption (Jesch & Carr, 2017). All extracted SBPs had high degree of esterification (>50%), which supports literatures' claims that they can reduce cholesterol absorption. Pectins with high degree of esterification are related to the chelation of bile acids and eventually increased lumen viscosity, which has also been associated with reducing cholesterol absorption (Brouns *et al.*, 2012).

In the digestive system, one possible mechanism for the cholesterol-lowering property of pectin is the increased lumen viscosity, leading to a reduced rate of glucose diffusion and absorption in the small intestine. This effect consequently causes a decrease in insulin production. Reduced insulin then decreases the activity of 3-hydroxy-3-methylglutaryl CoA enzyme, which is responsible for the synthesis of cholesterol (Celus *et al.*, 2018). However, *in-vitro* results from this study suggested that pectin itself binds to cholesterol by lowering the actual concentration of cholesterol in the micelle solution.

Bile acids are a group of amphiphilic molecules synthesised from cholesterol, which is naturally produced by the body for their role in digestion, transportation, and absorption of dietary lipids in the gastrointestinal tract (Lopez-Pena, Arroyo-Maya & McClements, 2019). Bile acids have a plate-like structure with polar and non-polar sides, which enable them to adsorb to oil-water interfaces (Cabral & Small, 2010). In lipid digestion, bile acids adsorb to the surfaces of lipids in gastrointestinal tract, breaking it down into smaller sizes with greater areas to act upon by lipase (Euston, 2017). Furthermore, bile acids are also an integral part of the micelle that solubilise and transport triglyceride hydrolysis products into the epithelium cells (Lopez-Pena *et al.*, 2019).

All samples had good binding with bile acids at the lowest concentration, 20 ug/mL. All pectins had better binding with taurocholate compared to glycocholate, with values statistically similar to commercial pectins and cholestyramine. Previous *in-vivo* studies confirmed the binding of pectin to cholesterol by the increase in bile acid excretion in the faeces (Dongowksi & Lorenz, 2004; Brouns *et al.*, 2012). An *in-vitro* study also showed the binding of pectin with high molecular weight and low degree of esterification to cholic acid (Rubio-Senent *et al.*, 2015). Binding to bile acids is one possible mechanism in the hypocholesterolemic property of pectins. Increased excretion of bile acid in faeces of subjects fed with pectin indicated that less bile acid was available, thus promoting the conversion of cholesterol to bile acid. This conversion eventually reduces cholesterol levels (Fang *et al.*, 2018).

Pectin molecules are negatively-charged in neutral pH due to their linear anionic regions of galacturonic acids. Similarly, bile acids are also negatively charged. Nevertheless, both molecules have non-polar groups that may interact with each other via hydrophobic forces. For instance, the non-polar region of bile acids may be bound to the non-polar methyl groups of pectin (Lopez-Pena *et al.*, 2019). Aside from hydrophobic interactions, increased bile acid excretion *in-vivo* was associated with gel formation and viscosity effects in the gastrointestinal tract (Dongowski, 2007). Since pectin was incubated with either sodium taurocholate or sodium glycocholate, the results of this study suggested that SBPs were able to bind to bile acid itself without the influence of environmental conditions in the gastrointestinal tract.

This study had demonstrated the possible lipid-lowering mechanisms of pectin and had also compared different extraction methods in terms of the properties of the pectins extracted from 'Saba' banana peels. The pectin samples tested were limited to the crude form, which have already shown positive responses to cholesterol and bile acid binding. Further purification of the samples can possibly show higher lipid-lowering capacities.

CONCLUSION

The possible mechanisms of lipid-lowering action by SBPs were cholesterol and bile acid binding. AP was the most effective in binding cholesterol and bile acids. MP and EP showed similar binding, but were slightly lower than AP. Acid extraction was observed to be the best method, as it resulted in pectin with the highest purity and best lipid-lowering activity, with significant binding to cholesterol, taurocholate, and glycocholate.

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Authors' contributions

EAGM, principal investigator, prepared the research design and methods for the *in vitro* experiment, performed the experiments, analysed the data, and prepared the draft of the manuscript; GPJV, extracted the pectin powder using acid extraction methods and helped in the *in vitro* experiments; RJP, optimised and performed the pectin extraction using microwave-assisted methods; VJC, assisted in the measurement of *in vitro* lipid-lowering activity using ultra high pressure liquid chromatography; TMAO, provided the laboratory space and equipment for the *in vitro* experimentation and reviewed the manuscript; CKAT, project leader, obtained the project funding, conceptualised the entire study, supervised all the activities and reviewed the manuscript.

Conflict of interest

Authors declare no conflict of interest.

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Implications of undernutrition in children with acute lymphoblastic leukaemia during induction therapy – experience from a developing country

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ABSTRACT

Introduction: Undernutrition is an important prognostic factor in children with acute lymphoblastic leukaemia (ALL) and higher incidences of mortality are reported during induction remission in severely undernourished children. This study was conducted to assess the prevalence and implications of malnutrition among ALL children during induction therapy. **Methods:** All children ≤18 years diagnosed and treated for ALL at our institution, between June 2010 to July 2016 were included in this retrospective cohort study. Nutrition was assessed by body mass index-for-age *z*-scores calculated using World Health Organization's Anthro (<5 years) and Anthro-Plus Software (≥5 years). Children with a *z*-score of <-2 standard deviation (*SD*) were classified as undernourished. All events and outcomes were compared between undernourished and adequately nourished children. **Results**: A total of 72 children were included in this study. Nineteen (26.4%) were undernourished at the time of diagnosis. Twenty-eight (38.8%) children had significant weight loss. Sixty-seven of them attained remissions by the end of induction chemotherapy. Five children who died had significant weight loss. Children with significant weight loss during induction phase had a higher risk of developing complications such as febrile neutropenia, pneumonia, mucositis, and drug interruptions. Those with a deteriorating nutritional status had a higher chance of poor treatment outcome (p=0.05, CI=95%). **Conclusion**: It is important to assess and monitor the nutrition status of children and timely nutritional intervention is essential. A simple, cost effective nutritional intervention that will decrease morbidity and mortality associated with the disease must be devised.

Keywords: acute lymphoblastic leukaemia, induction therapy, outcome, undernutrition

INTRODUCTION

The five years survival rate for acute lymphoblastic leukaemia (ALL) is more than 80% in many developed countries, but the cure rate is lower in developing countries. The causes of poorer outcomes in developing countries are multifactorial, and these include limited resources for diagnosis, limited access to treatment, diagnostic delays due to lack

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of awareness, infections, and underlying increased incidence of undernutrition. One of the major issues in improving survival rates of children with ALL in developing countries is the increased rate of mortality during the induction phase, which is again attributed to infections, undernutrition, and poor tolerance to treatment. When compared to developed countries, a higher proportion of children in developing countries have undernutrition at the time of diagnosis and also higher number of high risk patients presenting with advanced disease than low risk patients (Maldonado *et al.*, 2015).

Advanced disease status alters nutritional state, causing protein and micronutrient deficiencies. Poor nutritional status in turn influences the course of disease and survival prospects. Various studies have proven that undernourished children with ALL have poorer clinical outcomes when compared to normally nourished children, due to decreased tolerance to chemotherapy, altered metabolism of chemotherapy drugs, and increased infection rates (Gokcebay *et al.*, 2015).

MATERIALS AND METHODS

This retrospective cohort study was conducted in the Division of Paediatric Hemato Oncology, at Sri Ramachandra Institute of Higher Education and Research, Chennai, India as a part of the Indian Council of Medical Research's (ICMR) Short Term Studentship (STS) programme. Institutional Ethics Committee approval was obtained. Participant's parental consent was also obtained.

All patients, between 1-18 years of age, who were diagnosed with ALL and treated throughout the course of induction therapy at our medical centre were included in the study. Patients above 18 years, those presenting with a relapse, those who have started treatment at another medical facility, and those who have abandoned treatment were excluded.

The study was conducted over a period of two months. The patients' medical records were accessed, and the necessary data were retrieved. These included demographic data, hospital identity, date of diagnosis, risk stratification, and drugs used in induction therapy. The patient's height in centimetres (cm) and weight in kilograms (kg) were noted from the medical records, on day 1 (day of diagnosis), and during every admission. Laboratory records were accessed and the presence of anaemia, hypoalbuminemia, and hypokalaemia at diagnosis were noted. Any events during treatment such as febrile neutropenia, drug interruption and dose modification, mucositis, blood products requirement, and infections were noted.

The Anthro Software of the World Health Organization (WHO) (version 3.0.1; Department of Nutrition, WHO) was used to calculate the body mass index (BMI) and BMI-for-age z-score of patients up to the age of five years (60 months). The WHO Anthro-plus software (version 1.0.2) was used to calculate the BMI and BMI-for-age z-score for children above five years of age (completed 60 months). Nutritional status was classified according to the WHO criteria (WHO, 2009; WHO, 2006). The study cohort was categorised into three groups:

- Undernourished – patients with a z-score >2 standard deviation (*SD*) below mean BMI-for-age (<-2SD)
- Adequately nourished – patients with a z-score between 2*SD* below (-2SD) and 1*SD* (+1*SD*) above the mean BMI-for-age
- Over-nourished – patients with a z-score above 1*SD* (+1*SD*) above mean BMI-for-age.

Weight loss >10% or a decrease in BMI *z*-score by ≥1*SD* below the previous *z*-score was considered significant.

Anaemia was diagnosed according to WHO criteria. Febrile neutropenia was defined as the occurrence of a single oral temperature of >38.3 ^{0}C (101.4F) or 38 ^{0}C(101F) for >1 hour along with an absolute neutrophil count (ANC) <500 or 1000 with predicted rapid decline during the next 48 hours.

Children with age >1 year and <10 years, white blood count (WBC)< 50,000/ mm^3, good response to prednisolone, no testicular involvement, no bulky disease, and no high risk cytogenetics were considered as standard risk.

Children with high risk cytogenetics like BCR ABL positivity, iAMP 21, MLL and T (1:19) positivity, hypodiploidy, poor response to prednisolone, and minimal residual diseases (MRD) positive at the end of induction, T-cell phenotype were considered to be of high risk.

Statistical analysis was done using SPSS version 17.0. Demographics and clinical variables were analysed using frequencies and percentages for categorical variables. We also determined the associations between various parameters including nutritional status at diagnosis and outcomes. Crude odds ratio (OR) and 95% confidence interval (CI) were calculated with those 'attaining remission' as the reference category. The statistical significance level was set at 5%.

RESULTS

Among 84 children who were diagnosed with ALL at our centre, between June 2010 and June 2016, one child abandoned treatment and 11 children continued further treatment at their native places. Thus, the final study population included 72 children.

Table 1 demonstrates the demographic and medical characteristics of the children. A total of 19 (26.3%) children were undernourished at diagnosis. Among these 19 who were undernourished, 15 (78.9%) also had anaemia. There was a strong association between the nutritional status of children and socioeconomic status (p<0.038, with 95% CI); malnutrition was found to be more common among children of lower socioeconomic status (Table 2). The mean *z*-score at diagnosis was -0.53 (*SD*: ±2.36). Thirty eight out of the 72 (52.7%) patients had weight loss; 28 (73.6%) of this 38 had significant weight loss. There was no statistical significance between socioeconomic status and significant weight loss (Table 3).

Table 4 gives the details of the events during induction phase. A total of 16 children had induction therapy free of events. Febrile neutropenia, mucositis, pneumonia, and drug interruptions were found to be more common in those who had significant weight loss than in those who were undernourished at diagnosis, but only febrile neutropenia was found to be statistically significant among the other variables (p=0.001).

DISCUSSION

Adequate nutrition in children with cancer is essential to maintain optimal growth and development, decrease toxicity, enhance survival outcome, and improve quality of life (Owens *et al.,* 2013). The heightened risk of infections in undernourished patients and the increased risk of toxicity from chemotherapy in these children are the main obstacles to improve the survival rates of ALL in developing countries. Undernutrition increases treatment-related mortalities and morbidities, leads to abandonment of therapy, and has a negative effect on the quality of life. In developed countries, undernutrition is reported to occur in less than 10% of children with ALL, whereas a higher

Table 1. Patients' demographic and medical characteristics at diagnosis

Characteristics	*n*	*%*
Age at diagnosis	72	
< 5 years	31	43.1
6 -10 years	19	26.4
>11 years	22	30.5
Gender		
Male	52	72.2
Female	20	27.8
Socioeconomic class (modified Kuppuswamy scale)		
Class 1	15	20.8
Class 2	21	29.2
Class 3	13	18.0
Class 4	12	16.7
Class 5	11	15.3
Risk stratification		
Standard risk	33	45.8
High risk	39	54.2
Anaemia at diagnosis	47	
Undernourished	19	40.4
Adequately nourished	22	46.8
Overnourished	6	12.8
Hypoalbuminemia at diagnosis	12	
Undernourished	5	41.7
Adequately nourished	6	50.0
Overnourished	1	8.3
Hypokalemia at diagnosis	6	
Undernourished	3	50.1
Adequately nourished	2	33.3
Overnourished	1	16.6

Socioeconomic class: class 1 – upper ; class 2 – upper middle; class 3 – lower middle; class 4 – upper lower ; class 5 – lower

Table 2. Correlation between socioeconomic status and nutritional status

Socioeconomic class	*Nutritional status at diagnosis*			*Total n (%)*	*p value*
	Undernourished	*Adequately nourished*	*Over nourished*		
Class 1	3	6	6	15 (20.8)	0.038
Class 2	5	16	0	21 (29.2)	
Class 3	3	8	2	13 (18.1)	
Class 4	2	7	3	12 (16.7)	
Class 5	6	4	1	11 (15.2)	
Total	19	41	12	72 (100.0)	

Table 3. Correlation between nutritional status at diagnosis and significant weight loss during induction phase

Nutritional status at diagnosis	*At diagnosis n (%)*	*No. of patients with significant weight loss during induction n (%)*	*p value*
Undernourished	19 (26.4)	5 (17.9)	0.205
Adequately nourished	41 (56.9)	16 (57.1)	
Over nourished	12 (16.7)	7 (25.0)	
Total	72 (100.0)	28 (100.0)	

Table 4. Correlation between nutritional status at diagnosis and events during treatment

Events	*Nutritional status*				*Total*
	Undernourished, n=19		*Significant weight loss, n=28*		
	n (%)	*p*	*n (%)*	*p*	
Febrile neutropenia	7 (36.8)	0.203	10 (35.7)	<0.001	17
Dosage interruptions	5 (26.3)	0.273	7 (25.0)	0.496	12
Pneumonia	3 (15.8)	1.000	6 (21.4)	0.011	9
Mucositis	5 (26.3)	0.868	9 (32.1)	0.023	14

Table 5. Outcome of induction therapy

Outcome	*n (%)*
Attained remission	67 (93.1)
Died	5 (6.9)
Total	72 (100.0%)

rate of 21-52% has been reported in developing countries (Sala *et al.,* 2012). The prevalence of undernutrition among children and adolescents with cancer ranges from 8%-60%, depending upon the type of cancer, treatment modalities and methods used to measure nutritional status (Agarwal *et al.,* 2012).

There are no standard clinical practice guidelines for monitoring nutritional status in children with cancer. Weight as an accurate parameter of nutritional status may be unreliable in cases with significant tumour volume, organomegaly, or altered hydration status. Cancer therapy alters muscle and fat composition. An evaluation effective to identify the type of nutritional impairment – adipose and/or muscle, is therefore essential. Unfortunately, BMI (body mass index) cannot distinguish between fat mass and lean mass, thus making it a poor measure of body composition. Instead, mid upper arm circumference (MUAC) can be used for assessing fat-free mass and triceps skin folds (TSF) for measuring fat mass. These are widely recommended as they are feasible in low- and middle-income countries. They have also been found to be better parameters of nutritional assessment and correlate with outcomes (Jaime-Perez *et al.,* 2008).

The causes of undernutrition at diagnosis and during treatment are diverse. The dynamic interactions between primary disease, effect of multimodal therapies, other co-morbid features, and socioeconomic status of the patient makes it more complicated. The combined status of increased need, decreased intake, inadequate supply, and increased inflammation leads to

protein energy deficit and pathological sequelae of those deficits (Brinksma *et al.,* 2012). So, patients with high risk for undernutrition, such as advanced stage disease or needing intensive chemotherapy regimens, should be identified and monitored closely.

Undernutrition present at the time of diagnosis in children with cancer, increases their vulnerability to alterations in the pharmacokinetics of anti-neoplastic agents. Pharmacokinetics of many drugs like methotrexate and anthracyclines are found to be influenced by the body composition of lean body mass and adipose tissue. At extremes of malnutrition, the pharmacodynamics of drugs are affected; and hence, their potential effectiveness is reduced (Murry, Riva & Poplack, 1998). There are only limited studies, which have evaluated the prevalence of undernutrition during the induction phase of treatment. Undernutrition at diagnosis is a poor prognostic factor resulting in lower event-free survival and greater treatment-related mortality. Tan *et al.* (2013) has reported that 15.1% of children were undernourished during the induction phase of ALL. Kumar *et al.* (2000) has reported 52% malnutrition among children with ALL and 36% weight loss during induction. Among our study population of 72 children, 19 (26.3%) were undernourished and 28 of them (38.8%) had significant weight loss during the induction period. Orgel *et al.* (2016) evaluated 2008 high risk ALL children and correlated the outcomes to duration of weight extremes during treatment. Underweight status was found to be associated with increased risk of fungal infections and haematological toxicity. Inferior event-free survival was reported in those who were found to be underweight for 50% of the time, between the end of induction and the start of maintenance.

Roy *et al.* (2013) has reported a higher incidence of febrile neutropenia in undernourished children with ALL. Altered nutritional and inflammatory status increase the risk of severe haematological toxicity following anti-cancer therapy (Alexandre *et al.,* 2003). There are significant treatment interruptions/modifications due to mucositis, co-morbid infections, and neutropenic status. Maldonado *et al.* (2015) and Sala *et al.* (2012) have correlated poor survival outcomes and treatment-related toxicity to undernourishment at diagnosis. Although a statistically significant association could not be found between malnutrition and mortality during induction to remission, Mejía-Aranguré *et al.* (1999) observed a strong relationship between the degree of malnutrition and the risk of death. He has quoted that undernourishment may influence early mortality during the induction to remission phase of the treatment. Severely undernourished children were found to have 3.5 times higher risk of death during induction than remission.

A study from St. Jude Children's Research Hospital had reported that infections contributed to 80% of deaths observed during the induction phase in children with ALL (Rubnitz *et al.* 2004). Marwaha *et al.* (2010) has reported an induction mortality of 10% and Rajeswari *et al.* (*2018*) has quoted it as 5.3% among children with ALL. Malnutrition compromises the integrity of the mucosal barrier and thereby predisposes these children to increased rate of infections. The induction mortality rate among our study population was 6.9% and all of them died due to infections. In our study, though there was no statistical significance to suggest that nutritional status at diagnosis was associated with outcomes, there was a strong association between a depletion in nutritional

status and treatment outcomes. In our study, all five children who died during induction phase had significant weight loss. The incidence of events, such as mucositis, pneumonia, and febrile illness, were more prevalent in patients who underwent significant weight loss through the course of treatment.

As undernutrition is a modifiable risk factor for the outcomes in ALL, longitudinal nutritional assessments should be incorporated and appropriate nutritional interventions should be implemented. Assessment should be a dynamic process and should be able to recognise at-risk patients to enable proactive care to those who are at the highest need of nutritional interventions. A study in Guatemala has demonstrated that correction of undernutrition in children with ALL within six months of diagnosis resulted in improvement of their survival rates as compared to the normally nourished children (Antillon *et al.,* 2013). Larger interventional studies with dietary modifications are lacking as there are methodological challenges to have randomised and double blinded studies for an accurate assessment. It has to be recognised that malnutrition is also a part of socioeconomic disadvantage and hence, simple and cost effective nutritional interventions can diminish the morbidity burden of undernourishment in low-income countries.

CONCLUSION

The incorporation of nutritional assessments into ALL treatment protocols, as well as adequate and appropriate nutritional interventions should become routine practices in clinical setting in order to improve the outcomes of remission during induction phase among childhood ALL patients.

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Authors' contributions

LMS, prepared the draft of the manuscript and reviewed the manuscript; LS, assisted in data collection and statistical analysis; AK, assisted in data entry and initial proof correction; JS, conceptualised and designed the study; DJ, assisted in reviewing the manuscript and data analysis.

Conflict of interest

Authors declare no conflict of interest.

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Relationship between 6-n-propylthiouracil (PROP) taster status, dietary intake and dental caries among young adult subjects

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ABSTRACT

Introduction: Previous studies have established an association between 6-n-propylthiouracil (PROP) taster and dietary intake. However, those studies mostly emphasised on macronutrients. The present study examined the dietary intake, including macro- and micronutrients, and caries experience among university students according to their PROP taster status. **Methods:** A total of 158 university students participated in this study. PROP taster status was determined using filter paper method. Dietary intake was collected using 24-hour diet recall method. Oral health examination was conducted to determine dental caries experience. **Results:** The results showed that majority of subjects were supertasters. No significant differences (p>0.05) were found in the macronutrient intakes among supertasters, medium tasters, and non-tasters. Significant differences (p<0.05) were found in the intakes of micronutrients, namely pantothenic acid, vitamin D, magnesium, manganese, and fluoride. There were no significant differences among group tasters in the dental caries experience scores of decayed (D), missing (M), and filled (F) teeth. **Conclusion:** In general, this study indicated that all group tasters had no difference in macronutrients intake and caries experience, but supertasters had significantly lower intakes of some micronutrients as compared to non-tasters and medium tasters. This suggested that PROP taster status could have some influence on micronutrient intakes.

Keywords: caries, dietary intake, macronutrients, micronutrients, PROP, young adults

INTRODUCTION

A healthy diet is crucial in maintaining optimum health. Poor dietary intake is said to be the factor contributing to increasing prevalences of obesity and non-communicable diseases. Dietary intake can be influenced by various factors, including social (such as family and friends), physical (such as food availability and affordability), and macro level environment (such as food marketing and cultural norms) (Osei-Kwasi *et al.*, 2020). In addition, previous work has shown that there is

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a connection between taste sensitivity with food acceptance and consumption (Cattaneo *et al.*, 2019).

The ability to taste the bitter compound 6-n-propylthiouracil (PROP) is genetically determined. The degree of sensitivity to PROP can be used as a criterion to classify an individual into a non-taster, medium taster or supertaster (Robino *et al.*, 2014). Some studies suggested that supertasters are more sensitive to taste compounds, and therefore, can perceive compounds, such as caffeine, sucrose, pepper, and fat, with greater intensity (Von Atzingen & Silva, 2012).

The difference in taste sensitivity plays an important role in food selection and preference, as well as dietary patterns (Yackinous & Guinard, 2002). Individuals with high taste sensitivity (supertasters) are suggested to avoid certain kinds of foods because the taste of food is too intense for them. Hence, supertasters could be a cause of picky eating, which leads to eating an unbalanced diet (Martha & Gary, 2010). On the contrary, non-tasters can appreciate taste at a higher concentration, which may lead them to choose foods with stronger taste or higher concentration of flavours, such as high sugary foods. High sugar intake in foods and beverages in an individual with a preference to sweetness can lead to diabetes and obesity (Jacques *et al.,* 2019).

Difference in the PROP taster status contributes to variation in food acceptability (Lim *et al.*, 2021), which in turn, may affect dietary intake. Reports have shown that taste perception may influence nutrient intakes and food selection. The results on nutrient intakes vary, with some reporting significant difference in the intakes of energy and carbohydrate (Cattaneo *et al.*, 2019) and fat (Yackinous & Guinard, 2002), while others found no significant difference in dietary intakes among tasters (Borazon *et al.*, 2012). PROP tasting is also associated with micronutrients intake. According to Inoue *et al.* (2017), PROP tasters consume greater amounts of dietary sodium. It is postulated that the intake of sodium serves as a masking for the taste of bitterness.

Diet is an important factor in oral health. High consumption of carbohydrate and sugar without any proper oral hygiene care may contribute to dental diseases such as dental caries and periodontal disease. The multifactorial interactions between the tooth structure, the microbial biofilm formed on the tooth surface and sugars, as well as salivary and genetic factors, can influence the development of dental caries (Pitts & Zero, 2016). Therefore, non-tasters who have higher frequencies and concentration of sugar intake in their dietary intake are more susceptible to dental caries (Arakawa *et al.,* 2021). Micronutrient intake, such as fluoride, is an important element to reduce caries risk as it is recognised and recommended by the US Food and Drug Administration (FDA) for the prevention of dental caries (Carey, 2014).

Studies on the Malaysian population regarding their taste sensitivity status are limited. The factors underlying dietary behaviour is crucial to determine the problem surrounding the status of PROP taster among Malaysians. Since different culture exhibit different lifestyles and dietary patterns, it is therefore worthwhile to study the association between PROP taster status with dietary intake and caries experience in Malaysian subjects. Previously, we have reported about the food preference of different taste food groups, namely sweet, salty, sour, and bitter among university students based on their PROP taster status (Syathirah Hanim *et al.*, 2020). As a continuation, the dietary intake and caries experience were determined in this study. The

present study also extended the results on micronutrients, which were scarcely reported.

MATERIALS AND METHODS

Subjects

This was a cross-sectional study in which 158 undergraduate students (aged between 19 to 25 years) participated through convenience sampling in the state of Kelantan, Malaysia. Power and Sample Size Calculation (PS) Software was used to calculate the sample size of this study, which resulted in a total of 144 subjects. After taking into account a 10% drop-out, a finalised number of 158 subjects were recruited for this study. The inclusion criteria were undergraduate students and free from any diseases or conditions that could alter taste sensation, such as ageusia and hypogeusia. Subjects were excluded if they were a smoker or taking long term medication for chronic diseases. All subjects gave their consent to participate in this study. This study was approved by the Human Research Ethics Committee of Universiti Sains Malaysia (Ref No: USM/JEPeM/18070313).

PROP taster classification method

Subjects were instructed to avoid consuming a large meal and drinking strong tea or coffee for at least one hour before the tasting session. Taste sensitivity was obtained by using PROP test paper (3cm in length) to detect the perception of bitter substrate. A PROP taste paper (PL Precision, Northampton) with 20 microgram of PROP concentration was placed on the tongue of the subjects for 30 seconds. Then, subjects were asked to rate the sensation perceived (intensity of bitterness) using the Green's Labeled Magnitude Scale (LMS) (Green, Shaffer & Gilmore, 1993). Previously, subjects were given instructions on how to use the Green LMS. The rating scale ranged from 0 to 100, with 0 representing barely detectable sensation and 100 was the strongest imaginable sensation of any kind. The subjects were identified as non-taster, medium taster, and supertaster if they scored <12 mm, 12-60 mm, and >60 mm, respectively.

Dietary intake

Dietary intake was conducted after subjects completed the PROP test. The 24-hour diet recall method was used to assess dietary intake. A face-to-face in-depth interview was conducted to recall in detail all the foods and drinks the subjects have consumed during the previous 24 hours. This method was chosen because it is an established method that is widely used to determine food intake and was considered the best to be used based on the feasibility and resources allocated for this study. The interview was conducted for three days in a week; 1-day diet recall for weekend and 2 days diet recall for weekdays. The interview was conducted at a time that was convenient for both the researcher and participant, typically out of school schedule. The subjects were asked to recall all foods and drinks consumed and assisted in estimating their portion sizes. To ensure that the data obtained were as accurate as possible, subjects were probed to get specific information, such as the brand consumed, type of food consumed (wholemeal, low-fat), and details on preparation and cooking methods.

Dental caries experience

Dental caries experience was performed after the dietary intake session. Subjects were asked to sit on a portable dental chair with adequate lighting from a portable light with the examiner seated in front of the chair. The subjects' teeth were examined in an orderly sequence from one tooth to the next adjacent tooth with the help of a disposable mouth

mirror; starting from 18 (third molar of upper right) to 28 (third molar of upper left) for the upper jaw, and 38 (third molar of lower left) to 48 (third molar of lower right) for the lower jaw. Disposable probes were used if food debris needed to be removed in detecting dental caries. All non-sharp disposable instruments were disposed in a sharps bin. Hand disinfectant was used before gloving and post-intra-oral examination was carried out for each respondent. The criteria used to diagnose a tooth's status and the coding number was based on World Health Organization (WHO) protocols (WHO, 2013). Dental caries experience was constructed on decayed, missing, and filled teeth (DMFT) index. The assessment scores were recorded per tooth on the DMFT index form. The dental caries experience of each subject (DMFT) was determined by adding the scores of decayed (D), missing (M), and filled (F) teeth. The minimum DMFT score was 0, while the maximum DMFT score was 32. A DMFT score of 0 indicated no decayed, missing or filled tooth, which reflected very low or no caries experience; a DMFT score of 32 indicated highest severity in caries experience.

Statistical analysis

The Nutritionist Pro™ Diet Analysis Software using the Malaysian food database was used to analyse the nutrient intakes of the participants. All data collected were entered and analysed using IBM Statistical Package of Social Science (SPSS) version 24.0. One-way analysis of variance (ANOVA) test was used to assess the significant difference in mean for dietary intake and caries experience among non-tasters, medium tasters, and supertasters. PROP bitterness rating was correlated with dietary intake and caries experience using Spearman's rank correlation. The value of $p<0.05$ was considered as statistically significant.

RESULTS

Table 1 shows the demographic characteristics of participants in the present study. A total of 158 undergraduate students took part in this study. Majority of subjects were females, which constituted about 79.7%, while 20.3% were male students. Malays (79.1%) constituted the highest number of participants, followed by Chinese (10.8%), other ethnic minorities (5.7%),

Table 1. General characteristics of the participants, *n* (%)

	Non-tasters (n=37)	*Medium tasters (n=34)*	*Supertasters (n=87)*	*Total (n=158)*
Gender				
Female	29 (23.0)	25 (19.8)	72 (57.1)	126
Male	8 (25.0)	9 (28.1)	15 (46.9)	32
Race				
Malay	28 (22.4)	27 (21.6)	70 (56.0)	125
Chinese	3 (17.6)	4 (23.5)	10 (58.8)	17
Indians	3 (42.9)	1 (14.2)	3 (42.9)	7
Others	3 (33.3)	2 (22.2)	2 (22.2)	9
Age (years)				
19 - 22	17 (17.7)	21 (21.9)	58 (60.4)	96
23 - 26	20 (32.3)	13 (20.9)	29 (46.8)	62

Table 2. Mean dietary intake among non-tasters, medium tasters, and supertasters

Dietary Intake	*Mean±SD*			*p-value*	*Correlation of PROP score and dietary intake (r)*
	Nontasters (n=37)	*Medium tasters (n=34)*	*Supertasters (n=87)*		
Macronutrients					
Energy (kcal)	1313±76	1408±76	1340±46	0.802	0.025
Protein (g)	37.2± 3.4	38.8±3.6	36.5±2.2	0.84	-0.031
Carbohydrate (g)	111.4±7.3	112.7±9.4	114.5±6.1	0.952	-0.009
Fat (g)	42.3±4.4	51.6±5.0	51.4±4.6	0.443	0.005
Sugar (g)	27.9±4.8	32.0±4.9	27.3±3.1	0.055	-0.054
Vitamins					
Thiamin (mg)	0.53±0.10	0.55±0.10	0.41±0.04	0.177	-0.109
Riboflavin (mg)	0.66±0.14	0.77±0.17	0.55±0.08	0.680	-0.009
Niacin (mg)	5.24±0.62	4.99±0.69	5.17±0.36	0.909	0.045
Pantothenic acid (mg)	0.54±0.08[a]	0.43±0.07[ab]	0.35±0.03[b]	0.018	0.172*
Pyridoxine (mg)	0.37±0.05	0.31±0.04	0.32±0.02	0.321	-0.050
Folate (µg)	45.24±6.25	48.08±7.45	53.53±9.01	0.816	-0.038
Cobalamin (µg)	0.60±0.10	0.64±0.11	0.85±0.27	0.701	-0.089
Vitamin C (mg)	15.17±2.50	14.62±2.37	11.45±1.49	0.313	-0.152
Vitamin A (µg)	31.26±5.07	29.14±6.46	26.97±4.32	0.871	-0.072
Vitamin D (µg)	0.29±0.06[a]	0.17±0.07[ab]	0.14±0.03[b]	0.028	0.180*
Vitamin E (mg)	1.75±0.29	1.37±0.26	1.65±0.18	0.328	-0.011
Vitamin K (µg)	4.75±1.60	4.76±1.80	4.53±0.86	0.617	0.068
Trace elements					
Calcium (mg)	307.54±61.36	326.49±63.49	263.79±38.00	0.321	-0.061
Iron (mg)	6.60±0.80	6.28±0.97	6.71±0.71	0.816	-0.056
Iodine (µg)	12.51±6.96	3.26±0.81	9.21±2.46	0.126	-0.078
Zinc (mg)	2.65±0.54	3.41±0.92	2.31±0.27	0.313	-0.087
Selenium (µg)	10.42±3.10	20.92±5.12	14.74±2.43	0.871	0.041
Phosphorus (mg)	335.06±81.31	800.47±41.76	372.57±56.97	0.701	0.004
Sodium (g)	0.18±0.05	0.13±0.04	0.11±0.02	0.328	-0.011
Potassium (g)	0.67±0.09	0.61±0.08	0.52±0.04	0.617	-0.116
Magnesium (mg)	78.09±16.64[ab]	103.15±31.19[a]	53.65±5.26[b]	0.032	0.177*
Manganese (mg)	0.47±0.18[ab]	0.51±0.35[a]	0.32±0.07[b]	0.016	-0.130
Fluoride (mg)	0.02±0.04[ab]	0.04±0.07[a]	0.01±0.02[b]	0.012	-0.135

p-value in bold indicates a significant difference ($p<0.05$) with different letters in a row showing significant differences
r value with (*) indicates significant difference at p<0.05

and Indians (4.4%). Majority of subjects were in the range of 19 to 22 years old (75.0%). Results regarding taster status indicated that more than half of the subjects were supertasters (55.1%), followed by non-tasters (23.4%) and medium tasters (21.5%).

The daily dietary intakes of energy and nutrients for all three groups of tasters are shown in Table 2. There were no significant differences (p>0.05) detected in macronutrients, namely total energy, carbohydrate, protein, and fat intakes among students in different groups. The mean daily energy intake was 1314 kcal, 1409 kcal, and 1340 kcal for non-tasters, medium tasters, and supertasters, respectively. No significant difference (p>0.05) was found in total sugar intake.

In terms of micronutrients, this study showed that the mean dietary intake of most vitamins was not significantly different among non-tasters, medium tasters, and supertasters, except for panthothenic acid (vitamin B5) and vitamin D (Table 2). Significant differences (p<0.05) existed between non-tasters and supertasters for both vitamins, in which non-tasters had significantly higher intake of panthothenic acid and vitamin D compared to supertasters. Table 2 also showed that the elements magnesium, manganese, and fluoride had significant differences (p<0.05), whereby medium tasters had significantly higher intake of these elements compared to supertasters. There were significant correlations between PROP bitterness rating and panthothenic acid (r=0.172), vitamin D (r=0.180), and magnesium (r=0.177).

Table 3 shows the caries experience of students according to their group tasters. The prevalence of dental caries among the students was 57.6% and the mean DMFT score was 1.71. In each of the group taster, there were more subjects with caries, which were 56.8%, 58.8%, and 57.5% for non-tasters, medium tasters, and supertasters, respectively. There was no significant difference (p>0.05) found in caries experience in DMFT score and the mean of D, F, and M scores among students in different group tasters. No correlation was found between PROP bitterness rating and caries experience too.

DISCUSSION

The results of the present study showed that the group with the highest and lowest number of subjects were supertasters

Table 3. Caries experience among non-tasters, medium tasters, and supertasters

Caries experience	*Mean±SD / n (%)*			*p-value*	*Correlation of PROP score and caries experience*
	Nontasters (n=37)	*Medium tasters (n=34)*	*Supertasters (n=87)*		
Caries experience				0.984	-0.003
No (DMFT=0)	16 (43.24)	14 (41.18)	37 (42.53)		
Yes (DMFT≠0)	21 (56.76)	20 (58.82)	50 (57.47)		
DMFT	1.54±1.92	2.38±3.01	1.52±2.07	0.312	-0.035
D	0.32±0.75	0.38±1.07	0.22±0.56	0.502	-0.072
M	0.14±0.42	0.26±0.57	0.17±0.55	0.564	0.012
F	1.16±1.71	1.74±2.31	1.13±1.66	0.241	0.035

DMFT, Decayed, Missing and Filled Teeth; D, Decayed; M, Missing; F, Filled
All data were not significant at p<0.05.

and medium tasters, respectively. The same result was reported by Karmakar *et al.* (2016) among school children, in which supertasters constituted the highest number, while medium tasters the lowest number. However, among university students, a previous study found medium tasters to be the majority (Gunawardane, Ariyasinghe & Rajapaske, 2016). In general, the proportion of tasters (medium and supertasters) were higher in the present study. As indicated by Robino *et al.* (2014), approximately 75% of the world population are considered as tasters, either medium or supertasters. The difference in the prevalence of PROP taster status could be due to the difference in geographic location and age discrepancy (Syathirah Hanim *et al.*, 2020).

The present study showed that there was no evidence that different groups of tasters differed in terms of their macronutrients intake. However, in general, most of the participants, regardless of their taste sensitivity level, failed to meet the Recommended Nutrient Intake for Malaysian (RNI). It is not surprising as this has been reported before that university students have poor dietary habits (Shahril, Dali & Lua, 2013).

The results regarding energy and macronutrient intakes among non-tasters, medium tasters, and supertasters from previous studies were inconsistent. Previously, no significant relationship between PROP taster status and food consumption in Filipino adolescents was reported (Borazon *et al.*, 2012). Yackinous & Guinard (2002) reported no significant difference in energy intake among all three group tasters of healthy college students, but found an association between PROP sensitivity and fat intake. According to their data, women in medium taster and supertaster groups derived a greater percentage of their dietary energy from fat. Cattaneo *et al.* (2019) too established a relationship between bitter taste sensitivity and total energy and carbohydrate intakes. Our findings, however, did not find any significant relationship between PROP taster status and macronutrients intake.

Low fruits and vegetables consumption is a major contributing factor for nutritional deficiency (Augusto, Cobayashi & Cardoso *et al.*, 2014). According to Chong *et al.* (2017), lower consumption of vegetables resulted in low intake of vitamins and minerals among Malaysian children. It is not surprising if this pattern also applies to university students as food intake pattern during childhood may continue into adulthood. Previously, low consumption of vegetables among medium tasters and supertasters were reported in a few studies (Dinehart *et al.,* 2006; Duffy *et al.*, 2010). Thus, it is not unexpected if the significant difference in micronutrients intake among group tasters in the present study could be due to low consumption of vegetables.

Drewnowski *et al.* (1999) reported that PROP taster status in young women was associated with reduced preference for bitter vegetables, such as Brussel sprouts, cabbage, and spinach, which in turn was related to respondents' dietary measures of reduced intakes of beta-carotene, carbohydrate, and fibre. In the present study, supertasters had significantly lower intakes of micronutrients, namely vitamin D, panthothenic acid, magnesium, manganese, and flouride compared to non-tasters or medium tasters. Of these micronutrients, pantothenic acid, vitamin D, and magnesium were found to be correlated with PROP bitterness rating. These micronutrients could be present in foods rejected by supertasters

due to their bitterness or unpleasant flavour. Avoidance of such foods might lead to supertasters having insufficient intake of these micronutrients. As suggested by Drewnowski *et al.* (1999), some phytochemicals with potential chemopreventive actions are bitter in taste and found in bitter vegetables and fruits. However, based on our previous study, there was no significant difference in the preference for bitter vegetables, such as broccoli, cabbage, and Chinese kale among the same subjects as the present study (Syathirah Hanim *et al.*, 2020). However, as this was a cross-sectional study, it limits causality.

In terms of caries experience, there was no significant difference found among all tasters and no significant correlation established between PROP taster status and caries experience in the present study. It has been reported that sweet preference is associated with bitter taste sensitivity to PROP, in which PROP tasters are more likely to dislike sweet taste, while non-tasters prefer sweet flavour (Arakawa *et al.*, 2021). Preference for sweetness on the other hand is reflected by high sugar intake, which has been linked to dental caries (Bashyam *et al.*, 2020). Thus, it has been suggested that non-tasters would probably have higher caries experience than supertasters. A study by Jyothirmai, Naganandini & Aradhya (2011) among 15-year-old children observed that decayed teeth in non-tasters were statistically significant compared to medium tasters and supertasters. A weak relationship between taste sensitivity and caries experience was also found in Saudi Arabia, Italy, and Mexico among 669 school children aged 13–15 years in a cross-sectional, multi-centre survey (Ashi *et al.,* 2017).

A study by Gunawardane *et al.*, (2016), which also focused on university students, resulted in a similar finding as the present study, in which no significant difference in caries experience was observed among the group tasters. Hence, most of the participants could be classified as having good dental status, which indicated that they had a very low caries experience in their life based on DMFT scores of lower than 5.0 (WHO, 2013). However, a study conducted by Saw *et al.*, (2012) among Malaysian adults showed that the DMFT score was higher than 5.0. It is suggested that the subjects for this study were predominately healthy university students and studying at a health campus might have exposed them to increased knowledge and attitude towards oral health care. This was supported by Kumar *et al.*, (2010), which found that university students studying health sciences reported significantly higher scores towards better oral health attitudes and behaviours compared to other university students. However, we do not reject the idea that the lack of association for caries experience in this study could be due to the subjects mostly coming from similar background without much diversity.

The PROP taster status in this study was found to be unrelated with caries experience. This was also supported by the dietary intake results, which found no correlation between major macronutrients and PROP taster status. Carbohydrate and sugar are the main dietary causes for dental caries. The normally synergistic relationship between the resident microbiota and the host is dynamic and can be perturbed by the frequent consumption of fermentable dietary carbohydrates, especially sucrose (Sheiham & James, 2014). However, in this study, there were no significant differences among the three taster groups in terms of macronutrients intake. Hence, it reflected no significant differences in dental caries among these groups.

CONCLUSION

The present study indicated that PROP taster status does not affect macronutrient intakes among non-tasters, medium tasters, and supertasters. However, some of the micronutrients, namely panthothenic acid, vitamin D, magnesium, manganese, and flouride consumed were significantly lower for supertasters when compared to non-tasters and medium tasters. The present study observed no difference in caries experience among all group tasters. This study suggested that PROP taster status has some influence on micronutrient intakes. However, since this was a cross-sectional study, direct causable relationship cannot be established. Nevertheless, this knowledge may enhance our understanding on the relationship between PROP taster status and dietary intake, and further intervention studies should be conducted to explore the effects of PROP taster status on dietary intake and food selection.

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Authors' contributions

SHAH, conducted the study, analysed and interpreted the data, assisted in drafting and reviewing the manuscript; RH, assisted in the analysis of dietary intake and reviewed the manuscript; NS, assisted in the analysis of caries experience and reviewed the manuscript; MAM, principal investigator, prepared the draft and reviewed the manuscript.

Conflict of interest

The authors have no conflict of interest.

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Effectiveness of school-based obesity prevention programme among elementary school children in Jakarta

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ABSTRACT

Introduction: Prevention and treatment of overweight and obesity are easier in children than in adults. This study was conducted to evaluate the Smart Eating and Healthy Activity (SEHAT) programme, an intervention programme involving parents, teachers, and students in Indonesia to prevent obesity at schools. The intervention was conducted in the form of seminars and leaflets distribution to parents, training of teachers, training of student health cadres, training of students by trained teachers, health promotion to school canteen vendors, and promoting healthy home food weekly. **Methods:** This non-randomised controlled trial study was conducted from January to May 2016 in North Jakarta. The primary outcome was body mass index (BMI) changes measured with SECA® digital scale for weight and microtoise for height measurements. The secondary outcomes were changes in children's knowledge, self-efficacy and behaviours, measured using self-made questionnaires, and physical activity using the Physical Activity Questionnaire for Older Children (PAQ-C). A total of 278 fourth and fifth-grade elementary school students aged 9 to 11 years old were recruited and grouped into intervention group (121 students) and control group (157 students). **Results:** The study reported a significant change between intervention and control groups on knowledge (1.28 vs 0.31), attitude (1.85 vs 0.06), physical activity (0.14 vs -0.32), eating fruits and vegetables (0.02 vs -0.78), and BMI (0.33 vs 0.71). **Conclusion:** The five-month SEHAT intervention programme effectively promoted knowledge on healthy eating and physical activity for obesity prevention by increasing physical activity, eating fruits and vegetables, and maintaining students' BMI.

Keywords: body mass index, children, healthy eating, physical activity, school-based intervention

INTRODUCTION

The World Health Organization (WHO) declared obesity a global pandemic because its occurrence is in developed and developing countries. Globally, over 340 million children and adolescents aged 5-19 years were overweight and obese in 2016 (WHO, 2021). In Indonesia, obesity prevalence is highest among children 5-12 years old, with a prevalence of 9.2% compared with children aged 13-15 and 16-18

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years (4.8% and 4.0%), respectively. The highest prevalence of obesity in children aged 5-12 years in Indonesia is in Jakarta, with approximately 14.0% (Kementrian Kesehatan RI, 2018).

Childhood overweight and obesity can persist into adulthood, causing an impact on both physical and psychological health, which reduces their quality of life. A research showed that over 60% of overweight children will continue to be overweight in early adulthood (Nittari *et al.,* 2019). Simulation research estimated that more than half (57.3%) of the children and adolescents would be obese by 35 years old, and half of the total prevalence of obesity begins in childhood (Ward *et al.,* 2017). Furthermore, one of the risk factors of adulthood obesity is adiposity rebound in early childhood. The impact of obesity can include short-term effects such as early puberty in children, menstrual irregularities, sleep disorders, psychological issues, as well as long-term consequences such as cardiovascular diseases, type 2 diabetes, high cholesterol level, liver diseases, and other chronic diseases (Kansra, Lakkunarajah & Jay, 2021; Sahoo *et al.,* 2015; Yan & Mi, 2021). Furthermore, several studies reported that obesity has become an economic burden in both developed and developing countries. The impact on health care cost includes the increased spending on obesity-related illnesses of a country (Biener, Cawle & Meyerhoefer, 2017; Tremmel *et al.,* 2017).

Childhood is a critical period because there is rapid development in physical, neurological, and social functions. Thus, prevention and treatment of overweight and obesity are considered more accessible during this period. Besides, it has been shown that intervention of obesity in adulthood faces more difficulties than in childhood (Lambrinou *et al.,* 2020; Yan & Mi, 2021). Therefore, childhood populations are a priority in implementing obesity intervention strategies.

School-based interventions are considered essential because: 1) primary school education is compulsory and reaches all children with varied backgrounds, 2) schools are places where children spend most of their time, 3) schools offer education and opportunities for physical education and activities, 4) schools offer an environment to easily apply interventions, 5) schools can also reach many children in a short time, 6) schools have teaching staff who can facilitate and contribute to intervention programmes, and 7) schools can actively involve parents in certain activities (Lambrinou *et al.*, 2020; van de Kolk *et al.,* 2019).

This research was based on the Social Cognitive Theory (SCT) from Bandura (Tougas *et al.*, 2015). This SCT states that human behaviour results from the interaction between personal factors (such as self-expectations, self-perceptions, goals, and intentions), cognitive, and environmental factors. Bandura explained that self-efficacy plays an essential role in an individual's capacity to organise and execute things, thus affecting his/her self-esteem and ability to compete with other individuals (Fertman & Allensworth, 2010; Tam *et al.,* 2012).

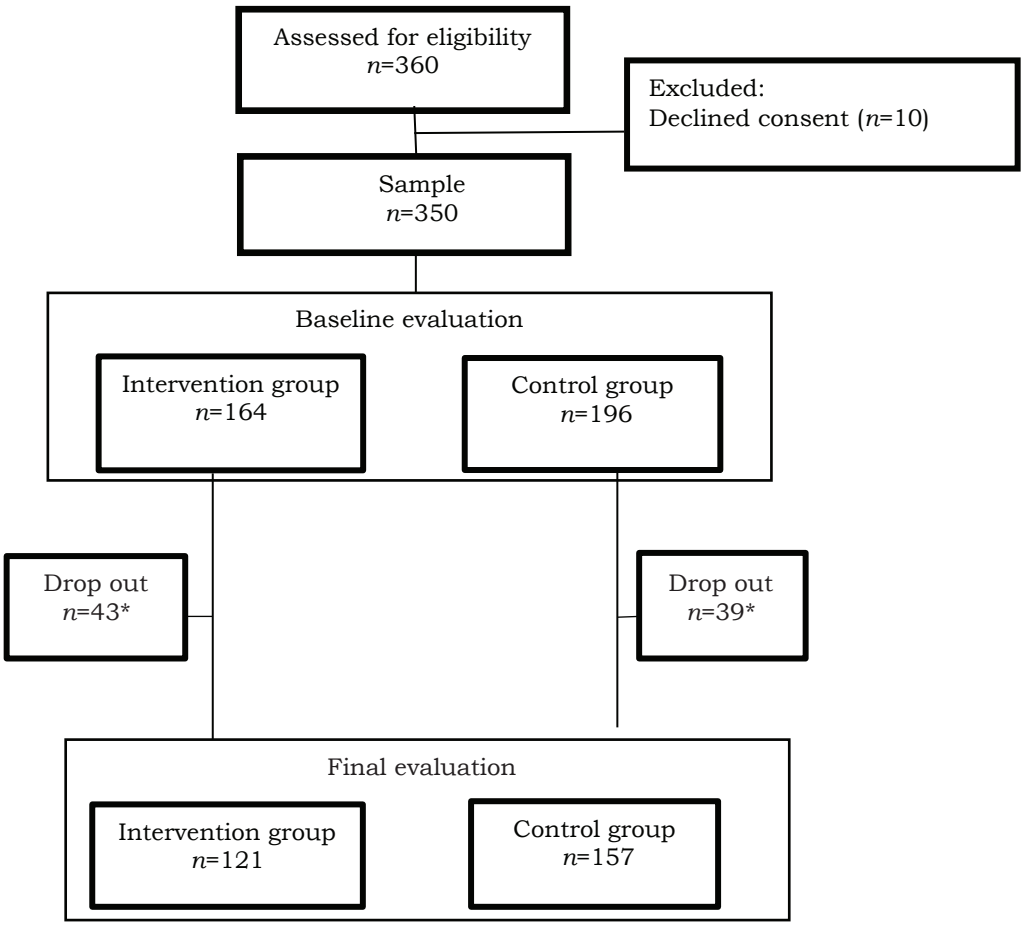
The SEHAT (Smart Eating and Healthy Activity) programme, a school-based health promotion intervention, was implemented to prevent the increasing prevalence of obesity in primary school students. The target participants of this study were children aged 9-11 years old because they could fill out the questionnaire and the incidence of obesity begins to increase at this age (Sahota *et al.,* 2001).

MATERIALS AND METHODS

Study design & procedures

This was a quantitative research using a quasi-experimental non-equivalent pre-test and post-test control group design. This study took place in North Jakarta with a heterogeneous society of different ethnicities, religions, and socioeconomic status, like most Jakarta areas.

The school criteria was accredited-A elementary schools with a prevalence of at least 30% overweight and obese students in grades IV and V. The intervention group was selected based on the number of students who were overweight and obese, and their availability to participate in the health promotion programme to prevent obesity in elementary school children. Students from each group were taken from two different elementary schools, one public school and one private school in North Jakarta. The intervention was conducted in Penjaringan Subdistrict, and the control group was conducted in a different sub-district from the intervention group, namely Pademangan District.



*The parents or the students did not fully attend the programme or the respondent data were incomplete

Figure 1. Flow chart of study population during the intervention study

This study was conducted during the 2015-2016 academic year. Although initial data were taken in early January 2016, the programme was held from January until May 2016 and evaluated in early June 2016.

Participants

This study used proportional stratified non-random sampling for both intervention and control groups. The inclusion criteria were: 1) students aged 9-11 years old; 2) students with normal and overweight body mass index (BMI); and 3) students who were willing to participate. The exclusion criteria were: 1) students who did not take the pre-test or post-test; 2) students who left or changed school in the middle of the intervention; or 3) students who did not complete the training.

In total, four schools were selected in this study. Initially, 360 students were assessed. Of these, 82 students were excluded based on the exclusion criteria due to several reasons such as family issues and waking up late. In total, the study analysed 278 students, which consisted of 121 students in the intervention group and 157 students in the control group (Figure 1). All participants took pre-test, post-test, and provided their weight and height measurements.

Approval and consent

This study's ethical clearance was approved by the Ethical and Research Committee of Atma Jaya Catholic University of Indonesia, Faculty of Medicine. All fourth and fifth-grade students who met the inclusion criteria were provided with verbal information about the study at the time of recruitment. In addition, written information was also provided to parents or guardians and they were asked for their written consent prior to their child's participation in this study.

SEHAT programme

This intervention aimed to prevent childhood obesity by expanding their knowledge, manners, self-efficacy, and outcome expectations of obesity prevention, which would be continued through available human resources at schools, including teachers and students as student health cadres. Student health cadres were eligible by specific criteria (such as intelligent, healthy, enthusiastic leadership, and responsible) and had been trained to carry out some efforts to maintain and improve their own health as well as that of their friends, family, and environment (Direktorat Jenderal Pendidikan Dasar, 2014). These student health cadres were expected to become role models in healthy living for their friends, especially in preventing overweight and obesity. In addition, this intervention also involved parents because they were responsible for regulating their children's eating patterns and behaviours as well as daily physical activity.

The SEHAT intervention programme consisted of six components. Firstly, health promotion to parents by health workers and psychologists was conducted through seminars on nutritional status and obesity, healthy food, physical activity, reading dietary facts, and a parenting guide based on their child's personality. In addition, parents also were given leaflets consisting of four topics about nutritional status and obesity, healthy food, physical activity, and how to read nutritional facts every two weeks. Secondly was training for teachers. Teachers were trained to be facilitators by health workers and given knowledge about healthy food, physical activity, measuring nutritional status, and reading nutrition facts. Thirdly, training of students by trained teachers was done with the help of some doctors. Materials given included information about healthy food, physical activity,

obesity, measuring nutritional status, healthy snacks, and reading nutrition facts. Fourth, training of student health cadres included how to motivate their friends. Fifth, health promotion to canteen managers was conducted by health workers about preparing, processing, and serving healthy food; and lastly, healthy food was brought from home once a week. Every Wednesday, students were asked to bring healthy food, including vegetables and fruits, to be eaten together at school during recess.

Instruments

The primary outcome of this study was BMI changes, and the secondary outcomes were changes of children's knowledge on healthy foods and drinks, physical activity, self-efficacy, and behaviour in physical activity and food intake. A trained research team measured students' BMI. Weight measurements were done using a SECA® digital scale to the nearest 0.1kg, and height measurements were done using a microtoise tape to the nearest 0.1cm. Questionnaire was used as data collection tool. Students were divided into small groups consisting of ten people and asked to fill out a questionnaire with the help of a facilitator. There were 15 questions about healthy foods and drinks, physical activity, and obesity with true or false options. A score of one was given for each correct answer and zero for each wrong answer. The expectation of the outcome was assessed with six statements, where each statement was given three choices with a Likert scale: important, doubtful, and not necessary. For example: "Regular exercise makes me healthy". Self-efficacy was assessed with 15 statements, divided into three groups. Each group consisted of five statements of self-efficacy, i.e., healthy eating behaviour, physical activity, and sedentary lifestyle. For example: "It is hard for me to eat vegetables if I am not eating with my parents" and "I am lazy to keep exercising if no one accompanies me". Every statement was given three choices with a Likert scale: agree, neither agree nor disagree, and disagree. Physical activity was assessed using the Physical Activity Questionnaire for Older Children (PAQ-C). Each answer was given a score of 1 for very low physical activity, 2 for low physical activity, 3 for adequate physical activity, 4 for high physical activity, and 5 for very high physical activity. The results were obtained from the average score of nine questions (Kowalski & Taylor, 2004). Fruits and vegetables intake and eating behaviours were assessed by filling out questions about like and dislike of eating fruits and vegetables, and the frequency of intake during the last week.

Data analysis

The collected data were analysed with IBM SPSS Statistics version 22.0 (IBM Corp, Armonk, New York, USA). Double entry was done before analysis to avoid data entry errors on quantitative data. A p-value of 0.05 was set as the cut-off for statistically significant results. T-test was used to measure the differences between intervention and control groups before and after the intervention.

RESULTS

Characteristics of the study participants between two groups were found to be not statistically significant (p>0.05) at the start of the study; thus, it can be concluded that there were no baseline differences between intervention and control groups (Table 1).

At the end of the SEHAT programme, the results showed a significant increase in knowledge mean values (p<0.05). On the contrary, there were no significant differences in self-efficacy and outcome expectations between pre-test and post-

Table 1. Demographic profile of the study participants

Variables	Intervention (n=121)		Control (n=157)		p-value
	mean±SD	n (%)	mean±SD	n (%)	
Sex					
Male		52 (43.0)		68 (43.3)	0.955
Female		69 (57.0)		89 (56.7)	
School year					
Grade IV		51 (42.1)		72 (45.9)	0.538
Grade V		70 (57.9)		85 (54.1)	
BMI (kg/m^2)	17.53±2.28		17.17±2.28		0.171
Father's educational status					
Primary school passed		33 (27.3)		29 (18.5)	0.453
High school and above		88 (72.7)		128 (81.5)	
Father's occupation					
Employed		120 (99.2)		157 (100.0)	0.255
Unemployed		1 (0.8)		0 (0.0)	
Mother's educational status					
Primary school passed		43 (35.5)		36 (22.9)	0.178
High school and above		78 (64.5)		121 (77.1)	
Mother's occupation					
Employed		29 (24.0)		35 (22.3)	0.743
Unemployed		92 (76.0)		122 (77.7)	

test on intervention group (p>0.05). Still, the mean values of those variables in the intervention group tended to increase.

There was also an increase in the variables of the intervention group by as much as 8.5% on knowledge, 0.3% on outcome expectations, 1.4% on self-efficacy on eating fruits and vegetables, 1.0% on self-efficacy on physical activity, 0.1% on physical activity, and 0.1% on eating fruits and vegetables behaviour. After the intervention period, the increase in BMI in the control group was higher than the intervention group (0.71 vs. 0.33) (Table 2).

Delta-mean between intervention and control groups for knowledge, physical activity, eating fruits and vegetables behaviour, and BMI variables were found to be statistically significant (p<0.05), and the intervention was shown to affect these variables (Table 3).

DISCUSSION

This study aimed to explain the SEHAT programme implementation and results after the programme was implemented for five months. Results after the SEHAT intervention programme showed that there was significant differences in the mean values of knowledge, physical activity, and eating fruits and vegetables behaviour in the intervention group compared to control group, but no significant differences in the outcome expectations, self-efficacy on eating fruits and vegetables, and self-efficacy on physical activity before and after the intervention. Insignificant self-efficacy results could be affected by students' poor outcome expectations in consuming healthy foods and increasing physical activity in daily life.

In Indonesia, parents consider themselves more powerful and often

Table 2. Mean comparison of knowledge, self-efficacy, outcome expectations, behaviour, and BMI before and after intervention

Variable	*Control*			
	Mean±SD	*p-value*	*Mean±SD*	*p-value*
Knowledge				
Pre-test	10.50±2.06	<0.001*	10.87±1.96	0.023*
Post-test	11.79±2.08		11.18±2.11	
Self-efficacy on eating fruits and vegetables				
Pre-test	11.99±2.22	0.446	12.60±2.06	0.199
Post-test	12.20±2.20		13.02±1.83	
Self-efficacy on physical activity				
Pre-test	11.61±2.27	0.582	11.82±2.04	<0.001*
Post-test	11.76±2.19		11.90±2.22	
Outcome expectations				
Pre-test	16.30±1.56	0.763	16.31±1.88	<0.001*
Post-test	16.36±1.84		16.68±1.77	
Physical activity				
Pre-test	2.49±0.55	0.368	2.55±0.58	0.012*
Post-test	2.63±0.63		2.23±0.58	
Eating fruits and vegetables behaviour				
Pre-test	9.82±2.61	0.948	10.01±2.50	<0.001*
Post-test	9.83±2.41		9.23±2.50	
BMI (kg/m^2)				
First measurement	17.53±2.28	<0.001*	17.17±2.28	<0.001*
Sixth measurement	17.85±2.33		17.88±2.60	

*$p<0.05$

show their dominance and expect their children to obey their wish. This is by characteristics of the Indonesian culture, where a large power gap exists and indicates individual inequalities in the society (Hofstede, 2001). Based on focus group discussion results, it was shown that most parents required their children to consume the food they have provided. The occurrence of a significant increase in knowledge without increment in outcome expectations and self-efficacy of the intervention group could be caused by parental influence on children's behaviours and eating patterns so that children only obeyed their parents while not increasing their own self-efficacy. Furthermore, based on the Family Systems Theory and Social Cognitive Theory, studies have found that controlling and restricting practices from a parent would result in higher BMI and lower self-efficacy in adolescents (Loncar, 2019).

After the intervention, there was a significant difference in mean BMI between intervention and control groups. Judging from the results, the SEHAT programme was considered successful in maintaining the stability of BMI in the intervention group. There were also no participants who changed to low or poor nutritional status. Significant differences between intervention and control groups on knowledge, eating fruits and vegetables behaviour, and

Table 3. Mean differences between pre-test and post-test in outcome variables for intervention and control groups

Variable	*n*	*Mean difference*	*p-value*
Knowledge			
Intervention	121	1.28±2.52	<0.001*
Control	157	0.31±2.50	
Self-efficacy on eating fruits and vegetables			
Intervention	121	0.21±2.98	0.531
Control	157	0.42±2.62	
Self-efficacy on physical activity			
Intervention	121	0.15±2.93	0.602
Control	157	0.09±2.54	
Outcome expectations			
Intervention	121	0.06±2.12	0.232
Control	157	0.37±2.18	
Physical activity			
Intervention	121	0.14±0.72	<0.001*
Control	157	-0.32±0.74	
Eating fruits and vegetables behaviour			
Intervention	157	0.02±2.84	0.029*
Control	121	-0.78±2.80	
BMI			
Intervention	121	0.33±1.01	<0.001*
Control	157	0.71±0.89	

*p<0.05

physical activity helped the intervention group achieve success in maintaining their BMI to be relatively stable compared to the control group. However, there was no significant difference between outcome expectations and self-efficacy, most likely because their eating patterns and behaviours, as well as physical activity were generally still determined by their parents.

Some factors that influence obesity prevalence causing different results from published school-based interventions were challenging to compare, including comparing this study with others' results. However, the present results were in accordance with several pieces of research that showed that school-based obesity prevention programmes combined with parents' involvement had favourable effects on children's weight status, dietary, physical activity, and sedentary behaviour (Norman *et al.,* 2019; Verjans-Janssen *et al.,* 2018).

Ultimately, the results from the evaluation of the SEHAT programme were considered successful in preventing obesity. Still, as children grow older and enter the adolescence period, parent-child relationships may change, whereby parental influence may decrease. Children will have a larger peer group, spend more time with them, and receive increasing support from their peers (Gao & Cummings, 2019). They will have more exposure to the outside world, including the obesogenic environment, where high-calorie fast food is booming and technological advances greatly facilitate human work, causing energy requirements for daily activity to decrease and sedentary

lifestyle to increase. High self-efficacy on a healthy lifestyle will control their negative health behaviours, excessive eating, and weight by not consuming excessive calories. This preventive healthcare self-efficacy is shown to be one of the significant factors in obesity (Altan & Bektas, 2017). Parenting styles are also associated with a child's and adolescent's self-efficacy; therefore, a good parenting style is favourable (Loncar, 2019). Apart from healthy food and physical activity, training and providing information on good parenting is also important in school-based health promotion programmes on preventing obesity.

Limitations and strengths

The limitation of this study was the limited number of students who met the inclusion and exclusion criteria so that purposive sampling methods were used. The study also assessed the students' behaviours based on questionnaires regarding their activities during the previous week, which could risk a recall bias. In addition, behavioural assessment on eating fruits and vegetables did not include the number of servings eaten per day, but only on students' preference and frequency of eating fruits and vegetables on average per day. However, measures had been taken to reduce these shortcomings. The behavioural assessment was conducted by a facilitator, and there was no time limitation for the process. Therefore, students had ample time to recall their activities in the past week.

Moreover, this was the first study in Indonesia that assessed the intervention programme, not only on knowledge, but also on behaviour and self-efficacy in children themselves, as well as in their parents.

CONCLUSION

The five months school-based intervention SEHAT programme for obesity prevention in fourth and fifth-grade primary school students was effective in increasing knowledge and giving positive influence on students' manners about the importance of healthy food and physical activity for preventing obesity in North Jakarta, Indonesia.

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Authors' contributions

FK, principal investigator, conceptualised and designed the study, prepared the draft of the manuscript, led the data collection and did data analysis; YSP, involved in study project, gave input for data analysis, reviewed the manuscript; DI, gave input in study design and data collection, and reviewed the manuscript; FTD, conceptualised and designed the study, analysed data results, reviewed the manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

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Validation of questionnaire for assessing perceived benefits and barriers of vegetable consumption in Japanese adults

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ABSTRACT

Introduction: This study aimed to develop and validate a diet consultation tool that assesses the perceived benefits and barriers of vegetable consumption attached to the stage of change in Japanese adults. **Methods:** A web-based survey was conducted among university and vocational school students, medical staffs, and local residents in the Aichi, Osaka, and Kyoto prefectures of Japan between September 2017 and January 2018. Participants comprised of 379 adults aged 20–70 years (mean age: 30.5±12.6 years; men: 21.4%). The scale for decisional balance of vegetable consumption contained 15 benefit items and 15 barrier items. The internal consistency of the scale was examined using Cronbach's alpha and construct validity was examined using an exploratory factor analysis with Promax rotation. **Results:** The developed questionnaire had 12 items across two domains for benefits and 12 items across three domains for barriers that were structured with high internal consistencies (Cronbach's alpha: 0.82, 0.79, 0.82, 0.76 and 0.76, respectively). The intraclass correlation coefficient in the test-retest reliability study was substantial (0.77). We found a very clear association between decreasing barrier score with increasing vegetable consumption and progress in the stage of change. The decisional balance score (benefits score minus barriers score) was positively correlated with the number of vegetable servings as an external parameter (Spearman's correlation: 0.461*; p*<0.001). **Conclusion:** The developed questionnaire was a valid, reliable, and useful tool for diet consultants to assess the perceived benefits and barriers of vegetable consumption in Japanese adults.

Keywords: balance, benefits and barriers, diet consultation, questionnaire, vegetable

INTRODUCTION

Eating vegetables has widely accepted health benefits, including the prevention of type 2 diabetes, hypertension, cancer, stroke, metabolic syndrome, cardiovascular disease, and a reduction in all-cause mortality (Aune *et al.*, 2017; Nanri *et al.*, 2017; Wang *et al.*, 2014). According to Meader *et al.* (2017), eating vegetables is a commonly recommended non-pharmacological intervention and is endorsed by most countries; however, many individuals do not consume enough vegetables to reap the benefits.

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Appleton *et al.* (2018) reported that the knowledge of the 5-a-day message in the UK encourages people to eat more fruits and vegetables.

The Japanese recommendation by the Ministry of Agriculture, Forestry and Fisheries (2010) of 350 g of vegetables per day for adults is equivalent to five servings (SVs) because a standard serving of vegetables is 70 g in Japan. However, as shown by the National Institute of Health and Nutrition (2018), only 30% of Japanese people (men: 30.7%, women: 27.0%) over 20 years of age consume five or more SVs of vegetables per day. It should be pointed out that unlike the proposals of the World Health Organization (WHO) and some countries, the 5-a-day campaign in Japan does not include fruits in five SVs because of the different roles of fruits and vegetables in the promotion of health, and the high sugar content in Japanese fruits. Wilunda *et al.* (2021) reported that vegetable consumption was inversely associated with weight changes in Japanese adults, while fruit consumption was positively associated with weight changes. Therefore, an effective assessment tool to promote vegetable consumption is required.

The transtheoretical model (TTM) is a unique scientific theoretical behavioural model, as well as a practice model, that involves distinct components such as changes in behaviour, self-efficacy, decisional balance, and change of process for effective intervention. Di & Prochaska (2010) reported that the decisional balance tool is a promotional tool that weighs the perceived benefits and barriers of a specific behaviour. Miller & Rose (2015) pointed out that in ambivalent people, interventions affecting decisional balance tend to hinder commitment to change. Several studies have been conducted on decisional balance tools for vegetable consumption, such as Shtaynberger & Krebs (2016), Wang *et al.* (2016), and Chuan & Horwath (2001). However, their results were not useful for diet consultation because vegetable consumption was determined on a daily gram amount basis, not on each meal serving basis, and the relationship between vegetable consumption and barriers to intake (barrier score) was not clear, even though the removal of barriers is regarded as one of the most effective ways to increase vegetable consumption.

Therefore, the aim of this study was to develop and validate a decisional balance tool, based on the stages of change, to help diet consultants identify ways to increase vegetable consumption in Japanese adults.

MATERIALS AND METHODS

Study design and participants

A web-based, self-administered questionnaire survey was conducted. The participants were recruited between September 2017 and January 2018 among university and vocational school students majoring in nutrition, medical staffs, and local area residents in the Aichi, Osaka, and Kyoto prefectures of Japan. Participants were provided with a study protocol paper with a QR code that introduced them to the website. The inclusion criteria were people of age 20 years or more and who could respond to the questionnaire using their own device. A total of 398 individuals responded to the web-based survey. Nineteen respondents were excluded because they did not meet the lower age limit of at least 20 years. The final number of adults enrolled in this study was 379.

Development of questionnaire

With reference to a previous study, the questionnaire developed for the web-based survey consisted of demographic parameters (age, marital status,

employment status, household income, residential situation), body mass index (BMI), vegetable consumption per meal (breakfast, lunch, dinner, snack), stage of change (pre-contemplation, contemplation, preparation, action/ maintenance), decisional balance (perceived benefits and barriers), the importance of vegetable consumption, and confidence (self-efficacy) in eating five SVs of vegetables per day.

The following question was asked to assess vegetable consumption: "About how many SVs of vegetables do you consume for breakfast, lunch, and dinner, and as a snack?", similar to the studies by Barad *et al.* (2019), and McGuirt, Jilcott & Gustafson (2018). Pictures and descriptions of vegetables, including root vegetables and vegetable juices, were provided. According to Health Japan 21 (published by the Ministry of Health, Labor and Welfare, 2012) and the Dietary Guidelines for Japanese (Ministry of Agriculture, Forestry and Fisheries, 2010), vegetables did not include potatoes, mushrooms, seaweed, or soybeans. A visual call-out box providing examples of SV sizes was included in the questionnaire; 0.5, 1, and 2 SVs consisted of 35, 70, and 140 g of raw vegetables, respectively. The red oval in Figure 1 indicates SV size of 0.5. The options for SV size per meal in the questionnaire were none, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, and 5 or more.

The stages in the TTM model can be applied to dietary behaviours, such as the consumption of vegetables and fruits in adults, as reported by Laforge, Greene & Prochaska (1994). The following question was asked to assess the stage of change for vegetable consumption: "Are you currently eating the target amount (350 g or more per day) of vegetables?". The answer options were as follows: "No intention of starting in the next six months" (pre-contemplation), "Intention of starting in the next six months" (contemplation), "Intention of starting in the next 30 days" (preparation), "Engagement in activity for less than six months" (action), and "Engagement in activity for more than six months"

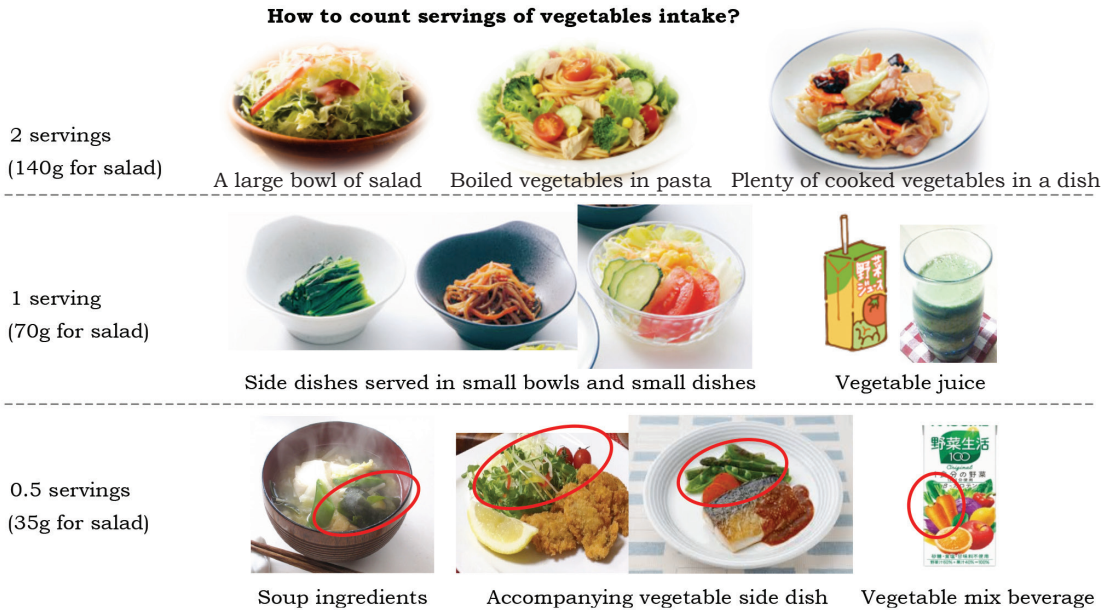

Figure 1. Number of servings as a guide for vegetable consumption

(maintenance). These answers were scored from 1 to 4, respectively, with the action and maintenance stages combined.

The questionnaire initially included 15 items related to perceived benefits and 15 items related to perceived barriers. Each item was scored on a 5-point Likert scale ranging from "strongly disagree" (1 point) to "strongly agree" (5 points).

Evaluation

The questionnaire was modified through evaluation by five dietitians and three researchers, who were engaged in diet consultation for outpatients with non-communicable diseases and their prevention.

Scaling

Exploratory factor analysis was performed using the Promax rotation to determine the factor structure of the benefits and the barriers, and to create scales of benefits and barriers.

The factor analysis involved the Promax rotation of the retained items. Promax rotation maximises the sum of the variance of the squared loadings, where loading is defined as the correlation between the item and the factor. It highlights a small number of key items, which simplifies the interpretation of the results. The interpretation of the rotated value involved the identification of the items loaded on each retained factor, the determination of the conceptual meaning of the items loaded on the same factor, and the conceptual differences between the items loaded on different factors. The relationship between each item and the underlying factor was expressed by the rotated factor loading value. Pattern loadings with an absolute value of approximately 0.35 or more were used to interpret the results, according to Hatcher (1994).

Validity

The items assessing perceived benefits and perceived barriers were tested for construct validity using the Kaiser–Meyer–Olkin (KMO) test. A KMO value of approximately 1 is good, and a value of 0.6 is acceptable. Items with KMO values <0.5, which indicates low communality, can usually be excluded from the analysis based on a previous report by Cerny & Kaiser (1977).

Reliability

The reliability of the questionnaire was evaluated using Cronbach's alpha coefficient, which scores internal consistency as follows: <0.5: unacceptable; 0.5 to <0.6: poor; 0.6 to <0.7: questionable; 0.7 to <0.8: acceptable; 0.8 to <0.9: good; and ≥0.9: excellent, as reported by Heo, Kim & Faith (2015).

The reliability of participants' responses to the questions was assessed by comparing two time points using intraclass correlation coefficients (ICCs) with 95% confidence intervals (CIs). The interval between the test and retest was at least one week, but less than four weeks. The ICCs were calculated using a 2-way mixed model based on absolute agreement. The strength of the agreement was rated as suggested by Landis & Koch (1977) as follows: <0.00: poor; 0.00–0.20: slight; 0.21–0.40: fair; 0.41–0.60: moderate; 0.61–0.80: substantial; and 0.81–1.00: almost perfect.

Statistical analysis

The association of decisional balance with vegetable consumption was analysed using logistical regression analysis. Trend analysis and *T*-scores were used to examine the relationship between decisional balance and the stage of change. Statistical significance

was set at $p<0.05$. Hedges' g was used to categorise effect sizes as small, medium, or large (g = 0.20, 0.50, and 0.80, respectively). The correlation between the decisional balance score and vegetable consumption was provided by Spearman's rank correlation coefficients. All statistical analyses were performed using the IBM SPSS Statistics version 20.0 (IBM Corp, Armonk, New York, USA).

Ethical approval

Informed consent was obtained from all participants prior to the start of the survey. The study design was approved by the ethics committee of Kyoto Medical Centre (18-095).

RESULTS

Characteristics of the participants

Our study comprised of 379 adults aged 20–70 years (mean age: 30.5±12.6 years; men: 21.4%) with a mean body mass index (BMI) of 21.0±2.8 kg/m^2. More than two-thirds were single (71.2%), although most lived with their families or others (67.3%). The annual household income was low (<2 million yen) in 4.0%, middle (>2 to <6 million yen) in 24.5%, high (>6 million yen) in 31.7%, and unknown in 39.8%. The number of vegetable SVs per day was 2.59±1.46; per meal was 0.36±0.48 (breakfast), 0.84±0.58 (lunch), 1.35±0.79 (dinner), and 0.05±0.19 (snack). Overall, 237 participants (62.5%) were aware of the current recommendation for vegetable consumption.

Scaling

Using exploratory factor analysis, six items (three for perceived benefits and three for perceived barriers) were excluded from the questionnaire owing to the factor loading value of <0.35. For perceived benefits, the excluded items were "I feel guilty if I don't eat vegetables", "Eating vegetables pleases my family", and "I drink vegetable juice as a part of meal every day" (questions 4, 10, and 15 on the questionnaire, respectively). For perceived barriers, they were "I don't know what vegetables I should buy", "Eating vegetables takes time", and "I don't have utensils for cooking vegetables" (questions 1, 5, and 10, respectively). The final 24 items had a two-domain structure ("pleasure" and "healthy") for perceived benefits and a three-domain structure ("not attractive", "low priority", and "hard to get") for perceived barriers.

Validity

The KMO values for the 12 items in the perceived benefits category and 12 items in the perceived barriers category were good (0.887 and 0.876, respectively).

Reliability

The two domains for perceived benefits (Cronbach's alpha: 0.82 and 0.79, respectively) and the three domains for perceived barriers (Cronbach's alpha: 0.82, 0.76, and 0.76, respectively) demonstrated acceptable or good internal consistency (Table 1). The Cronbach's alpha coefficients ranged between 0.76–0.87, which were within the range previously reported by Ma *et al.*, (2002) and Fontes *et al.*, (2005) for pro and con items, and the process of change measurements in adults had high internal consistency (Table 1). The test-retest reliability study showed that the agreement ICCs was 0.77 (95% CI 0.59-0.88), demonstrating 'substantial'.

Association of vegetable consumption with stage of change and decisional balance

Regarding the stage of change for vegetable consumption, 10.6% of the participants were in the pre-contemplation stage, 63.6% were in

Table 1. Factors and factor loading values for vegetable consumption

	Items	*Factor loading*
Perceived benefits (Cronbach's α = 0.87)		
Pleasure (Cronbach's α = 0.82)		
9	Eating fresh vegetables makes me feel better.	0.79
3	Vegetables are delicious.	0.77
8	Eating seasonal vegetables puts me in touch with the season.	0.71
14	A variety of vegetables makes eating enjoyable.	0.69
2	Eating vegetables refreshes my mouth.	0.51
5	I feel full after eating vegetables.	0.47
Healthy (Cronbach's α = 0.79)		
7	Eating vegetables improves my appearance (especially my skin condition).	0.75
12	Eating vegetables helps me stay healthy.	0.75
13	Vegetables are healthy because of low energy density.	0.60
6	Eating vegetables aids bowel movements.	0.48
1	Eating vegetables maintains a good physical condition.	0.40
11	Dishes with vegetables look appealing and colorful.	0.40
Perceived barriers (Cronbach's α = 0.87)		
Not attractive (Cronbach's α = 0.82)		
8	Vegetables are boring because of limited cooking methods.	0.73
3	Vegetables do not last long and cannot be used up well.	0.66
9	Cooking and preparing vegetables is time-consuming.	0.65
6	It is difficult to buy the right amount of vegetables.	0.59
11	The vegetables I cook myself are not tasty.	0.47
13	Buying vegetables is not economical.	0.40
7	I do not feel satisfied after eating vegetables.	0.39
Low priority (Cronbach's α = 0.76)		
14	I do not eat vegetables when I have a late dinner.	0.82
15	I do not eat vegetables when I am tired.	0.73
12	I do not eat vegetables if there are other choices more to my liking.	0.50
Hard to get (Cronbach's α = 0.76)		
4	It is difficult to go to stores to buy vegetables.	0.79
2	I do not have time to buy or obtain vegetables.	0.70

contemplation, 8.7% in preparation, and 17.1% in action/maintenance stages. The characteristics of the participants at each stage of change are shown in Table 2. Since more than 60% of the participants belonged to the contemplation stage, concern arose about the statistical analysis being affected by unbalanced stage settings. It was assumed that the effect of unbalanced settings was small because the trend analysis demonstrated 'reasonable'. The number of SVs for the stages were 2.04, 2.23, 2.67, and 4.22, respectively (p for trend <0.001). For each meal except snacks, vegetable consumption increased across the stages (p for trend <0.001).

The decisional balance score (the benefit score minus the barrier score) was 0.72 for pre-contemplation, 1.28 for contemplation, 1.73 for preparation, and 2.30 for action/maintenance (p for trend <0.001). It increased in both benefit domains and decreased in all

Table 2. Characteristics of the participants by stages of change

Variables	*Stage of change*					*p* *PC vs A/M*
	All (n=379)	*PC (n=40)*	*C (n=241)*	*P (n=33)*	*A/M (n=65)*	
Age (years)	30.5±12.6	26.7±9.7	29.3±12.0	31.5±13.7	36.5±13.9	<0.001
Sex (female, %)	78.2	72.5	80.5	81.8	73.8	1.000
Body mass index (kg/m^2)	21.0±2.8	20.6±2.8	21.0±2.6	21.2±3.4	21.1±3.0	0.413
Marital status (single, %)	71.2	85.0	74.3	66.7	53.8	0.001
Household income (high, %)	52.6	27.3	53.6	47.4	63.3	0.009
Residential situation (alone, %)	32.7	35.0	34.4	42.4	20.0	0.109

Values are presented as mean±standard deviation
t-test and Fisher's exact test were used.
Household income: A total of 151 participants with missing data were excluded (PC, pre-contemplation = 18, C, contemplation = 103, P, preparation = 14, A/M, action/maintenance = 16)

three barrier domains across the stages (p for trend <0.001) (Table 3). At each stage, there was a significant difference between the *T*-scores for the benefit and the barrier items (Figure 2).

Higher vegetable consumption was associated with lower perceived barrier scores (odds ratio (OR): 0.42; 95% CI: 0.26, 0.68) and higher perceived benefit scores (OR: 2.75; 95% CI: 1.40, 5.40). Awareness of the importance of, and confidence (self-efficacy) in, eating five SVs of vegetables per day at each stage of change is shown in Table 3. Both parameters differed significantly across the stage of the change spectrum in the trend analysis (p<0.05).

Correlation between vegetable consumption and decisional balance

The number of vegetable SVs was directly proportional to the perceived benefits score and inversely proportional to the perceived barriers score (Spearman's correlation: 0.324 and -0.435, respectively). The decisional balance score was positively correlated with vegetable consumption (Spearman's correlation: 0.461; p<0.001). For each increase in the number of vegetable SVs, the benefits score increased by 0.76 (standard error: 0.12), whereas the barriers score decreased by 0.77 (standard error: 0.09). Interestingly, the effect sizes for the pro and con items were similar (Hedges' g: 1.18 and 1.29, respectively).

DISCUSSION

We developed and validated a diet consultation tool to assess the perceived benefits and barriers of vegetable consumption in adults. In contrast to a prior study by Wang *et al.* (2016), our results showed a very clear relationship between vegetable consumption and decisional balance, as well as decisional balance and stage of change. Thus, the developed questionnaire stands useful for promoting vegetable consumption.

The clear association between increasing vegetable consumption and decreasing barrier score in accordance with the progress in the stage of change is a useful message for diet consultants

Table 3. Vegetable consumption and decisional balance scores by stages of change

Stages of change	*All (n=379)*	*PC (n=40)*	*C (n=241)*	*P (n=33)*	*A/M (n=65)*	*p*
Vegetable consumption, SVs						
Breakfast	0.36±0.48	0.19±0.29	0.26±0.38	0.41±0.46	0.78±0.63	<0.001
Lunch	0.84±0.58	0.81±0.55	0.73±0.53	0.89±0.46	1.24±0.64	<0.001
Dinner	1.35±0.79	1.04±0.58	1.20±0.68	1.33±0.55	2.11±0.95	<0.001
Snack	0.05±0.19	0.00±0.00	0.04±0.18	0.03±0.12	0.10±0.28	0.013
Decisional balance score†	1.43±1.12	0.72±0.79	1.28±1.07	1.73±0.86	2.30±1.10	<0.001
Benefits†						
Total score	4.00±0.60	3.66±0.62	3.95±0.59	4.16±0.42	4.32±0.52	<0.001
"Pleasure"	3.92±0.71	3.55±0.74	3.85±0.71	4.12±0.48	4.31±0.58	<0.001
"Healthy"	4.08±0.61	3.77±0.64	4.04±0.62	4.21±0.48	4.33±0.52	<0.001
Barriers†						
Total score	2.57±0.76	2.94±0.61	2.67±0.72	2.43±0.71	2.02±0.77	<0.001
"Not attractive"	2.81±0.82	3.16±0.64	2.92±0.77	2.69±0.82	2.27±0.88	<0.001
"Low priority"	2.16±0.96	2.56±0.93	2.26±0.97	2.10±0.88	1.58±0.76	<0.001
"Hard to get"	2.30±1.09	2.75±1.19	2.40±1.09	2.02±0.91	1.79±0.94	<0.001
Importance/ Confidence‡						
Importance	4.47±0.62	4.08±0.66	4.43±0.62	4.64±0.49	4.78±0.52	0.001
Confidence	2.17±1.18	1.65±0.77	1.90±0.98	2.09±0.91	3.52±1.21	<0.001

Values are presented as mean±standard deviation.
p for trend analysis was used to examine the relationship between the values and the stage of change.
PC (pre-contemplation, *n*=40), C (contemplation, *n*=241), P (preparation, *n*=33), A/M (action/ maintenance, *n*=65)
†The decisional balance score consisted of 12 benefits and 12 barriers items scored from 1 to 5 Likert scales anchored from 1 = not important (confident) up to 5 = completely important (confident)
‡The question is "How important (confident) are you on a scale of 1 to 5 that you eat 5 SVs of vegetables, with 1 being not at all important (confident) and 5 being very important (confident)?"

who promote vegetable consumption. This is because the removal of a barrier factor is more important than adding a benefit factor for people in the early stage due to lack of confidence (self-efficacy).

In our study, the decisional balance score varied across the stages of change, which is consistent with the findings of previous studies by Greene *et al.* (2004), Mainvil *et al.* (2010), and Chuan & Horwath (2001).

Implication for practice

From the perspective of cost effectiveness, it is important to adopt a stage-matched intervention using a population strategy. Further study is needed to develop an effective diet consultation intervention programme that promotes vegetable consumption using the developed questionnaire.

In addition, it is desirable to monitor the population strategy for health promotion in local communities, occupational health, schools, hospitals, etc., through a regular web-based survey using the developed questionnaire.

Limitation

This study has some limitations. Firstly, it included only Japanese adults. Further investigation is required to determine

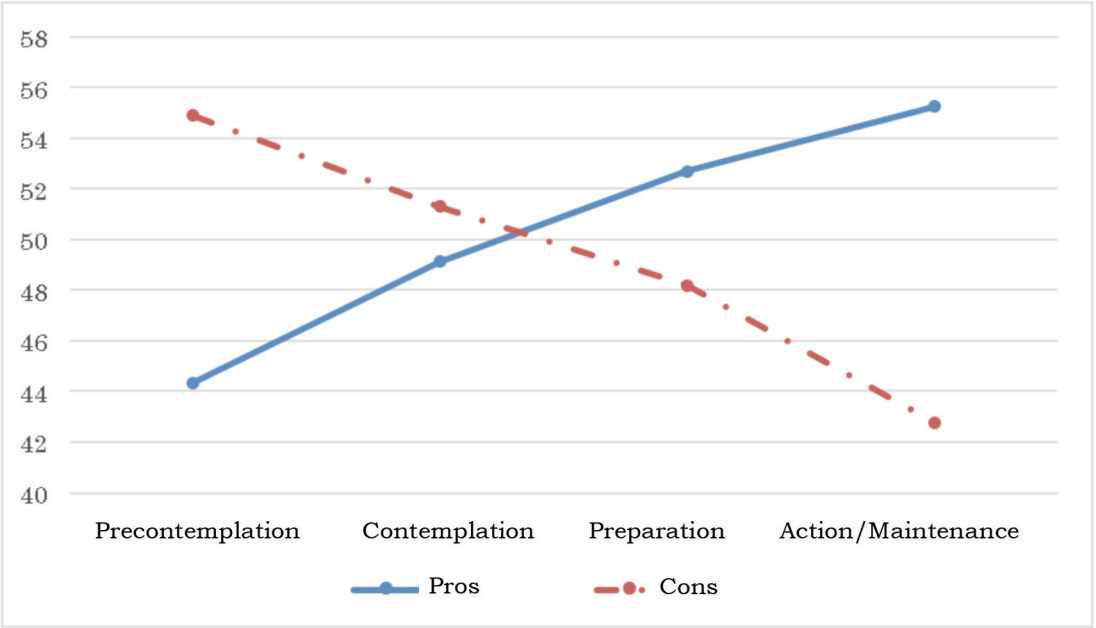

Figure 2. Benefit and barrier *T*-scores by stage of change. The scores are presented as standardised *T*-scores (mean=50, standard deviation=10)

Supplemental Table S2. Likert scale values: stages of change and importance/confidence of vegetable consumption

Item	*Stages of change*					*p*
	All (n=379)	*PC (n=40)*	*C (n=241)*	*P (n=33)*	*A/M (n=65)*	
Importance	4.47±0.62	4.08±0.66	4.43±0.62	4.64±0.49	4.78±0.52	0.001
Confidence	2.17±1.18	1.65±0.77	1.90±0.98	2.09±0.91	3.52±1.21	<0.001

Values are presented as mean±standard deviation.
PC (pre-contemplation), C (contemplation), P (preparation), A/M (action/maintenance)
Likert scales anchored from 1 = not important (confident) up to 5 = completely important (confident). The question is, "How important (confident) are you on a scale of 1 to 5 that you eat 5 SVs of vegetables, with 1 being not at all important (confident) and 5 being very important (confident)?"
p for trend analysis was used to examine the relationship between the values and the stage of change.

whether our results can be extended to other ethnic groups and children. Moreover, it is important to examine the willingness to eat vegetables at an earlier age. Secondly, we did not consider the stage of change or decisional balance variations for different vegetable categories such as tuber, leafy and non-leafy vegetables. Finally, the data were self-reported and were therefore subjected to recall bias.

CONCLUSION

The developed questionnaire is a valid, reliable, and useful tool for diet consultants to assess the perceived benefits and barriers of vegetable consumption in Japanese adults.

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Authors' contributions

YK, principal investigator, conceptualised and designed the study, prepared the draft of the manuscript and reviewed the manuscript; JS, led the data collection, advised on data analysis and interpretation, and reviewed the manuscript; NS, conducted the study, conceived the ideas, reviewed the manuscript; CK, conducted data analysis and interpretation, and reviewed the manuscript; AS, collected and analysed the data.

Conflict of interest

The authors declare no conflict of interest.

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Development of nutrition screening guideline content for use by healthcare staffs in older adults in health clinic setting: A scoping review

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ABSTRACT

Introduction: Malnutrition, specifically undernutrition, in community-dwelling older adults reduces their well-being and predisposes to diseases. Therefore, timely malnutrition identification through nutrition screening is needed to identify at risk and malnourished patients. This study aimed to develop the content of nutrition screening guideline to facilitate healthcare staffs in health clinics to administer a validated nutrition screening tool specifically for older adults. **Methods:** A scoping review was conducted electronically using SCOPUS, PubMed, ProQuest Health & Medical Complete, and Cochrane databases. The systematic search was performed up to 31st December 2021. Search terms were created for identification of eligible and related articles. Inclusion and exclusion criteria were determined for the systematic search. The search was limited to English and Malay languages, and full text articles with no limitation of years. All data were extracted and analysed, guided by the PRISMA extension for scoping reviews (PRISMA-ScR). **Results:** From 728 identified articles, 18 articles were included in the analysis. Identified information for the guideline content were: introduction, aims and objectives, definition of malnutrition, prevalence of malnutrition, implementation of nutrition screening, guidance on administering items in validated tools, and guidance on anthropometric measurements. Meanwhile, format and flow charts from established guidelines served as references for the guideline development process. **Conclusion:** Appropriate content to develop a nutrition screening guideline has been identified based on this review. Development of a guideline based on this content can facilitate healthcare staffs to perform timely nutrition screening in older adults.

Keywords: healthcare staffs, malnutrition, nutrition screening guideline, older adults, scoping review

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INTRODUCTION

Older adults are susceptible to malnutrition due to physiological changes, side effects of medication, chronic diseases, functional decline (Mathew & Funderburg, 2007; Volkert, 2002), socioeconomic factors (Donini *et al.*, 2013; Eldardery, Mo'awad & Fouad, 2018), loneliness, depression, and anxiety (Kennelly *et al.*, 2010). Malnutrition has been defined as "a subacute or chronic state of nutrition, in which a combination of varying degrees of under- or over-nutrition and inflammatory activity have led to a change in body composition and diminished function" (Soeters *et al.*, 2008, p. 708). In this review, malnutrition is referred as undernutrition.

Malnutrition has been described as a 'silent crisis' in older adults because it often remains undetected (Davidson & Getz, 2004). According to the World Health Organization (WHO), the prevalence of malnutrition in older people living in the community ranges between 1.3% and 47.8% (WHO, 2017). Previous studies have shown percentages of 27% to 38% of older adults at risk and malnourished in community setting (Kaiser *et al.*, 2010; Volkert *et al.*, 2019; Winter *et al.*, 2013). Meanwhile, in Malaysia's community setting, the prevalence of malnutrition is between 34.0% to 48.9% and 42.2% to 66.6% of male and female older adults, respectively, having risk of malnutrition (Muhamad *et al.*, 2019; Suzana *et al.*, 2013; Zainudin *et al.*, 2019). If malnutrition is left untreated, it will lead to undesirable health effects. Malnourished older adults have high risk of mortality (Söderström *et al.*, 2017), poorer function, low quality of life (Eldardery *et al.*, 2018), and delayed wound healing (Ahmed & Haboubi, 2010).

Timely malnutrition identification and management are needed for patients and healthcare benefit (Brotherton *et al.*, 2011). Identification of malnutrition risk can be performed through nutrition screening. Nutrition screening is the first step in identifying patients who are at risk of nutritional problems or who have undetected malnutrition (Elia *et al.*, 2011; Mathew & Funderburg, 2007). Therefore, nutrition screening is advocated for malnutrition identification. However, malnutrition identification in community living older adults through nutrition screening in health clinics in Malaysia is not systematically performed; although it is recommended to be conducted routinely across all healthcare settings (Elia, Zellipour & Stratton, 2005). Due to this, malnutrition is still under-recognised and under-treated due to the absence of formal screening procedures in health clinic setting (Elia *et al.*, 2005; Kennelly *et al.*, 2010). Thus, malnutrition identification through nutrition screening is required for provision of appropriate nutritional care among at-risk and malnourished patients (Brotherton *et al.*, 2011).

There are many available validated nutrition screening tools - Mini Nutritional Assessment Short-Form (MNA-SF), Nutritional Risk Screening (NRS 2002), Malnutrition Universal Screening Tool (MUST), Elderly Nutrition Screening (ENS), Malnutrition Screening Tool (MST), Seniors in the Community: Risk Evaluation for Eating and Nutrition questionnaire I (SCREEN) and others (Hamirudin, Charlton & Walton, 2016). However, from all of these validated nutrition screening tools mentioned, MNA-SF has been identified as the most appropriate tool for older adults in community, based on its specificity and sensitivity (Philips *et al.*, 2010). Most importantly, it has been validated in Malaysia (Suzana & Siti Saifa, 2007).

Previous studies have discussed regarding barriers and opportunities to perform nutrition screening. Lack

of education and knowledge has been identified as one of the barriers (Craven *et al.*, 2017; Endevelt *et al.*, 2009; Hamirudin *et al.*, 2013; Vandewoude *et al.*, 2011). Therefore, opportunities need to be identified to ensure that nutrition screening can be routinely performed. Opportunities like providing education and knowledge related to nutrition screening have been highlighted as one of the enablers (Craven *et al.*, 2017; Endevelt *et al.*, 2009; Vandewoude *et al.*, 2011).

Guideline is defined as "systematically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances" (Lohr & Field, 1992, p.2). Current established guidelines in the Malaysian health clinic setting are related to flow, system and policy (BPPK, 2015; IHSR, 2018). Besides, other available guidelines are related to guidance on how to perform community screening programme in health clinic operating areas (BPPK, 2013). To date, there is no comprehensive guideline specifically for malnutrition risk identification in the Malaysian health clinic setting. Thus, the development of nutrition screening guideline is needed for healthcare staffs to provide knowledge on nutrition screening procedures in older adults. Hence, this scoping review aimed to develop the content of nutrition screening guideline to facilitate healthcare staffs in health clinics to administer validated nutrition screening tool specifically for older adults.

MATERIALS AND METHODS

Study design

A scoping review is defined as a synthesis of knowledge that follows a systematic approach aimed to map particular topic, main concepts, theories, sources, and knowledge gaps (Tricco *et al.*, 2018). The development of this scoping review was guided by the PRISMA extension for scoping reviews (PRISMA-ScR) (Tricco *et al.*, 2018).

The scoping review was conducted to answer the research question comprehensively (Munn *et al.*, 2018). Therefore, identifying research question was the early stage in conducting a scoping review (Arksey & O'Malley, 2005; Tricco *et al.*, 2018). Scoping reviews are useful in answering much broader questions (Tricco *et al.*, 2018). In this study, the research question was "What are the suitable content that can be included to develop a nutrition screening guideline?". Besides, Arksey & O'Malley (2005) have suggested to develop and maintain a broad approach of research question and refine it in a collaborative research team; which has been the construct of this scoping review. The aim was to generate a breadth of coverage. In scoping reviews, inclusion of grey literature is based on research question and objective, which should be reported if done (Tricco *et al.*, 2018). Thus, to answer the primary question, identifying relevant studies through different sources (electronic databases and manual search) was performed in this scoping review.

Search strategy

Four electronic search engines; SCOPUS, PubMed, ProQuest Health & Medical Complete, and Cochrane were used to identify eligible articles. Manual search was also performed in identification of related articles. Systematic search was conducted up to 31st December 2021. The search was limited to English and Malay languages, full text articles with no limitation of years. Search terms in Box 1 were used in order to identify studies that had provided relevant content to the guideline. Keywords and Boolean operators were used in the search strategy for comprehensive search.

("Nutrition*" OR "Nutrition*risk*" OR "Malnutrition" OR "Undernutrition" OR "Malnourished" OR "Undernourished" OR "Nutrition* status") AND ("Elder*" OR "Geriatric*" OR "Ageing" OR "Aging" OR "Older adult*" OR "Older people" OR "Senior" OR "Senior citizen" OR "Veteran") AND ("Nutrition* screening" OR "Screen*" OR "Nutrition*risk screen*" OR "Screening tool*") AND ("Community" OR "General practice*" OR "Outpatient" OR "Clinic*" OR "Primary care") NOT ("Hospital" OR "Nursing home*" OR "Inpatient" OR "Ward") NOT ("Children" OR "Paediatric" OR "Pediatric" OR "Adult*" OR "Young adult*" OR "Adolescent*") NOT ("Maternal" OR "Pregnant")

Box 1. Search algorithm used in the review

Selection criteria

The inclusion criteria in this review were: (1) older adults aged 60 years and above, (2) studies in community, clinics, general practice, primary care, and outpatient settings, (3) studies using validated nutrition screening tools, (4) publication either in Malay or English languages, and (5) full text. Meanwhile, the exclusion criteria were (1) aged below 60 years old, (2) studies in hospital, nursing home, inpatient, and ward settings, (3) studies using assessment tools, (4) studies on relationship, association, assessment, and prevalence, (5) studies on nutrition risk, and (6) studies on nutrient or biomarker. Studies that did not provide any content to the development of nutrition screening guidelines were excluded.

Data extraction

Articles that were obtained in the identification step were then screened, where duplicate articles were discarded. Documents were screened based on title and abstract; and full text articles were examined to find relevant documents that answered the aim of this review. Data were extracted on purpose of the study, study design, sample characteristics, main outcome from results, and method of study. Sample characteristics included participants, sample size, and study setting.

Level of evidence and quality appraisal

Level of evidence and quality of the studies were identified and presented in Table 1. Level of evidence were assigned to the studies based on their methodological quality, validity, and applicability to patients (Ackley *et al.*, 2008). Level I was the highest ranking of evidence; whilst level VII was the lowest. Level I was evidence from a systematic review or meta-analysis from randomised controlled trials and clinical guidelines based on systematic review or meta-analysis; Level II represented evidence from one or more randomised controlled trials; Level III was evidence from controlled trials without randomisation; Level IV was evidence from case-control or cohort studies; Level V was evidence from systematic reviews of descriptive and qualitative studies; Level VI was evidence from a single descriptive or qualitative study; and finally, level VII represented evidence from expert opinions (Ackley *et al.*, 2008).

Meanwhile, quality of the studies was assessed by two researchers independently. The National Heart, Lung, and Blood Institute (NHLBI) assessment tool was used for quantitative studies (NHLBI, 2014), while the Critical Appraisal Skills Programme (CASP) was used for mixed-method and qualitative studies (CASP, 2013). The NHLBI tool consisted of 14 questions about study quality, while the CASP tool included ten items. Researchers then needed to rate the study as Good, Fair, and Poor based on the researchers' answers. For qualitative assessment, the ratings were based on overall qualitative judgement and not based on summary scores. Sampling methods, sample

characteristics, participation rate, and analysis method were the questions focused in both tools. Discrepancies of study quality rated by researchers were resolved through discussion. The quality rating of each study is presented in Table 1.

RESULTS

The identification step retrieved 728 documents by using the search engines mentioned and manual search as shown in Figure 1. Duplicate studies were removed and this resulted in 564 documents. Then, all documents were screened thoroughly based on title and abstract. This procedure resulted in 101 full text articles that were reviewed for eligibility for inclusion in the final review. Finally, 18 articles met the inclusion criteria, which are summarised and tabulated in Table 1. Table 1 presents the main outcome or method that have been discussed in articles and can be included in the content of the guideline.

Characteristics of included papers

18 journal articles (Table 1) were included in the review. Of these 18 journal articles, nine studies discussed regarding barriers, enablers, and facilitators to conduct nutrition screening among older adults (Avgerinou *et al.,* 2020; Craven *et al.*, 2017; Endevelt *et al.*,2009; Gaboreau *et al.*, 2013; Green *et al.*, 2014; Hamirudin *et al.*, 2013; Mays *et al.*, 2019; Vandewoude *et al.*, 2011; Winter *et al.*, 2013). Meanwhile, another eight studies mentioned about anthropometric measurements and guidance on administering validated screening tools (Butler *et al.*, 2017; Callen & Wells, 2005; Chatindiara *et al.*, 2019; Cuervo *et al.*, 2009; El-Desouky & Abed, 2017; Ghimire, Baral & Callahan, 2017; Rodriguez-Tadeo *et al.*, 2012; Villaverde-Gutiérrez *et al.*, 2015). One expert opinion was included in this review as the aim was to provide guidelines for undernutrition screening in primary care setting and suggest strategies to address undernutrition in older patients (Flanagan *et al.*, 2012). Most of the studies were cross-sectional studies. The year of these included studies were between 2005 to 2020.

Barriers and opportunities to conduct nutrition screening

Results in Table 1 showed the identified barriers and opportunities to conduct nutrition screening. Based on these articles retrieved, five studies discussed barriers to conduct nutrition screening (Avgerinou *et al.,* 2020; Craven *et al.*, 2017; Gaboreau *et al.*, 2013; Green *et al.*, 2014; Hamirudin *et al.*, 2013). Barriers to screening were common to both patients and healthcare staffs (Harris *et al.*, 2019). Time factor was one of the barriers to conduct nutrition screening as mentioned by five studies (Avgerinou *et al.,* 2020; Craven *et al.*, 2017; Gaboreau *et al.*, 2013; Green *et al.*, 2014; Hamirudin *et al.*, 2013). Lack of knowledge and training (Avgerinou *et al.,* 2020; Craven *et al.*, 2017; Gaboreau *et al.*, 2013; Hamirudin *et al.*, 2013), general practice limitations (Hamirudin *et al.*, 2013), funding and resources, as well as organisational factors (Avgerinou *et al.,* 2020; Craven *et al.*, 2017) were also identified as barriers to conduct nutrition screening.

On the other hand, nine studies regarding opportunities to perform nutrition screening have been identified (Avgerinou *et al.,* 2020; Craven *et al.*, 2017; Endevelt *et al.*, 2009; Flanagan *et al.*, 2012; Green *et al.*, 2014; Hamirudin *et al.*, 2013; Mays *et al.*, 2019; Vandewoude *et al.*, 2011; Winter *et al.*, 2013). Opportunities and enablers that are stated in Table 1 can be taken into consideration for the development of content. Based on the results,

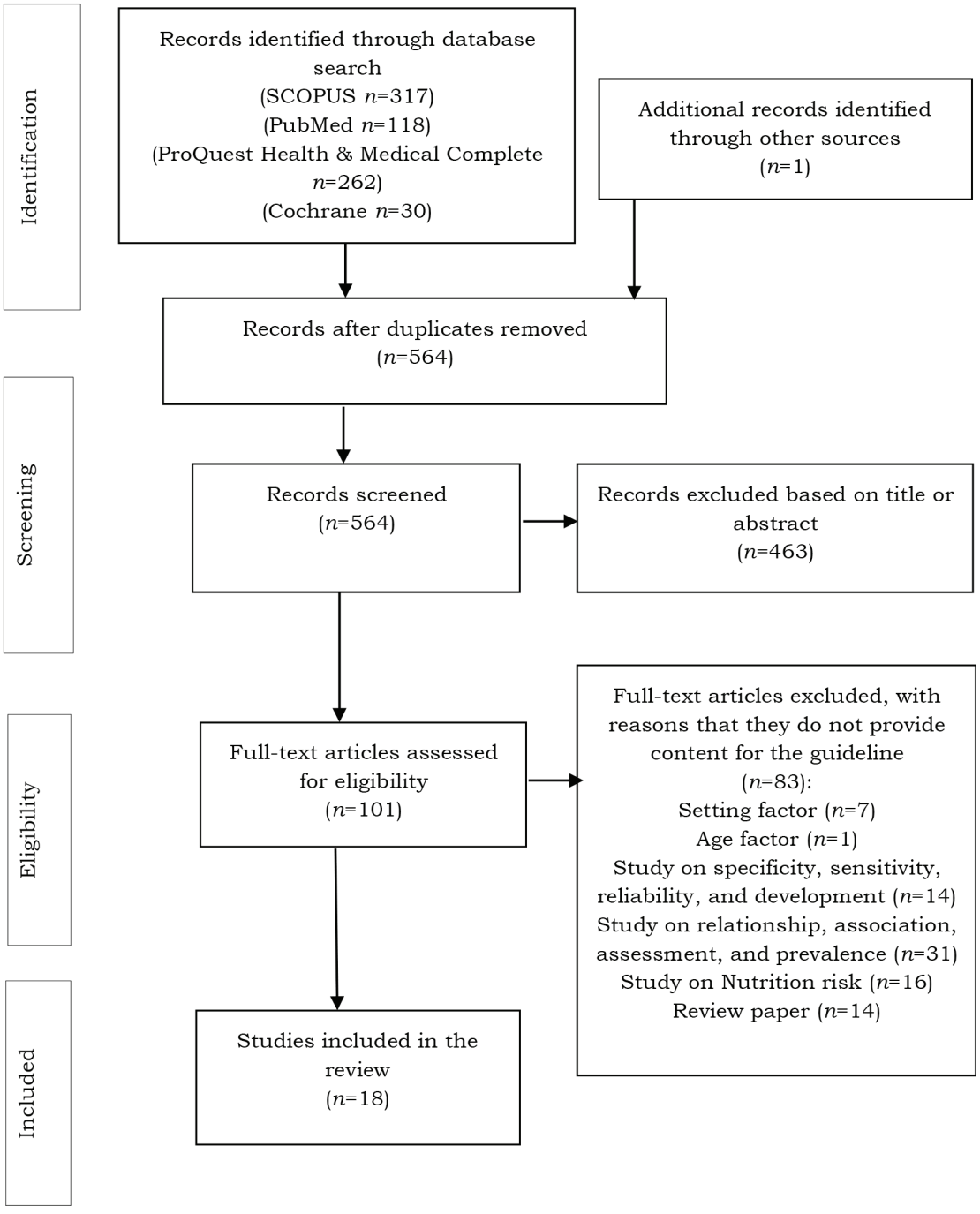

Figure 1. Flow chart illustrating the selection process of documents to be included in this review guided by PRISMA extension scoping reviews (PRISMA-ScR)

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
1	Craven *et al.*, (2017) Australia	Barriers and enablers to malnutrition screening of community-living older adults: A content analysis of survey data by Australian dietitians Purpose: To identify barriers and enablers to malnutrition screening of CLOAs from the perspective of dietitians	Mixed-method	• Setting: Community • Participants: Dietitians working for government, not-for-profit and private organisations in Australia (working with community living older adults ≥65 years old) • Total participants: (*n*=92) • Dietetic experience range: 1-42 years (median: 8 years) • Years working with CLOAs: 1-35 years (median: 5 years)	Barriers to malnutrition screening: 1. Organisational factors - Time - Funding and resources - Policy and procedure - Training and education 2. Staff factors - Knowledge - Screening burden - Management support 3. Older adult factors - Knowledge and communication Enabler to malnutrition screening: 1. Organisational factors - Policy and procedure - Training and education - Funding and resources 2. Staff factors - Knowledge - Communication - Management support 3. Screening factors - Screening tools - Screening outcome	1. Training and education 2. Organisation: Policy and procedure of nutrition screening 3. Staff involved 4. Screening tools: Validated nutrition screening tool 5. Screening outcome (pathway for intervention)	Level VI	Good

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
2	Endevelt *et al.* (2009) Israel	Nurses' knowledge and attitudes regarding nutrition in the elderly Purpose: To assess nurses' knowledge and attitudes regarding nutritional care for the elderly, and the impact of their attitude on the quality of assessment-care they provide to this growing population in need of nutritional-care	Cross sectional	• Setting: Healthcare service • Participants: Nurses at Healthcare services • Total participants: (n=159) Mean age (years±SD): 36.7±13.6	1. Participants' attitudes, knowledge and practice - 60% agreed or strongly agreed that it is difficult to change nutritional behaviours among the older adults - 85% agreed or strongly agreed that a dying older adults patient should receive nutritional care 2. Knowledge about nutrition - 89% agreed with the statement that it is a difficult task to change nutritional habits in the older adults population 3. Attitudes concerning the contribution of nutrition to various conditions - The majority (79%-95%) agreed or strongly agreed that nutrition influences outcomes in cases of obesity, diabetes, and high blood pressure 4. Treat of nutritional issues in the older adults - 32% of the nurses strongly agreed that it should be physicians and 63% thought that dietitians should provide nutritional care - 38% strongly agreed that nurses themselves should provide nutritional care. 11% of the nurses strongly agreed that their knowledge of nutrition could help influence the nutritional habits and behaviours of their older adults patients	1. Training and education by provision of knowledge related to nutrition screening for nutritional problems in older adults 2. Effects and consequences of nutritional problem 3. Role of healthcare professional in treating of nutritional issues in older adults population	Level VI	Poor

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
3	Vandewoude *et al.* (2011) European countries	Variability of nutritional practice by Geriatricians across Europe Purpose: To learn more about the knowledge and attitudes of geriatricians across Europe towards nutrition and their interest in receiving training	Quali-tative	• Setting: Community setting (Geriatric care) • Participants: Geriatricians from European Union Geriatric Medicine Society (EUGMS) • Total participants: (n=208), ratio male/female: 1:3	• Respondents with longer medical practice were less likely to identify training needs in nutrition (p=0.038) or to express interest in attending educational courses (p=0.041) • 20.3% of respondents had formal nutrition training, although nearly all indicated that they routinely considered nutrition when promoting healthy ageing • E-learning was the preferred education format (48.4%), followed by symposia for 38.5% • Less likely to identify training needs in nutrition or to express interest in attending educational courses • Majority recognised that a weight loss of 5-10% over the previous 6 months as indicative of malnutrition risk, and 19% use body mass index cut-off value of 18.5 kg/m2 to initiate nutritional intervention • 55% considered a cut-off value of 20kg/m2 as indicative of malnutrition MNA and MUST were the most frequently used nutritional screening tools	1. Training and education 2. Guidance for validated nutrition screening tools 3. Screening tool: Validated nutrition screening tool that suits with the older adults population	Level VI	Fair

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
4	Gaboreau *et al.* (2013) France	What are key factors influencing malnutrition screening in community dwelling elderly populations by General Practitioners? A large cross-sectional survey in two areas in France Purpose: To determine knowledge, attitude and practice on malnutrition screening implementation in community-dwelling elderly populations by French GPs	Cross sectional	• Setting: Primary care • Participants: General practitioners in primary care • Total participants: (n=493)	• 72.2% felt that malnutrition screening was useful. • Only 26.6% implemented each year and 11.9% implement every 2-5 years Barriers: 1.Forgetting to screen 2. Lack of knowledge 3. Time 4. Unsuitable working conditions 5. Insufficient motivation 6. Technical support Promote of screening practices as part of GP functions	Promote screening as routine practice	Level VI	Fair
5	Hamirudin *et al.* (2013) Australia	'We are all time poor' Is routine nutrition screening of older patients feasible Purpose: To identify perceived barriers and opportunities to implementing nutrition screening in General Practice	Qualitative	• Setting: General Practice • Participants: Healthcare staff in General Practices • Total participants: (n=25) Gender: Male (n=9), Female (*n*=16)	Barriers: 1. Lack of time 2. Patient's attitude towards nutrition 3. General practice limitation 4. Lack of nutrition screening knowledge 5. Low priority for nutrition 6. Lack of resources 7.Outcomes of nutrition screening Opportunities: 1. Current practice 2. Patient's condition 3. Staff initiative	1. Based on current practice in clinics 2. Patient's condition 3. Staff	Level VI	Good

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
6	Green *et al.* (2014) United Kingdom	Barriers and facilitators to screening for malnutrition by community nurses: a qualitative study Purpose: To understand community nurses' perceptions of barriers and facilitators to undertaking nutritional screening	Qualitative	• Setting: Primary care services • Participants: Community nurses in organisation • Total participants: (n=20)	Barriers: 1. Professional judgement as good as screening 2. Time and resource to screen and intervene Facilitators and barriers: 1. Supportive (or unsupportive) organisational culture 2. Need for (or lack of) training and sharing good practice 3. Ease and acceptability of the screening tool Suggested ways: 1. Better communication between care setting	1. Training and education 2. Organisational 3. Screening tool: Validated nutrition screening tool	Level VI	Good
7	Cuervo *et al.* (2009) Spain	Impact of global and subjective Mini Nutritional Assessment (MNA) questions on the evaluation of the nutritional status: The role of gender and age Purpose: To study the independent value of the global and the subjective MNA questions to predict undernutrition according to the full MNA score, and to analyse the influence of gender and age on such items	Cross sectional	• Setting: Community • Participants: Community dwelling older adults in Spain (75±6.8) years (65-100 years old) • Total participants: (n=22,007) 8014 men (36.4%) and 13,993 women (63.6%) 75.2±6.8 years with a range from 65 to 100	Data collection method: • Height and weight self-reported. Measurement was performed if doubt Mobility (3 levels): 1. When participants were not able to get out of bed or chair 2. When the participants were able to get out of bed or chair but did not get out home 3. When he/she was able to go out home - Psychological stress or acute diseases was answered with information reported by the participant or by relative if it was needed - Neuropsychological problems (dementia or depression) was based on subjective impression of the interviewer	1. Guidance on asking the questions from validated nutrition screening tool 2. Guidance on anthropometric measurement	Level VI	Fair

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
8	Ghimire, Baral & Callahan (2017) India	Nutritional assessment of community-dwelling older adults in rural Nepal Purpose: 1. To validate a Nepalese version of the MNA tool 2. To use the MNA to estimate the prevalence of malnutrition among elderly people in the Okharpauwa Village Development Committee (VDC) in the Nuwakot District of Nepal	Cross sectional	• Setting: Community • Participants: Older adults people in Okharpauwa, Nepal • Total Participants: (*n*=242) Gender: Male (*n*=111) (45.9%) Female (*n*=131) (54.1%)	Data collection method: - Used four anthropometric assessments (participants wore light clothing and barefoot) 1. Height (using a mechanical stadiometer) 2. Weight (using a digital weighing scale) 3. Calf-circumference was measured on seated participants with an inextensible tape at several locations to find the maximal bare calf circumference 4. Mid-arm circumference - The participant's forearm was held in horizontal position to locate and mark the mid-distance between the acromial surface of the scapula and the olecranon process of the elbow. Arm need to hanging freely at the side, circumference at that marked arm mid-point was measured - BMI was calculated as weight in kg/ (height in m)^2	1. Guidance on anthropometric measurement a) Height b) Weight c) Calf-circumference (CC) d) BMI	Level VI	Good

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
9	Rodriguez-Tadeo *et al.* (2012) Mexico	Malnutrition risk factors among the elderly form US-Mexico border: The "One Thousand" Study Purpose: To examine nutritional, functional, and cognitive impairments, as well as depression, in non-institutionalized elderly Mexicans along Mexico's northern border	Observational, descriptive and cross-sectional	• Setting: Community • Participants: Older adults inChihuahua, Mexico (60-79 years old) • Total participants: (n=760) Gender: n=570 were women (75%), and n=190 were men (25%), with a mean age of 71.0±7.7 and 73.7±7.9 years, respectively	Anthropometric measurements: - Collected after standardisation for human error - Weight measurement need to be performed (little clothing as possible), without shoes, on a SECA 804 digital scale and recorded on the sheet of anthropometry (in kg). BMI will be calculated Physical limitations: - Used gender-specific formulas developed by Chumlea: 1. Height- estimated by knee height (use gender specific equations) 2. Arm and calf circumference in cm (using flexible fiberglass tape) 3. Waist circumference in the abdominal region 4. Skin folds were measured with a Lange skin fold calliper	1. Guidance on anthropometric measurement - Weight and Height -BMI -Measurement for individuals with physical limitations: 1. Calf circumference 2. Knee height 2. Weight measurement needs to be performed with as little clothing as possible, and without shoes, in kilogram (kg) 3. Provide gender-specific formula by Chumlea 4. List of tools for nutrition screening	Level VI	Fair

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
10	Chatindiara *et al.*, (2018) New Zealand	Associations between nutrition risk status, body composition and physical performance among community-dwelling older adults Purpose: To investigate the associations between nutrition risk status, body composition and physical performance among community-dwelling older New Zealanders	Cross sectional	• Setting: Community • Participants: Community-dwelling older adults aged 65 years and older • Total Participants: (n=257) Gender: Male (*n*=120) (46.7%), Female (*n*=137) (53.7%)	Data collection method: - All assessments were performed according to the MNA-SF user guide - Weight and height measured using portable stadiometer (SECA 213) - BMI was calculated (kg/m^2)	1. Guidance on anthropometric measurement -Weight and height - BMI 2. List of tools	Level VI	Good

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
11	Winter *et al.* (2013) Australia	Nutrition screening of older people in a community general practice using the MNA-SF Purpose: To determine the prevalence of malnutrition risk in a population of older people (aged 75 years and over) attending a community general practice and identify characteristics of those classified as malnourished or at risk of malnutrition	Cross sectional	• Setting: Community General Practice • Participants: Older adults75 years and over at general medical practices • Total participants: (n=225) Gender: Male 48% (n=108) female 52% (n=117)	Data collection: - Six nurses conducted the 75+ health assessments across medical practice - All nurses were instructed in administering the MNA-SF by one of the investigators (DF) and were provided with instructions on interventions based on the MNA-SF score - Nurses measured weight and height all patients - The MNA-SF was added to the regular assessment to screen for risk of malnutrition. - If subjects were identified as being at risk of malnutrition or malnourished, nurses were instructed to explain the importance of good nutrition and provide some simple and dietary advice or offer services (such as home delivered meals or some help) as required	1.Staff involved 2. Provide education 3. Pathway for intervention of after nutrition screening 3. Guidance on anthropometric measurement	Level VI	Fair

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
12	Mays *et al.*, (2019) United States	Identifying geriatric patients at risk for malnutrition: A quality improvement project Purpose: Implementation of Mini Nutritional Assessment Short-Form (MNA-SF) in the preoperative clinic of a large academic health center to identify patients at-risk for malnutrition prior to elective surgery	Before-after pre post studies with no control group	• Setting: Clinic setting • Participants: Patients aged 65 years and older at preoperative clinic • Total Participants: (n=280) Gender: Male 135 (48.2%), female 139(49.6%), 6 (2.1%) refused to disclose their gender Age range: 65-92 years old	Data collection method: - MNA-SF was incorporated in the current system and got permission from Nestle Nutrition Institute and in compliance with copyright and trademark rules - Educational session and explanation on: 1. Project objectives 2. Intervention of tool - Via the Nestle MNA-SF user guide and 11-minutes instructional video. - The nursing staff were given two weeks to complete the instructional materials and a 30 minute in service was provided to address questions regarding screening process - Screening was conducted during the nurse-patient interview as part of the routine nursing intake process and the MNA-SF score was documented in the EHR. - Measurement of weight, height and body mass index (BMI) - Additional questions asked by the nursing staff based on MNA-SF questions	1. Incorporation within the current system (provide flow chart based on clinic system) 2. Training and education 3. Objectives 4. Pathway for intervention of validated nutrition screening tool 5. Guidance on anthropometric measurement	Level IV	Fair

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
13	Butler *et al.* (2017) East of England, United Kingdom	BMI calculation in older people: The effect of using direct and surrogate measures of height in a community-based setting Purpose: To assess how the use of direct and surrogate measures of height impacts on BMI calculation in people aged 75 years	Cross sectional	• Setting: Community • Participants: Free-living older people aged ≥75 years • Total Participants: (n=64) Age range in years/mean age in years: 85.0±5.7	- All other anthropometric measures were carried out by three trained researchers who used the same protocol and underwent the same training to minimise inter-variability - Current height (HC) was measured using a Leicester height measure portable stadiometer (SECA, Birmingham, UK) to the nearest 0.5 cm and weight measured to the nearest 0.1 kg using compact digital floor scales (SECA model 888, Birmingham, UK) - Shoe heel height was measured with a flexible tape if footwear of participant cannot be removed. Ulna length was measured. By using a flexible tape measure (WM02 Body Tape, Chasmors Ltd) and knee height was measured using a sliding caliper (Knee Height Caliper, Chasmors Ltd) - Calculations of predicted maximum height using surrogate height measures from ulna (HU) and knee height (HK) were performed using published values BMI [weight (kg)/height (m^2)] was calculated using current measured height (BMIC) and predicted using reported maximum adult height (BMIR), ulna length (BMIU) and knee height (BMIK)	1. Guidance on anthropometric measurement Including if individuals have physical limitations 2. List of tools	Level VI	Fair

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
14	El-Desouky & Abed (2017) Egypt	Screening of malnutrition and its correlates among a sample of rural elderly in Qalyobeya Governorate, Egypt Purpose: To screen the elderly persons for malnutrition and to detect the underlying factors of this problem	Cross sectional	• Setting: Community • Participants: Older adults, 60 years and above at selected village in Qalyobeya Governorate, Egypt • Total participants: (n=320) mean 70.1±7.1 (61-89) male (n=167) (52.2%) female (n=153) (47.8%)	- Weighing weight by electronic digital scale to the nearest 0.1 kg, in light indoor clothes without shoes - Height was measured in the standing position to the nearest 0.1 cm. -BMI was calculated as weight (kg)/ height (m^2) - Calf circumference was measured to the nearest 0.1 cm and obtained at the most prominent point of the calf - BMI in older adults was classified according to Mini-Nutritional Assessment-Short Form (MNA-SF) into four categories: – less than 19 (severe malnutrition) – 19 to less than 21 (moderate malnutrition) – 21 to less than 23 (mild malnutrition) – At least 23 (no malnutrition) - It is a functional classification where higher BMI in the older adults is associated with better functional status even in BMIs (≥30 kg/m^2)	1. Guidance on anthropometric measurement -Weight -Height -BMI	Level VI	Good

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title Purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
15	Callen & Wells (2005) United States	Screening for nutritional risk in community-dwelling old-old Purpose: To identify the leading risk factors associated with non-invasive measures of poor nutritional status among elders aged 80 or older still living independently in the community	Cross sectional descriptive mixed-method	• Setting: community • Total participants: (*n*=68) • Participants: Age 80 or older of community living older adults Mean age±SD 85.7±4.4 (range 80-102)	Anthropometric measurements: 1. For measurement of height, subjects stood without shoes against a wall. Height was measured using a non-stretchable measuring tape 2. Weight was obtained with subjects in stocking feet using the same calibrated portable electronic scale designed for home health use 3. Amount of weight change in the 6 months prior to the interview was assessed with the question: - Have you lost or gained weight unintentionally in the last 6 months? If so, how much? - Weight loss, particularly an involuntary weight loss is perhaps the most important finding indicating the presence of malnutrition in the older adults and is associated with increased morbidity and mortality	1.Guidance on anthropometric measurement - Weight - Height - BMI 2. Guidance on asking the questions from validated nutrition screening tool	Level VI	Fair

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title & purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
16	Villaverde-Gutiérrez *et al.*, (2014) Spain	Should arm span or height be used in calculating the BMI for the older people? Preliminary results Purpose: To consider using arm span rather than height for calculating the body mass index, as a parameter that offers greater long-term stability, for the nutritional assessment of persons aged over 65 years	Cross sectional & observational	• Setting: community • Total Participants: • (n=76) • Participants: 65 years and older community living older adults Mean age±SD 80.2±6.8 (range 65- 89) Male (33.33%) female (66.7%)	- The anthropometric measures considered were weight, height and arm span, to calculate conventional BMI (weight/ height) and BMI.1 (weight/ arm span); in the latter, height was replaced by arm span (maximum extension of the arms, forming an angle of 90 degrees with respect to the trunk)	Guidance on anthropometric measurement	Level VI	Fair

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title Purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/ method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
17	Flanagan *et al.*, (2012) Australia	Managing undernutrition in the elderly Prevention is better than cure Purpose: Provides guidelines for screening for undernutrition in general practice, and suggests strategies to address undernutrition in older patients	N/A Expert opinion	N/A	1. Definitions - Malnutrition: "A deficiency or excess (or imbalance) of energy, protein and other nutrients, which causes measurable adverse effects on tissue/body form (shape, size, composition), function and clinical outcome. Can encompass both over nutrition and undernutrition, but often used to refer to undernutrition only" - Undernutrition: "A clinical syndrome characterised by weight loss associated with significant depletion of fat stores and muscle mass. Also known as protein energy undernutrition" 2. Identifying undernutrition in the older adults by nutrition screening 3. Incorporating screening into general practice - Screening for undernutrition among older adults patients should be incorporated into routine practice to improve focus time and intervention for older adults who are at greater risk - A systematic approach is identifying older adults who are at risk by measuring weight every visit or twice to see any weight loss 4. Validated nutrition screening tools in identification of undernutrition 5. Identifying and addressing contributing factors 6. Management strategies	From this expert opinion paper. Key points can be included in the guidelines are 1. Nutrition screening is needed for early identification of malnutrition 2. Nutrition screening can be incorporated into routine practice 3. Systematic approach is needed to monitor weight 4. Validated nutrition screening tool is required 5. Involvement of all healthcare professional will beneficial towards this issue	Level VII	N/A

Table 1. Summary of suggested topics to be included in nutrition screening guideline (from articles) (continued)

No.	*Author, (Year), Country*	*Title Purpose of the study*	*Study design*	*Sample description*	*Main outcome (From results/method)*	*Suggested topics to be included*	*Level of evidence*	*Quality of study*
18	Avgerinou *et al.*, (2020) United Kingdom	Supporting nutrition in frail older people: a qualitative study exploring views of primary care and community health professionals Purpose: To explore primary care and other community health professionals' views on how to support nutrition in frail older people, in order to inform future community-based interventions for this population	Qualitative study	• Setting: General practices and community setting • Participants: general practices: at each practice, all GPs, practice nurses, and healthcare assistants; • Health professionals from frailty MDTs; and • • Dietitians working with community - dwelling older people.	Four themes were identified: 1. Understanding and identifying malnutrition 2. Management of unintentional weight loss in the community 3. Challenges to addressing malnutrition 4. Potential solutions	1. Training and education by provision of knowledge 2. Role of healthcare staff 3. Organisation: Policy and procedure of nutrition screening 4. Validated nutrition screening tool	Level VI	Fair

opportunities and enablers of nutrition screening can be categorised into several categories: organisational, staff, and screening factors. Organisational factors involved system, policy and procedure in the clinics (Avgerinou *et al.,* 2020; Craven *et al.*, 2017; Flanagan *et al.*, 2012; Hamirudin *et al.*, 2013; Mays *et al.*, 2019), training and education (Avgerinou *et al.,* 2020; Craven *et al.*, 2013; Green *et al.*, 2014; Mays *et al.*, 2019; Vandewoude *et al.*, 2011; Winter *et al.*, 2013), as well as funding and resources in the clinics (Avgerinou *et al.,* 2020; Craven *et al.*, 2017). Staff factors included knowledge (Avgerinou *et al.,* 2020; Craven *et al.*, 2017; Endevelt *et al.*, 2009), communication and management support (Craven *et al.*, 2017; Green *et al.*, 2014), and role of staff in nutrition screening (Avgerinou *et al.,* 2020; Endevelt *et al.*, 2009; Hamirudin *et al.*, 2013; Winter *et al.*, 2013). Meanwhile, screening factors were related to the use of screening tool (Flanagan *et al.*, 2012; Vandewoude *et al.*, 2011), outcome and intervention pathway of the screening (Craven *et al.*, 2017; Flanagan *et al.*, 2012; Mays *et al.*, 2019; Winter *et al.*, 2013), and acceptability and ease of nutrition screening (Craven *et al.*, 2017; Green *et al.*, 2014). Provision of knowledge and education (Endevelt *et al.*, 2009; Vandewoude *et al.*, 2011; Winter *et al.*, 2013), and enhancement of practices related to nutrition screening (Gaboreau *et al.*, 2013) were also significant enablers that have been identified. Therefore, these factors may facilitate healthcare staffs in performing nutrition screening. The incorporation of nutrition screening into routine screening is needed to help focus time and intervention resources for individuals who are identified as at greatest risk (Flanagan *et al.*, 2012). Consequently, nutrition screening can be routinely performed as part of health clinic practice (Gaboreau *et al.*, 2013).

Guidance on administering validated nutrition screening tools

There are many available validated nutrition screening tools. However, MNA-SF is recognised as the most suitable tool that can be used in community living older adults population (Philips, 2010). Six studies (Callen & Wells, 2005; Chatindiara *et al.*, 2018; Cuervo *et al.*, 2009; El-Desouky & Abed, 2017; Mays *et al.*, 2019; Winter *et al.*, 2013) have discussed administering the items of validated nutrition screening tool. Besides, two studies have used MNA-SF user guide as guidance to administer the items of MNA-SF (Chatindiara *et al.*, 2018; Mays *et al.*, 2019). Pathway after nutrition screening is recommended to be included in the intervention component (Mays *et al.*, 2019; Winter *et al.*, 2013). Hence, guidance on administering items of validated nutrition screening tools is essential as the total score will determine the nutritional status of patients.

Guidance on anthropometric measurements

Generally, nutrition screening tools are available in questionnaire format with or without anthropometric data (Power *et al.*, 2018). Therefore, guidance on anthropometric measurements is needed to facilitate the administering of nutrition screening. Based on the results in Table 1, ten studies have mentioned about anthropometric measurements and the tools required in the method part (Butler *et al.*, 2012; Callen & Wells, 2005; Chatindiara *et al.*, 2018; Cuervo *et al.*, 2009; El-Desouky & Abed, 2012; Ghimire *et al.*, 2017; Mays *et al.*, 2019; Rodriguez-Tadeo *et al.*, 2012; Winter *et al.*, 2013; Villaverde-Gutiérrez *et al.*, 2014). Weight, height, and body mass index (BMI) were the most common data needed during nutrition screening. Furthermore, steps on how to measure weight and height with the required tools

were explained in five studies (Callen & Wells, 2005; Chatindiara *et al.*, 2018; El-desouky & Abed, 2017; Ghimire *et al.*, 2017; Rodriguez-Tadeo *et al.*, 2012). Besides, measuring height and weight for older adults with limitation are also presented in Table 1. Based on the studies, measuring arm and mid-arm circumference (MAC) (Ghimire *et al.*, 2017; Rodriguez-Tadeo *et al.*, 2012), calf circumference (CC) (El-Desouky & Abed, 2012; Ghimire *et al.*, 2017; Rodriguez-Tadeo *et al.*, 2012), knee height (Butler *et al.*, 7017; Rodriguez-Tadeo *et al.*, 2102) were other alternatives to estimate weight and height for older adults with limitation. To summarise, guidance on anthropometric measurements needs to be included in the guideline.

Quality appraisal of studies

Quality of studies were appraised and included in Table 1. Two types of assessment tools were used to assess the quality of studies. Based on the results, studies were categorised as quantitative or qualitative based on study design.

Five qualitative studies have been rated good and fair (Avgerinou *et al.,* 2020; Craven *et al.*, 2017; Green *et al.*, 2014; Hamirudin *et al.*, 2013; Vandewoude *et al.*, 2011). Out of these five studies, only two studies were rated as fair (Avgerinou *et al.,* 2020; Vandewoude *et al.*, 2011). Qualitative studies were assessed by using the CASP checklist. In general, this checklist was used to assess methodology of the study including data collection, ethical issues, and data analysis.

Meanwhile, a total of 12 quantitative studies have been presented in Table 1. Three studies have been rated as good quality (Chatindiara *et al.*, 2018; El-desouky & Abed, 2017; Ghimire *et al.*, 2017), eight studies rated as fair quality (Butler *et al.*, 2017; Callen & Wells, 2005; Cuervo *et al.*, 2009; Endevelt *et al.*, 2009; Gaboreau *et al.*, 2013; Villaverde-Gutiérrez *et al.*, 2016; Winter *et al.*, 2013), and one study as poor (Rodriguez-Tadeo *et al.*, 2012). Quantitative studies were assessed by using the NHLBI tool. The assessment included aim of the study, participants' characteristics, methodology of study, and data analysis. An expert opinion paper (Flanagan *et al.*, 2012) was not rated for quality appraisal as there was no suitable tool.

DISCUSSION

This study has reviewed the content that can be included in a guideline for use by healthcare staffs to administer a validated nutrition screening tool in older adults in health clinic setting. A total of 18 articles were retrieved regarding barriers and opportunities to perform nutrition screening, format, flow and topics that can be included in the guideline, guidance on administering validated nutrition screening tools, and guidance on how to perform anthropometric measurements. Therefore, this review was a key step to establishing the content of a guideline for health clinics.

Based on the results, suitable content for the guideline consisted of introduction, aims and objectives, definition of malnutrition, prevalence of malnutrition, implementation of nutrition screening, and guidance on administering items in validated nutrition screening tools. In general, the purpose of the nutrition screening guideline is to facilitate healthcare staffs in health clinics in implementing nutrition screening among older adults.

Barriers and opportunities to conduct nutrition screening

Barriers and opportunities of nutrition screening need to be identified. The identification of barriers may lead to the development of tailored nutrition

screening implementation guidelines. Besides, identified opportunities may also help in content development of the nutrition screening guidelines. A total of nine studies have discussed regarding barriers and opportunities of nutrition screening (Avgerinou *et al.,* 2020; Craven *et al.*, 2017; Endevelt *et al.*, 2009; Gaboreau *et al.*, 2013; Green *et al.*, 2014; Hamirudin *et al.*, 2013; Mays *et al.*, 2019; Vandewoude *et al.*, 2011; Winter *et al.*, 2013). Out of these nine studies, two studies discussed specifically regarding knowledge, attitude and practice towards nutrition among older adults (Endevelt *et al.*, 2009; Vandewoude *et al.*, 2011).

Provision of knowledge and education can enhance the enforcement of nutrition screening (Endevelt *et al.*, 2009; Mays *et al.*, 2019; Vandewoude *et al.*, 2011; Winter *et al.*, 2013). Nutrition care and screening outcomes among older adults will be improved due to sustained screening through the provision of education among healthcare professionals (Kennelly *et al.*, 2011). Besides, enforcement of policy and procedure (Avgerinou *et al.,* 2020; Craven *et al.*, 2017), as well as nutrition screening as a screening practice based on clinics' condition were identified as other enablers in implementing nutrition screening (Gaboreau *et al.*, 2013; Hamirudin *et al.*, 2013). Incorporation of nutrition screening into the current system and routine practice of the clinic is the best way to implement nutrition screening (Flanagan *et al.*, 2012). From the findings, three studies highlighted this point (Hamirudin *et al.*, 2013; Mays *et al.*, 2019; Winter *et al.*, 2013). Therefore, these identified opportunities from other studies can be incorporated into the content development of the nutrition screening guidelines for healthcare staffs.

Format and flow of the nutrition screening guidelines

During the development process, format and flow of the guidelines are important criteria that need to be included for clarity in presenting information. The established guidelines developed by the Ministry of Health (MOH) could be used as guidance and references. From the six guidelines that have been identified, four guidelines from the Ministry of Health (MOH), Malaysia were in A4 size (GEM, 2004; BPKK, 2013, BPKK, 2015; IHSR, 2018). In addition, two guidelines presented information on policy and system in health clinics (BPKK, 2015; IHSR, 2018). This information may help in understanding the clinics' condition to facilitate nutrition screening in this setting. Flow charts in the established guidelines could become references in terms of formatting (BPKK, 2015). Nevertheless, the content will be based on health clinics. Besides, most of the guidelines have outlined the following information, namely: introduction, aims and purpose, implementation including guidance on how to complete nutrition screening, flow chart, appendices, and references. The outline will serve as a useful guidance in providing the required information comprehensively.

Guidance on administering validated nutrition screening tools

Based on the results, information related to guidance on administering validated nutrition screening tools need to be included in the guidelines. From previous studies, validated nutrition screening tool has been administered by referring to the user guide of the tool (Chatindiara *et al.*, 2018; Mays *et al.*, 2019). Validated nutrition screening tools need to be administered in a proper way in order to obtain correct scores. For example, a study has shown that item related to weight changes in a validated

tool can be asked as such: "Have you lost or gained weight unintentionally in the last six months? If so, how much?" (Callen & Wells, 2005). This is particularly important as the total score in a screening tool is an indicator of malnutrition risk (Reber *et al.*, 2019; Rosa *et al.*, 2017).

Meanwhile, two established guidelines provided guidance on how to administer items in validated tools (NNI, 2011; Sakinah *et al.*, 2017). However, out of these two established guidelines, only one provided a pathway after nutrition screening (NNI, 2011). The intended development of this guideline will be in the Malay language for use by staffs in the Malaysian health clinics.

Guidance on anthropometric measurements

Based on the results, guidance on anthropometric measurements needs to be included in the guidelines. Few studies have emphasised on anthropometric measurements in the method part, which indicated its importance. Based on the studies reviewed, important measurements that must be included are weight and height (Callen & Wells, 2005; Chatindiara *et al.*, 2018; Cuervo *et al.*, 2009; El-desouky & Abed, 2018; Ghimire *et al.*, 2018; Rodriguez-Tadeo *et al.*, 2012; Winter *et al.*, 2013). The way of measuring weight and height have also been explained in these studies; for instance, minimal clothing, barefooted, and subject must stand against a wall during height measurement (El-Desouky & Abed, 2017; Ghimire *et al.*, 2017; Rodriguez-Tadeo *et al.*, 2012). Weight and height need to be measured in a proper way to avoid measurement errors. Based on the included studies, the tools required for this measurement are mechanical stadiometer and digital weighing scale, and reading must be reported in cm and kg, respectively (Chatindiara *et al.*, 2018; El-desouky & Abed, 2018; Ghimire *et al.*, 2017; Rodriguez-Tadeo *et al.*, 2012). BMI can then be obtained as it is one of the required items in most validated nutrition screening tools. It can be defined as a measure of weight adjusted for height, calculated as weight in kilograms divided by the square of height in meters (kg/m^2) (Centers for Disease Control and Prevention, 2009).

BMI is one of the indicators of nutritional status. Values of BMI were obtained in previous studies by using the afore-mentioned BMI formula as a risk of malnutrition (Chatindiara *et al.*, 2018; El- desouky & Abed, 2017; Ghimire *et al.*, 2017; Mays *et al.*, 2019; Rodriguez-Tadeo *et al.*, 2012). Meanwhile, the recent Global Leadership Initiative on Malnutrition (GLIM) has identified five criteria for malnutrition identification, which are phenotypic criteria (weight loss, low body mass index, and reduced muscle mass) and etiologic criteria (reduced food intake or assimilation and inflammation or disease burden) (Cederholm *et al.,* 2019). Hence, to diagnose a patient with malnutrition, one of the phenotypic criteria and etiologic criteria should be present (Cederholm *et al.,* 2019). Thus, information related to both criteria should be included in the guideline development to identify malnutrition risk.

Previous studies have also emphasised on alternative ways to measure weight and height. For example, calf circumference, mid-arm circumference, girth of arm, and arm span (Goswami *et al.*, 2018) can become alternative measurements (Ghimire *et al.*, 2017; Rodriguez-Tadeo *et al.*, 2012; Villaverde-Gutiérrez *et al.*, 2015). Other ways to measure height that have been highlighted are measurements of half arm span (Siqueira *et al.*, 2012) and knee height (Chumlea, Roche & Steinbaugh, 1985). In MNA-SF, measuring calf circumference is an alternative to body

mass index. A value of <30.1cm (man) and <27.3cm (woman) will classify an older adult as malnourished (Harith, Shahar & Adznam, 2016). These cut-off points can be used by health professionals in Malaysia to screen for older adults who are at risk of malnutrition.

Quality appraisal of studies

All included studies were rated as good, fair or poor quality. From the findings, 35% of the studies were rated as good quality, 59% rated as fair quality, and the remaining 6% rated as poor quality studies.

Limitation and strength

Limitation of this review was the exclusion of non-English and non-Malay journal articles. However, this review was able to provide essential content to be included in the nutrition screening guideline in health clinics by following a systematic approach using PRISMA extension for scoping reviews (Tricco *et al.*, 2018). Further studies can be done in the future to measure the outcomes of using this newly developed nutrition screening guideline. Therefore, feasibility of the newly developed guideline can be measured.

CONCLUSION

Development of a guideline based on the identified content can facilitate healthcare staffs to perform nutrition screening among older adults in the health clinic setting. The comprehensive details in the guideline can become a main reference for nutrition screening procedures, particularly in Malaysian health clinics. Subsequently, appropriate nutrition intervention by nutrition experts can be implemented to improve patients' nutritional status. Hence, timely malnutrition identification using the nutrition screening guideline could improve older adults' nutritional status and decrease the number of at-risk and malnourished patients.

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Authors' contributions

SNASH, conducted the study, data analysis and interpretation, prepared the draft of the manuscript and reviewed the manuscript; AHH, principal investigator, conceptualised and designed the study, contributed expertise in data analysis and interpretation, and reviewed the manuscript; SH, contributed expertise and reviewed the manuscript; MAMA, contributed expertise and reviewed the manuscript; KHAA, contributed expertise and reviewed the manuscript; INNA, contributed to data analysis and interpretation; NSAR, contributed expertise and reviewed the manuscript.

Conflict of interest

Authors declare no conflict of interest.

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Knowledge, attitude, and behaviour towards nutrition radio programmes in mothers of children under five years with severe acute malnutrition in Northern Nigeria

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ABSTRACT

Introduction: Although the mass media are increasingly becoming a platform for disseminating health messages to promote attitude and behavioural changes, little is known about how radio programmes influence safe child feeding practices among mothers of infants and children. Consequently, this study examined the knowledge, attitude and behaviour towards food and nutrition radio programmes in mothers of children under five years with severe acute malnutrition in Northern Nigeria. **Methods**: This study employed a survey research design using data derived from a structured questionnaire undertaken with mothers (*N*=402) of children suffering from severe acute malnutrition (SAM) and who have been listening to radio programmes on tackling malnutrition within six months to the time of the fieldwork. **Results**: Findings revealed that while mothers appeared to have a higher comprehension of child feeding programmes on the radio, their attitude and actual uptake of the messages were not encouraging. Furthermore, being young, having few children, having a primary education, and frequent listening to SAM-related messages on the radio were associated with mothers' positive knowledge, attitude and actual uptake of the messages disseminated. **Conclusion**: The findings provided a link between demographic characteristics of mothers and how they comprehend, believe and act on the messages they received from these radio programmes. It is therefore argued that the understanding of this link might inform the focus of future intervention aimed at promoting best child feeding practices in Northern Nigeria.

Keywords: health education, intervention, malnutrition, mothers, radio programmes

INTRODUCTION

Campaigns, which aim at providing supplementary foods for children affected by varying grades of malnutrition, are globally recognised as an important part of health intervention (Satiawati & Januraga, 2018). However, one crucial aspect which accounts for the success of nutritional interventions on malnutrition in children under five years is the knowledge and trust that caregivers have in the likely benefits

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the programme has to offer (Satiawati & Januraga, 2018). A study conducted in Burkina Faso revealed that these attributes (knowledge and trust) played a significant role in effective supplemental food provision (Iuel-Brockdorf *et al.*, 2016). Other studies like that of Rogers *et al.* (2015) also reported that lack of community awareness alongside low recognition of child acute malnutrition and inadequate knowledge of existing intervention programmes on the part of caregivers accounted for the expected success of these programmes. To this end, Satiawati & Januraga (2018) and Iuel-Brockdorf *et al.* (2016) concluded that interventions that are poorly received could result in caregivers using foods that are not rich in nutrients, thereby leading to a decrease in the nutritional status of children, as well as wasting resources.

As a result, it is important to continue to examine how knowledge, attitude and behaviour of caregivers towards supplemental food interventions against acute malnutrition in children affect the successes and impacts of such initiatives. It is maintained that broader understanding of the subject under study could inform an evidence-based approach which is capable of improving future interventions that will guarantee better child malnutrition outcomes. In this study, we examined knowledge, attitude, and behaviour towards radio nutrition assistance programmes in mothers of children under five years with severe acute malnutrition in Nigeria – a place where the condition is prevalent.

Research context

This research was undertaken in Northern Nigeria with an estimated population of 90 million people over a total land area of 660,000 km^2. The region is divided into three major geopolitical zones, which are further sub-divided into 19 states. It is estimated that the region has 3,900 to 6,200 health clinics in each zone (Sato, 2019). The region has the highest level of malnutrition among children in Nigeria. For example, Northern Nigeria has about 88 percent of Nigeria's acute malnourished children (Abubakar, 2018). Also, relative to other geopolitical zones in the country, the North West (55.0%), North East (42.0%), and North Central (29.0%) have the highest proportion of children who are malnourished (USAID, 2018).

This situation had earlier made the government and other stakeholders to declare a public health emergency on acute malnutrition in some parts of the northern region (Leidman *et al.*, 2016). Disseminating messages through the media has been an intervention tool adopted in Northern Nigeria. The messages disseminated through these channels are generally about giving out basic information regarding the importance of preparing nutritive food with available resources, necessary information about how to get help from local community volunteers, suggest practices and present testimonies that could inform listeners and motivate them to action (ACF International, 2015).

Extant literature has posited that mothers and caregivers often lack optimum knowledge on how to properly prepare nutritious food and feed their children effectively due to lack of health education (Groce *et al.*, 2014). Invariably, studies have demonstrated that even when mothers and caregivers are exposed to a high level of media awareness regarding supplementary nutrition interventions, comprehension, belief, and feasibility of implementing these recommended behaviours may remain a challenge, as awareness does not always translate into acceptability, which influences their attitude. As a result, it is advocated by studies that promoters of nutrition programmes should place an emphasis on caregivers'

implementation of interventions. (Kim *et al.*, 2018). Studies have equally linked issues on knowledge and uptake of mass media campaigns targeted against malnutrition in children to the personal characteristics of caregivers and mothers (Asare *et al.*, 2018; Griaudze *et al.*, 2020; Kim *et al.*, 2018). For example, being young, highly educated, owning and frequently watching a TV, and receipt of at least one home visit from community mobilisers were associated with higher odds of comprehending mass media messages targeted towards malnutrition in children (Kim *et al.*, 2018).

While it is a fact that mass media are continuously being used to disseminate health messages to promote healthy behavioural changes due to their capacity to improve knowledge and attitude of a large number of people, their effect on behavioural changes are varied and well documented in several studies (Kim *et al.*, 2018). Despite these various outcomes, evidence showing how exposure to mass media information impacts a set of nutritional practices for infants is scanty (Kim *et al.*, 2018). More specifically, little is known about the influence of media intervention on knowledge, attitude and behaviour of mothers and caregivers on the prevention and management of malnutrition in children under five years in a country like Nigeria. This study specifically focused on severe acute malnutrition (SAM) because very few (i.e., two out of every ten) out of the estimated two million children suffering from this condition is currently reached with treatment (UNICEF, 2020).

Therefore, by examining the influence of radio awareness campaigns on mothers with children suffering from SAM in Northern Nigeria, we might begin to understand the process through which nutrition knowledge, attitude and behaviour change occur. Also, situating mothers' knowledge, attitude and behaviour regarding these radio messages within the context of certain personal characteristics could inform the focus of future interventions in the region.

Study objectives

As a result, this study attempts to:

1. Examine the influence of radio awareness campaigns on knowledge, attitude and behaviour of mothers with children with severe acute malnutrition.
2. Identify the factors influencing the uptake of these messages on popular radio stations in the northern region of the country.

Child feeding and SAM-related radio interventions in Northern Nigeria

There are a number of radio stations, such as BBC Hausa, VOA Hausa, Vision FM, Rahama Radio, and Radio Kano, which air a 15-minute child health programme, with particular focus on malnutrition on a weekly basis. The stations equally air advertisement spots that raise awareness on the same subject. The programmes and spots are produced in the Hausa language. Many of the programmes are BBC sponsored. One popular programme that is common in the region is called: *LafiyaZinariya*, which literarily means that 'health is wealth'. This particular programme is presented by Fauziyya, Kabir Tukur to educate residents in Northern Nigeria about their health, especially caregivers on proper nutrition for their children. Other radio stations that disseminate various health programmes that sometimes focus on malnutrition messages include Freedom Radio and Arewa Radio, which are two of the most influential radio stations in Kano (state with the highest population in Northern Nigeria). According to statistics, the influence of these radio stations cut across some 2.5 million ardent listeners

(Misbanu, 2020). Further to this, the BBC weekly radio programme -*Ya Take Ne Arewa* (What's happening in the North) also focuses on health issues that affect common health realities in communities. This programme in particular reaches more than 8.6 million listeners weekly across 15 states of Northern Nigeria. The thirty-minute weekly programme, which discusses topics, such as malnutrition, antenatal care, and family planning issues, is mainly targeted at parents and caregivers. In fact, a recent broadcast of Future Assured Half Hour was transmitted across several radio platforms in Northern Nigeria on the 1st of August 2020. The major highlights of the programme included discussions on the importance of early initiation of breastfeeding within the first hour, the need for exclusive breastfeeding for up to six months and continuing to two years, among others.

These programmes, which we consider as listener-led, are so popular in Northern Nigeria that people form separate listening groups in some states to discuss issues treated on air. Participation in these groups informs feedbacks on the part of radio presenters, who then use the groups' input to shape future conversations on radio.

MATERIALS AND METHODS

This study employed a survey research design using data derived from a structured questionnaire undertaken with mothers (*N*=402) of children suffering from SAM and who have been listening to radio programmes on tackling malnutrition within six months to the time of the field work. An initial quantitative sample size of 384 was statistically (using Cochran's formula) derived. With 95% level of confidence, an estimated level of listenership to radio programmes on how to respond to child malnutrition at 50% (0.5), and a permitted margin of error at 0.05 (5% points), we determined the sample size (Cochran, 1963, p. 75) using the following steps:

$$n = \frac{[Z/_2]^2 (p\ q)}{e^2} n = \frac{[Z/_2]^2 (P)(1\text{-}P)}{e^2}$$

Where: *n*= sample size, Z^2= confidence level, p= rate of occurrence or prevalence (the estimated proportion of an attribute that is present in a population), q= complement of p, and e= margin of error. Therefore;

$$n = \frac{[1.96]^2 0.5\ (1 - 0.5)}{0.05^2} \quad n = \frac{3.8416\ (0.25)}{0.0025}$$

n= 384

Furthermore, an adjusted 5% non-response rate was added and resulted in 404, where n* (adjusted non-response rate) = 384/0.95 = 404. The sample size was considered adequate to collect data that are sufficient to perform statistical analysis that could allow for inferences. The research adopted a multi-stage sampling procedure to select the samples for the study. At the first stage, three states (Kano, Yobe, and Niger) were purposively selected from the 19 states in the region. The states were selected because they share a disproportionately high burden of wasting in their respective sub-regions. Under a naturally stratified condition, we selected one senatorial district from each of the states (i.e., Kano North, Yobe East, and Niger West) using a simple random sampling approach (balloting). Furthermore, by adopting a purposive sampling, one local government area (LGA) – Bida, Damaturu, and Gwarzo was selected from each of the senatorial districts. The prevalence rate of severe acute malnutrition and the public level of exposure to media campaigns on the need to eradicate malnutrition informed the selection. A simple random sampling approach was afterwards adopted to select households, which eventually

provided the mothers who responded to the questionnaire items. However, eligibility criteria for interview included: (1) must be a mother of child/children under five years, with a self-reported history of or currently suffering from severe acute malnutrition, and (2) must have been a listener [whether active or passive] to radio programmes within the past six months. We obtained ethical clearance from the Health Research Ethics Committee (HREC), which is the institutional review body domicile at the University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu. Signed informed consent was obtained from each of the respondents during the field work.

Measurement

Knowledge

Knowledge is operationalised as the level of comprehension that mothers possess following their exposure to radio spots or programmes on malnutrition prevention and management. Knowledge was measured using a scale with seven statements/questions. For example, one of the items was worded: 'It is mass media health message that inform on how to ensure household foods have the needed nutrients, vitamins and minerals for their nutrition'. Scores of each item were totalled, with the score ranging from 2 to 28. Response options ranged from 'strongly disagree' (1) to 'strongly agree' (4). Cronbach's coefficient of 0.87 was derived and was found to be highly reliable.

Attitude

As for attitude, the variable was defined within the context of the present study as the level of credibility and feasibility possessed by mothers towards radio spots or programmes on malnutrition prevention and management. Attitude was therefore measured using a scale that had seven statements/questions. An example of one of the items was: 'I believe in the healthy nutrition message advocated by the radio awareness campaign on SAM'. Response options ranged from 'strongly disagree' (1) to 'strongly agree' (4). By summing up scores for each item, the total score was found to range from 6 to 32. The Cronbach's coefficient was found to be reliable (0.74).

Behaviours

Self-reported behaviours were measured in the study context as the level of preventive and management practices adopted by mothers owing to their exposure to the programmes. Behaviour was measured on a scale with seven items/statements with the following examples: 'To a large extent, the healthy nutrition message promoted by the media awareness campaign have helped my household to get rid of taking unbalanced diets', 'I regularly play my own part in the community mobilisation efforts towards prevention and management of SAM regarding my child/children', etc. Response options ranged from 'strongly disagree' (1) to 'strongly agree' (4). A total score ranging from 4 to 28 was calculated by summing up scores for each of the items in the scale. The Cronbach's coefficient was found to be highly reliable (0.96). Further to this, respondents were asked to give a categorical assessment as to whether they consistently adopt at least four of these practices since they have started listening to messages on SAM prevention and management.

Data analysis

Initially, a Cronbach's alpha reliability test was conducted using the Statistical Package for Social Sciences (SPSS 23). Reliability scores with 70% and above were considered as highly consistent. We also used correlation analysis to ascertain the relationships between the outcome variables (knowledge,

attitude, and behaviour). Furthermore, linear multiple regression and logistic regression analysis were used to examine relationships raised between variables in the study. While multiple linear regression was used to examine the relationship between continuous variables (knowledge, attitude, practice, KAP scores) and demographic variables, binary logistic regression was used to examine the likelihood of having adopted the behaviours by demographic characteristics, which were all defined as categorical variables.

RESULTS

A 99.5% response rate was recorded, which was considered very good and suitable for analysing the elicited data. Results showed that mothers were between the ages of 15 and 49 years (mean= 33.12 years, standard deviation, *SD*= 5.21 years). An overwhelming majority of the women (74.4%) were married; 53.5% of the mothers had either seven or more children and 53.0% did not have any formal education. This was not surprising in that it reflected the reality that half of the young women in Northern Nigeria have no formal education (Education Policy and Data Centre, 2014). As to the extent of exposure to SAM messages on radio in the past six months (at the time of the field work), results revealed that 57.0% of the mothers listened to these messages occasionally, while the remaining 43.0% listened to the messages very often.

Correlation analysis was further conducted. As shown in Table 2, correlation analysis showed that significant positive associations existed

Table 1. Characteristics of the respondents

Variables	*n*	*%*
Age (years)		
15-24	95	23.6
25-34	130	32.3
35-44	169	42.0
45-49	8	2.0
Marital status		
Single	16	4.0
Married	299	74.4
Divorced	31	7.7
Widowed	47	11.7
Separated	9	2.2
Number of children		
1-3	47	11.7
4-6	81	20.1
7 and above	215	53.5
None	59	14.7
Education level		
No education	213	53.0
Primary	189	47.0
Extent of exposure to SAM messages on radio in the past 6 months		
Very often	173	43.0
Occasionally	229	57.0

Table 2. Descriptive statistics, Cronbach's alpha values and correlation output among respondents' knowledge, attitude and behaviour towards SAM messages on radio in the past six months

Variable	*Mean±SD*	*Cronbach's alpha*	*Knowledge*	*Attitude*	*Behaviour*
Knowledge	35.4±5.6	0.872	1		
Attitude	14.6±10.9	0.740	0.312**	1	
Behaviour	8.4±17.2	0.961	0.403**	0.341**	1

Two-tailed Pearson correlation significant at **p<0.01

between mothers' knowledge and attitude, knowledge and behaviour, as well as attitude and behaviour owing to their exposure to SAM spots and programmes on the radio. A closer look at the mean in the table also suggested that women scored lower in their attitude and behaviour compared to their knowledge score. This might imply that despite a good level of comprehension of the messages women listened to, the messages might not have had an important influence on their attitude and most especially, their practices of proper preventive and management measures of SAM.

Demographic influence on mothers' knowledge regarding radio spots or programmes on SAM prevention and management

The predictive factors accounted for 61.3% of the variation in message comprehension among mothers of children under five years. Comprehension of SAM messages was negatively predicted by age and number of children, but positively predicted by education and exposure to SAM messages on the radio (Table 3). However, marital status coefficient was not significant.

Demographic influence on mothers' attitude towards radio spots or programmes on SAM prevention and management

The predictive factors accounted for 46.2% of the variation in the mothers' attitude towards the SAM messages they listened to. Attitude towards SAM messages was negatively predicted by age and number of children, but positively predicted by education and exposure to SAM messages on the radio (Table 4). Nonetheless, marital status coefficient did not reach statistical significance.

Table 3. Linear multiple regression analysis on the influence of age, marital status, number of children, education, and exposure to SAM messages on knowledge (comprehension) of the messages

Model	*Unstandardised coefficients*		*t*	*Sig.*
	β	*Std. error*		
Age	-5.412	0.763	-2.231	<0.001
Marital status	0.372	0.525	0.251	0.890
Number of children	-3.711	0.700	-3.412	<0.001
Education	3.152	0.416	2.462	0.001
Exposure to SAM messages	2.532	0.662	5.515	0.001
R^2	0.613			
ΔF	349.113**			

**p<0.01

Table 4. Linear multiple regression analysis on the influence of age, marital status, number of children, education, and exposure to SAM messages on attitude (believability and credibility) of the messages

Model	*Unstandardised coefficients*		*t*	*Sig.*
	β	*Std. error*		
Age	-4.132	0.813	-12.101	0.001
Marital status	0.031	0.410	0.300	0.610
Number of children	-5.310	0.312	-6.339	0.000
Education	4.311	0.527	3.116	0.008
Exposure to SAM messages	3.131	0.329	4.331	0.002
R^2	0.462			
ΔF	268.012**			

**p<0.01

Demographic influence on mothers' self-reported behaviour regarding radio spots or programmes on SAM prevention and management

Results of the binary logistic regression showed that mothers who were 25-34 years old were 1.56 times more likely to adopt the practices according to the SAM messages than mothers who were 15-24 years (95%CI: 1.91–3.55; p<0.001). We also found that mothers who were maritally stable (i.e., married) were 2.48 times more likely to adopt the practices according to SAM messages compared to single mothers (95%CI: 1.13–4.72; p<0.001). Furthermore, results revealed that mothers with 4-6 children were 3.61 times more likely to report practising SAM messages relative to those who have between one and three children (95%CI: 1.89–3.35; p<0.01). Also, mothers with primary education were 2.56 times more likely to practise SAM messages accessed on radio compared to mothers with no education. Finally, findings showed that those who accessed SAM messages very often on radio within the past six months were 5.21 times more likely to practise SAM messages compared to those who had access occasionally (95%CI: 4.10–9.86; p<0.001).

DISCUSSION

The study examined the influence of radio awareness campaigns on knowledge, attitude and behaviour of mothers with children with severe acute malnutrition. From the results of the descriptive analysis, there were reasons to indicate that even though data on exposure to SAM messages on popular radio channels were based on self-report, there was a decline in the attitude and behaviour of mothers towards SAM messages despite their occasional and consistent exposure to the messages when compared to their level of knowledge. Findings suggested that a notable improvement was only noticed in mothers' knowledge (comprehension) and attitude (believability) towards the SAM messages on radio. Previous studies have highlighted the media effects of campaigns focusing on nutrition towards mothers and caregivers' knowledge, attitude, intentions, and practices about nutritional issues (Abdul-Fadi, 2012; Alnasser *et al.*, 2018; Msiska *et al.*, 2017). Also, studies highlighting the difference between knowledge and attitude, as well as practices of good nutritional behaviours exist (Mogre *et al.*, 2016; Vijayalakshmi

Table 5. Binary logistic regression analysis for possible influences of age, marital status, number of children, education, and exposure to SAM messages on behaviour (actual practices) of the messages

Variable	*OR*	*95% CI*	
		Lower	*Upper*
Age			
15-24 years (Reference)	1		
25-34 years	1.56***	1.91	3.55
35-44 years	0.35	0.43	1.75
45-49 years	0.82	0.38	2.10
Marital status			
Single (Reference)	1		
Married	2.48***	1.31	4.72
Divorced	0.31	0.52	2.03
Widowed	0.76	0.17	1.34
Separated	0.81	0.37	1.98
Number of Children			
1-3 (Reference)	1		
4-6	3.61**	1.89	3.35
7 and above	0.43	0.74	1.32
None	0.23	0.62	3.70
Educational Level			
No education (Reference)	1		
Primary	2.56***	2.34	7.83
Extent of exposure to SAM messages on radio in the past 6 months			
Occasionally (Reference)	1		
Very often	5.21***	4.10	9.86

**p<0.01
***p<0.001

et al., 2015). These studies showed that while knowledge and attitude of good nutrition was high among mothers and caregivers, their nutritional behaviours were discouraging. This implies that the actual practice of what is being learnt might become difficult for mothers and caregivers across various samples.

The result of the linear multiple regression revealed that being young could translate to becoming more knowledgeable about SAM messages on the radio. Previous studies like that of Kim *et al.* (2018) have shown an association between younger maternal age and higher comprehension of TV spot messages on child feeding in Bangladesh. Our result therefore extends previous findings by showing how knowledge/ comprehension of SAM messages could be understood within the context of age in a different sample, where the radio serves as a common health information channel.

Findings equally implied that mothers with fewer children have the capacity to understand more of the SAM messages compared to those with larger number of children. This highlights the importance of family size on the ability or capacity

to comprehend details of child feeding campaigns. As an example, the Central Statistical Agency & ICF International (2012) found that larger family size influenced the inadequate knowledge of mothers on infant and young child feeding (IYCF) recommendations in an Ethiopian sample. Put together, plausible explanation for the present outcome might be that mothers and caregivers are probably overwhelmed with the responsibility of providing scarce food and resources to feed their many children, consequently gave less concern to some radio programmes.

Furthermore, findings showed that knowledge of SAM messages was positively predicted by education and the extent to which they listened to the radio messages. These outcomes are consistent with previous findings elsewhere (e.g., Central Statistical Agency & ICF International, 2012; Demilew, 2017). For example, in a cross-sectional assessment of knowledge among mothers resulting from their exposure to IYCF recommendations in an Ethiopian city, Demilew (2017) revealed that positive knowledge from the child feeding campaign was significantly associated with mothers who had above primary education and was in possession of a radio. Although such positive knowledge correlated with mothers' education level in our study, it was only noticed in mothers with primary education. In practical terms, this output should be interpreted with caution because a primary education could still be classified as very low education status. Recall that it was stated in the study that women and girls are disproportionately disadvantaged in terms of access to formal education.

The findings on the influence of mothers' age and education are in agreement with extant research showing that being young, having higher education level, and frequent TV watching impacted the believability of mass media intervention to improve child feeding in Bangladesh (Kim *et al.*, 2018). Such findings extend the results of previous studies as they highlight how demographic variables could impact the ways these messages are received in different populations. We also observed that young mothers can be encouraged to form or participate in listening groups (i.e., targeting those who do not own a radio, but could join others who own one to listen along). While radio programmes could be designed to encourage listeners to form listening groups, child feeding attitudinal change strategies (as obtained from episodes of these programmes) could be incorporated and taught by knowledgeable members of the group.

Finally, being young, married, having 4-6 children, having a primary education, and listening to SAM-related messages on the radio impacted the likelihood of practising SAM messages. These findings corroborate earlier findings (Aswathy *et al.*, 2020; Kim *et al.*, 2018). Related studies have also looked at the influence of marital instability on proper child feeding practices and stunting (Neji *et al.*, 2015; Ntoimo & Odimegwu, 2014). Our finding on marital influence extends this evidence by showing that marital status might also have an impact on the ways and manners in which mothers act on mass media information that encourage best child feeding practices.

Limitations of the study

It is a fact that no work is immune to limitations. Therefore, our study is no different. One of the limitations of this study was our reliance on self-report with regards to radio listenership on SAM-related topics, as well as behaviours related to the messages in the northern region. Since we did not design the radio programme, as well as control variables for experimental purposes, we resolved to relying on self-report measures, which

allowed us to select mothers who have actually been exposed to SAM-related radio programmes over a period of six months to the time of the field work. The study was equally limited because we did not adopt an experimental approach, which could have enabled us to ascertain causality and actual effects. The study also did not focus on the experience of fathers. The study was restricted to only three out of the 19 northern states in the country, thus could only be generalised to areas with high prevalence of SAM and access to radio messages. Nevertheless, future research could strengthen the study outcomes by addressing these limitations.

CONCLUSION

Based on the study, the likely influence of radio intervention was mostly observed on mothers' comprehension of the messages disseminated. However, mothers' attitude (believability of the messages) and actual practice of what was heard on the radio was not encouraging. While the study showed that the influence of SAM-related radio spots or programmes on mothers' knowledge, attitude and behaviour might be minimal, the findings provided a link between demographic characteristics of mothers and how they comprehended and acted on the messages they received from the radio programmes. We argue that the understanding of this link might inform the focus of future interventions aiming to promote best child feeding practices in Northern Nigeria.

Based on the findings of this study, it is recommended that campaign developers focus more on age-specific factors, as well as improve on language and concepts that could be appealing to all age categories. We also advise the adoption of interventions and continuous introduction of family planning as one of the measures to make intending parents consider their family size relative to available food resources. In addition, radio programmes on SAM should be redesigned to focus more on mothers who are illiterate. Programme designers could tap into relatable languages and ideas that could attract this demographic. Complementary child feeding attitudinal change communication through existing SAM-related radio programmes should be timely. For example, by designing such attitudinal change communication to focus more on mothers who are older, illiterate, listen to SAM messages occasionally, and have large family size, we might begin to motivate significant attitudinal change towards believing in these messages. Finally, intervention approaches should encourage mothers to form radio listening groups where they can motivate one another to always listen to these SAM-related programmes.

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Authors' contributions

OAE and ALI, principal investigators, conceptualised and designed the study, led the data collection in Northern Nigeria; IOO, co-led the data analysis and interpretation; BBM, co-led the data analysis and interpretation; LBF, prepared the manuscript and assisted in data collection; OV, compiled the draft and reviewed the manuscript.

Conflict of interest

The authors report no conflict of interest. The authors alone are responsible for the content and writing of the manuscript.

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