MALAYSIAN JOURNAL OF

NUTRITION

VOL. 26 NO. 3 DECEMBER 2020

PP18053/02/2013 (033331)

ISSN 1394-035X

Official Publication of the
PERSATUAN PEMAKANAN MALAYSIA
NUTRITION SOCIETY OF MALAYSIA

Malaysian Journal of Nutrition is abstracted/indexed by Google Scholar, the WHO Western Pacific Region Index Medicus, Elsevier databases of the Scopus, EBiology and Ecare, ASEAN Citation Index (ACI), CABI Global Health database and Asian Digital Library (ADL)

MALAYSIAN JOURNAL OF NUTRITION

Peer-reviewed Journal of the Nutrition Society of Malaysia
(http//www.nutriweb.org.my)

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Malaysian Journal of Nutrition
Vol. 26 No. 3, 2020

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Mal J Nutr 26(3): 317-332, 2020

Factors influencing malnutrition in Filipino elderly

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ABSTRACT

Introduction: The elderly population is susceptible to malnutrition due to the physiological and functional changes caused by ageing. Hence, to prevent the degenerative nutritional conditions of the elderly and improve their quality of life, this study aimed to determine the influencing factors of malnutrition among Filipino elderly. **Methods:** Anthropometric component data from the 8th National Nutrition Survey (NNS) were utilised along with the nutritional status of Filipino elderly, based on body mass index as the dependent variable and variables from the clinical and health, dietary, and socioeconomic components of NNS as explanatory factors. Multinomial logistic regression analysis was then performed in fitting models. **Results:** High magnitude and severity of malnutrition were observed among Filipino elderly – 20.2% were underweight and 24.8% were overweight. Significant influencing factors in estimating an elderly's odds of being underweight were the elderly's age group, presence of hypertension, presence of anaemia, and adequacy of vitamin A intake. Whereas, significant influencing factors in estimating an elderly's odds of being overweight/obese included highest educational attainment, presence of anaemia, hypertension, diabetes, and dyslipidaemia. **Conclusion:** Knowing the influencing factors may help the elderly become more aware and conscious of their health, as well as to promote nutrient intakes to prevent malnutrition that can worsen their health conditions. Additionally, concerned institutions in the country could use the findings of this study as one of the bases in strengthening their approach and implementation or even provide relevant and timely policies and programmes that address malnutrition in the elderly of this country.

Keywords: Multinomial logistic regression, nutritional status, elderly

INTRODUCTION

The ageing population is increasing worldwide. According to the World Health Organization (WHO), the total number of people ≥ 60 years is estimated to increase from 900 million in 2015 to 1.4 billion by 2030, to 2.1 billion by 2050, and to 3.2 billion in 2100. This information shows how the number of elderly is expected to grow rapidly worldwide. It is also claimed that people aged ≥ 60 years are expected to outnumber children aged ≤ 5 years by 2020. Furthermore, it is projected that by 2050, a great portion of this increase will be shared by developing countries (WHO, 2018). In the Philippines, the percentage of older people is likewise increasing, even faster than the total population growth of the country. In 2000, about 4.6 million Filipino belonged to the age group of ≥ 60 years, which constituted around 6.0% of the total population. This number has increased to 9.4 million after two decades, constituting about 8.6% of the

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doi: https://doi.org/10.31246/mjn-2020-0051

total population. By 2050, it is projected that about 16.5% of the total population in the country will be composed of the elderly. The increasing trend in the elderly population worldwide could be attributed to decreasing fertility and an increased life expectancy (HelpAge International, 2012).

Having a longer life gives the elderly more chances to contribute to their families and society. However, it is important as well to realise that a fast increase in the older population raises several concerns and creates challenges that affect their families and policy makers. There will be challenges in earning enough income to support elderly needs, especially in developing countries. Loss of social status and acknowledgement could also be some of those disheartening challenges that could be experienced by the elderly people. Along with these concerns, health services of a country will have higher demands. These are just some of the concerns and challenges that need to be considered by the economic and social institutions of a country. Plans and programmes that would address income security, health care and other needs of the elderly population must be developed (Panigrahi, 2009; Agarwalla, Saikia & Baruah, 2015).

Health, independency and quality of life of older people are contingent with their nutritional condition. Elderly people are susceptible to malnutrition due to the physiological and functional changes caused by ageing. This is in addition to the other concerns regarding insufficient financial support and inadequate access to nutritious foods (Agarwalla *et al.*, 2015). The risk of malnutrition among the ageing population increases even further in the case of multi-morbidity, which is mutual among the elderly (Marengoni *et al.*, 2008). Hence, to prevent the degenerative nutritional conditions of the elderly and to improve their quality of life, it is vital for health and nutrition institutions to form timely interventions that would lessen the age group's risk of being malnourished.

To contribute towards the timely intervention of concerned institutions in the country, this study aimed to determine the nutritional conditions of Filipinos and identify factors that may influence malnutrition in the elderly. In doing so, policy makers would be made aware of the characteristics of the elderly people who are prone to undernutrition or overnutrition. Malnutrition is a state in which a deficiency (undernutrition), excess (overnutrition), or imbalance of energy, protein, and other nutrients affect the human body in a negative manner. Both undernutrition and overnutrition are related to the increased risk of excess mortality, poor cognition, chronic diseases, and poor health-related quality of life (Selvamani & Singh, 2018). This study also sought to identify factors that lead to malnutrition in the elderly. Knowing suggestive determinants of malnutrition among the elderly would be significant to policy makers as these would allow them to develop relevant and timely interventions for the nutritional well-being of the elderly.

Several studies have been conducted to identify factors associated with the nutritional status among elderly people. Some of the factors identified include biochemical, clinical, dietary intake, food security, and socioeconomic factors. Social and economic conditions greatly affect an older person's choices of diet and even eating patterns, which can lead to poor nutrition. The process of ageing also affects other nutrient needs. As an example, the required intake for some nutrients should be reduced. However, according to some data, requirements for other essential nutrients may, in fact, increase as age increases. Thus, there is a serious need to review current recommended daily nutrient allowances for the elderly group. Lifestyle and daily

activities of elderly people also affect their nutritional status (Boscatto *et al.*, 2013). Additionally, systolic hypertension was found to be associated with underweight (Ly *et al.*, 2013). Shibata *et al.* (2018) stated that underweight was inversely and significantly associated with high cholesterol, which is also a risk factor of obesity.

Indeed, various studies have provided meaningful information on the factors that affect the nutritional status of an individual. However, influencing factors of the elderly's nutritional status may vary according to the location of the study conducted due to several reasons, such as culture, lifestyle, and economic status of a country. The results of this study may provide additional information on the subject and will be very helpful in identifying the causes of poor nutrition.

MATERIALS AND METHODS

Data source

Data from the 8th National Nutrition Survey (NNS) conducted by the Food and Nutrition Research Institute (FNRI) in 2013 were utilised in this study. The NNS is the key source of information that serves as the government's basis for the formulation of health and nutrition plans and programmes for Filipinos. This survey has ten components: anthropometry, biochemical, clinical and health, dietary, socioeconomic, food security, government programme participation, infant and young child feeding (IYCF), maternal health and nutrition, and household awareness and usage of iodised salt, nutrition label, and nutrition facts.

The anthropometry component deals with data that reflect the nutritional status of Filipinos across all ages. This study considered elderly Filipinos aged ≥ 60 years old as the age group of interest, and their nutritional status was assessed based on their body mass index (BMI). Moreover, to explain the variation in the nutritional status of elderly and what causes them to become malnourished, some explanatory variables were generated from the clinical and health, dietary, and socioeconomic components of the NNS. The clinical and health component was used to determine the clinical signs of nutritional deficiencies such as vitamin A deficiency, iron deficiency, and iodine deficiency, along with some other lifestyle-related diseases, including hypertension, diabetes, and dyslipidaemia among others. Alternatively, the dietary data were used to measure food and nutrient intakes at the household and individual levels. Lastly, the socioeconomic component was considered for the living conditions of the household (FNRI-DOST, 2013).

The survey used a stratified three-stage sampling design. For the first stage, primary sampling units (PSUs), consisting of one barangay or a combination of contiguous barangays with at least 500 households, were selected. Within the selected PSUs, enumeration areas with 150 to 200 households were determined, and the housing units were randomly selected. Afterwards, households were randomly selected in the last stage (Barcenas, 2004). The NNS's design complexity was considered in the percentage distribution and fitting of model in this study. With merging done to all NNS components considered, data collected from 1,807 Filipino elderly samples were subjected to analysis.

Data collection

Standard techniques in measuring the elderly individual's height and weight were followed in data collection. Detecto™ platform beam balance scale was used in measuring weight. At most, three measurements were obtained in which a third measurement was only taken if the difference between the first two measurements was greater than 0.3 kg. The final measurement was the average recorded to the nearest

0.1 kg. The weighing scale used for weight determination was calibrated using 5 kg standard weights. On the other hand, standing height was obtained using a Microtoise. Similar to weight measurements, at most, three measurements were also obtained in which a third measurement was only taken if the difference between the first two measurements was greater than 0.5 cm. The final measurement was the average of the measurements and was recorded to the nearest 0.1 cm. For height measurement, the instrument used was calibrated with a standard two-meter steel ruler. However, the height of individuals with body defects, such as polio and hunchback, was not measured (FNRI-DOST, 2013).

Personal interviews were conducted to determine the socio-demographic characteristics of the elderly. Smoking and alcohol consumption behaviours of the elderly population were identified based on the WHO operational guidelines. Food consumption of the elderly was determined using a 24-hour food recall through an interview. Moreover, the Food Composition Library, the Philippine Recommended Energy and Nutrient Intake (RENI) 2002 edition and the Philippine Dietary Reference Intake (PDRI) were employed in the dietary evaluation and assessment of the adequacy of nutrient intakes. The elderly's health conditions, which included diabetes, dyslipidaemia, fasting blood sugar (FBS), and blood lipid levels, were determined through blood samples extracted using venepuncture, following standard procedures. In addition, blood pressure level of the elderly was measured twice using a non-mercurial sphygmomanometer and stethoscope. Finally, haemoglobin level of the elderly was determined on-site using a spectrophotometer (FNRI-DOST, 2013).

Ethics approval

The FNRI has a review committee named the Institutional Ethics Review Committee (FNRI-IERC). However, because it was FNRI who has the official mandate to define the nutritional status of Filipinos in general, an ethics review was not required in conducting the NNS. Nonetheless, the FNRI ensured that the ethics and practices when conducting a survey were followed and implemented. These included informed consent forms that assured the confidentiality of the data collected and that the respondents may refuse to continue data collection at any time. Moreover, FNRI submitted the 8th NNS questionnaires to the Philippine Statistics Authority (PSA) for their review and approval (FNRI-DOST, 2013).

Data analyses

The weighted percentage distribution of the Filipino elderly population, according to their nutritional status, was constructed. To know the characteristics of malnourished elderly, the nutritional status of the elderly was cross-tabulated with the explanatory variables considered in the study, incorporating the sampling weights to adjust for the complexity of the sampling method employed in the NNS. A multinomial logistic regression analysis was performed to identify significant determinants of malnutrition in the elderly. This study considered the nutritional status of Filipino elderly as the dependent variable, *Y*, with values 0, 1, and 2 to indicate an elderly with normal weight, underweight, and overweight/obesity, respectively. The elderly was classified as underweight if BMI was < 18.5 kg/m^2, normal if BMI was 18.5-24.99 kg/m^2, and overweight/obese if BMI was ≥ 25 kg/m^2 (WHO/NCHS, 1978).

Two logistic equations were considered in which the category normal or (*Y*=0) served as the reference category. The equations are as follows:

$$\ln\frac{\pi(y=1)}{\pi(y=0)} = \alpha_{1+\beta_{11}X1+\beta_{12}X2+\cdots+\beta_{1K}X_k}$$
$$\ln\frac{\pi(y=2)}{\pi(y=0)} = \alpha_{2+\beta_{21}X1+\beta_{22}X2+\cdots+\beta_{2K}X_k}$$

From the logistic equations, the likelihood of each outcome was computed as:

$$\Pi(Y=0) = \frac{1}{1+e^{\alpha_{1+\beta_{11}X1+\beta_{12}X2+\cdots+\beta_{1K}X_k}+e^{\alpha_{2+\beta_{21}X1+\beta_{22}X2+\cdots+\beta_{2K}X_k}}}$$
$$\Pi(Y=1) = \frac{e^{\alpha_{1+\beta_{11}X1+\beta_{12}X2+\cdots+\beta_{1K}X_k}}}{1+e^{\alpha_{1+\beta_{11}X1+\beta_{12}X2+\cdots+\beta_{1K}X_k}+e^{\alpha_{2+\beta_{21}X1+\beta_{22}X2+\cdots+\beta_{2K}X_k}}}$$
$$\Pi(Y=2) = \frac{e^{\alpha_{2+\beta_{21}X1+\beta_{22}X2+\cdots+\beta_{2K}X_k}}}{1+e^{\alpha_{1+\beta_{11}X1+\beta_{12}X2+\cdots+\beta_{1K}X_k}+e^{\alpha_{2+\beta_{21}X1+\beta_{22}X2+\cdots+\beta_{2K}X_k}}}$$

The significance of the overall model, as well as the predictors were assessed. The sign of the coefficient of a certain factor was also checked for consistency in the literature. STATA was used to facilitate all the analyses.

RESULTS

Nutritional status across some factors

A high magnitude and severity of malnutrition among the elderly Filipinos were observed wherein 20.19% of the elderly population were underweight, and approximately a quarter (24.83%) were determined as overweight or obese (Figure 1). In particular, 10.96% and 15.31% of the elderly population were females who were underweight and overweight/obese, respectively. Meanwhile, the proportions of underweight and overweight/obese male elderly were 9.24% and 9.52%, respectively. About one in every ten individuals (9.92%) aged 60-70 years were underweight, while around one in every 25 individuals (4.36%) were classified as overweight/obese. Also, there were more elderly above 70 years old who were underweight than overweight, comprising 14.42% and 3.89% of the elderly population, respectively. As for educational attainment, the largest portion of underweight individuals was observed among elderly with no grades completed (9.21%), a little higher than those with elementary level as their highest educational attainment (7.99%). Likewise, 10.60% of the elderly individuals who attained elementary education were overweight/obese. The largest portion (23.57%) of elderly with normal nutritional status were still actively working. Among the underweight elderly, 6.30% had no occupation. In contrast, the highest proportion of overweight elderly had a job (Table 1).

This study also determined the nutritional status of elderly by considering

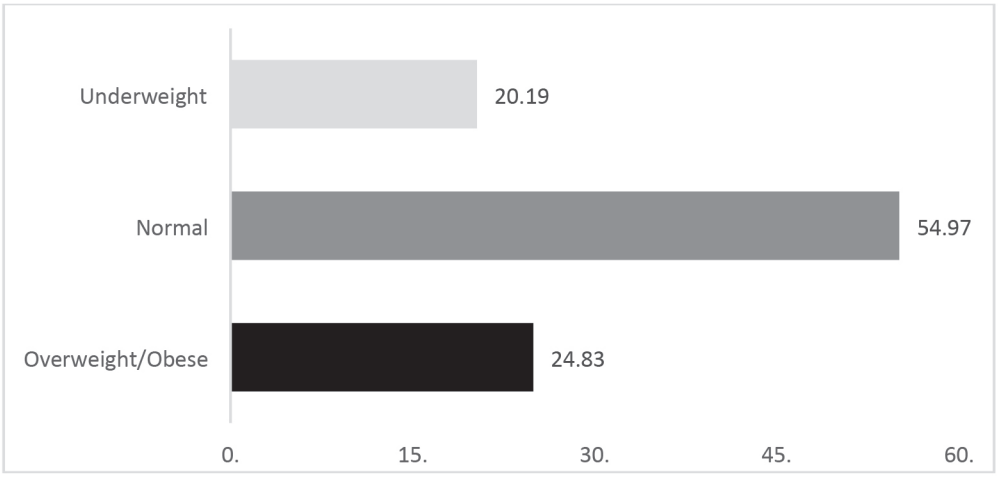

Figure 1. Weighted percentage distribution of Filipino elderly by nutritional status based on the 2013 NNS

Table 1. Weighted percentage distribution of Filipino elderly by nutritional status and by certain factors based on the 2013 NNS

Factor	*Nutritional status*		
	Normal	*Underweight*	*Overweight/Obese*
Sex			
Male	26.41	9.24	9.52
Female	28.57	10.96	15.31
Age group (years)			
60-70	34.36	9.92	4.36
71-80	16.25	7.73	2.55
Above 80	4.36	6.69	1.34
Highest educational attainment			
No grades completed	19.18	9.21	4.91
Elementary	22.44	7.99	10.60
High school	8.54	2.24	4.56
College and post-graduate	4.81	0.70	3.91
Occupation			
Unemployed	15.85	6.30	4.88
Housekeeper	9.40	4.08	5.73
Pensioner	6.16	1.69	4.85
Employed	23.57	8.13	9.36
Alcohol status†			
Non-alcoholic	24.56	9.01	12.18
Alcoholic	18.38	6.02	6.96
Drinks alcohol occasionally	9.10	4.25	4.84
Smoking status†			
Never smoked	28.12	8.65	16.08
Former smoker	11.99	6.09	2.71
Current smoker	11.92	4.53	5.20

†percent total is not equal to 100% due to missing values

some factors related to their health conditions such as anaemia, diabetes, dyslipidaemia, and hypertension. Among the elderly, 6.14% were underweight and had anaemia, while 2.77% were overweight and had anaemia. As for diabetes, a higher proportion of the elderly population was overweight and diabetic (5.91%) compared underweight and diabetic (1.80%). Similarly, a higher proportion was classified as overweight with dyslipidaemia compared to the proportion who were underweight with dyslipidaemia, comprising 2.84% and 0.60% of the elderly, respectively. Moreover, 12.80% of the elderly had hypertension and were recorded to be overweight – twice higher than those who were underweight with hypertension at 6.26%. Concerning dietary intake, a higher proportion with inadequate iron intake and malnutrition were overweight than underweight, constituting 4.22% as compared to 1.51% of the elderly. Among the elderly with inadequate niacin intake, a higher percentage was underweight (13.38%) than overweight (10.19%). On the other hand, among those with adequate or more intake of niacin, the number of those classified as overweight (14.64%) was greater than those who were underweight (6.82%). As for those with inadequate thiamine intake, the number of those classified as overweight was 1.55% greater than those classified as underweight. In

addition, 1.14% of the elderly had inadequate intake of vitamin A and were underweight – a bit higher than the 0.20% who were overweight. On the contrary, a considerably higher proportion of those with more than adequate vitamin A intake were overweight (12.15%) than underweight (6.15%) (Table 2).

Influencing factors

Among the independent factors considered in the study, age group, hypertension, anaemia, and adequacy of Vitamin A intake were found to be significant determinants in estimating the odds of an elderly becoming underweight. Table 3 gives the regression coefficients, standard error, odds ratio, a 95% confidence interval for odds ratio, and the *p*-value of the predictors considered in the model. According to the fitted model, the likelihood of an elderly to become underweight was higher if he/she was ≥ 70 years old or diagnosed with anaemia or had inadequate vitamin A intake, holding other factors constant. Specifically, the odds of an elderly to be underweight was 1.52 times and 1.80 times more likely if he/she was 71-80 years old and > 80 years, respectively, as

Table 2. Percentage distribution of the nutritional status of elderly in the Philippines by health conditions and by dietary intake based on the 2013 NNS

Factor	*Nutritional status*		
	Normal	*Underweight*	*Overweight/Obese*
Health Condition			
Anaemia			
Without anaemia	44.34	14.05	22.06
With anaemia	10.64	6.14	2.77
Diabetes			
Without diabetes	47.78	18.40	18.92
With diabetes	7.19	1.80	5.91
Dyslipidaemia			
Without dyslipidaemia	51.70	19.59	21.99
With dyslipidaemia	3.28	0.60	2.84
Hypertension			
Without hypertension	30.29	13.93	12.03
With hypertension	24.68	6.26	12.80
Dietary Intake			
Iron			
Inadequate	7.96	1.51	4.22
Adequate	47.01	18.68	20.61
Niacin			
Inadequate	30.07	13.38	10.19
Adequate	23.83	6.56	14.03
More than adequate	1.07	0.26	0.61
Thiamine			
Inadequate	4.48	1.17	2.72
Adequate	50.49	19.02	22.11
Vitamin A			
Inadequate	0.96	1.14	0.20
Adequate	29.39	12.91	12.48
More than adequate	24.62	6.15	12.15

compared to the elderly belonging in the age group of 60-70 years old. With 95% confidence, the true odds ratio for 71-80 years old and > 80 years old adult lie in the range of 1.13-2.06, and 1.09-2.95, respectively. It can also be noted that an elderly was less likely to be underweight if he/she had hypertension. Particularly, the odds of an elderly being underweight was reduced by about 44% if he/she was hypertensive in comparison to one who had normal blood pressure. Similarly, it was 2.25 times more likely that an elderly was underweight if he/she had inadequate vitamin A intake compared to one with enough intake of vitamin A, with a 95% confidence limits of odds ratio between 1.14 and 4.42. Alternatively, it was less likely for an elderly to be underweight if he/she had an over-adequate intake of vitamin A compared to one with adequate intake,

Table 3. Estimated parameters of the logistic regression model for underweight among elderly in the Philippines

Factor	*Coefficient*	*Odds ratio*	*95% CI for odds ratio*	*p-value*
Underweight				
Constant	-1.500			0.001
Age group[1]				
71 – 80 years	0.422	1.52	[1.13, 2.06]	0.006**
>80 years	0.586	1.80	[1.09, 2.95]	0.021*
Hypertension[2]				
Yes	-0.582	0.56	[0.42, 0.74]	<0.001***
Anaemia[3]				
Yes	0.390	1.48	[1.08, 2.02]	0.015*
Adequacy of vitamin A intake[4]				
Inadequate	0.810	2.25	[1.14, 4.42]	0.019*
Over-adequate	-0.375	0.69	[0.52, 0.92]	0.011*
Overweight				
Constant	-1.559			<0.001
Highest educational attainment[5]				
Elementary	0.472	1.60	[1.14, 2.26]	0.007**
High school	0.640	1.90	[1.26, 2.86]	0.002**
At least college level	1.039	2.83	[1.72, 4.65]	<0.001***
Anaemia[3]				
With anaemia	-0.578	0.56	[0.38, 0.83]	0.004**
Hypertension[2]				
With hypertension	0.295	1.34	[1.02, 1.77]	0.036*
Diabetes[6]				
With diabetes	0.639	1.89	[1.33, 2.69]	<0.001***
Dyslipidaemia[7]				
With dyslipidaemia	0.550	1.73	[1.07, 2.81]	0.025*

Base category: [1] 60-70 years; [2] without anaemia; [3] without hypertension; [4] adequate; [5] no grades completed; [6] without diabetes; [7] without dyslipidaemia
*significant at $p<0.05$
**significant at $p<0.01$
***significant at $p<0.001$

with an odds ratio of 0.69, wherein the true odds ratio is between 0.52 and 0.92 (Table 3).

When considering educational attainment, based on the fitted model, the likelihood of an elderly becoming overweight/obese was higher if he/she reached elementary, high school, or at least college level and if one had hypertension, diabetes, and dyslipidaemia, holding other factors constant. Results of the modelling showed that, in particular, the odds for an elderly to be overweight/obese increased as educational attainment got higher, with the odds ratio of 1.60, 1.90, and 2.83 for those whose highest educational attainment were elementary, high school, and at least college level, respectively, relative to those recorded with no grades completed. The true odds ratio for elementary is within 1.14 to 2.26, for high school: 1.26-2.86, and for at least college level: 1.72-4.65, in relation to those with no grade completed at 0.95 level of confidence. It was estimated that elderly with hypertension, dyslipidaemia, and diabetes mellitus were 1.34, 1.73, and 1.89 times more likely to be overweight/obese, respectively in comparison with elderly individuals who were not suffering from these said diseases. Moreover, a 95% confidence limits showed that true odds ratio for hypertension, diabetes, and dyslipidaemia are within [1.02, 1.77], [1.33, 2.69], and [1.07, 2.81], respectively, over without these diseases. Meanwhile, the estimated model revealed that the odds of an elderly being overweight was reduced by about 44% if he/she had anaemia, with a true odds ratio lies between 0.38 and 0.83. This was consistent with the result of the fitted model for those underweight in which the likelihood of the latter was higher in the presence of anaemia (Table 3).

We noted that both the fitted models were significant (p-value of <0.0001); hence, the overall model fitted the data for both underweight and overweight. Likewise, the Receiver Operating Characteristic (ROC) revealed 65.6% area under the curve for underweight. Since it covered more than 50% of the

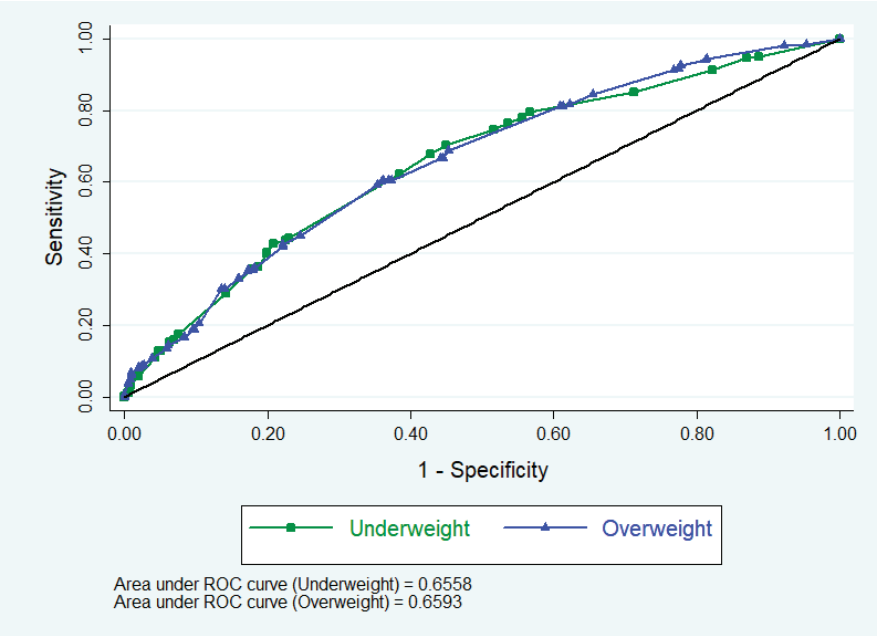

Figure 2. ROC curve of the fitted model for overweight and underweight Filipino elderly

reference line, the model is said to have a fair predicting power. Similarly, the fitted model for the likelihood of overweight gave a fair predicting power, with an area under the ROC curve of 66% (Figure 2).

DISCUSSION

Nutritional status across some factors

Although the majority of the Filipino elderly were assessed to have a normal nutritional status, considerably high portions of them were either underweight or overweight. Results showed alarming values, which may imply that the elderly population are exposed to malnutrition. More females than males were found experiencing malnutrition. Similar results were found by Rawal *et al.* (2016) in their study about the prevalences of underweight, overweight, and obesity, and their associated risk factors among Nepalese adults where the proportions of underweight and overweight were high among female adults compared to male adults. In their studies, Boulos *et al.* (2013) and Saeidlou *et al.* (2011) also found a significant positive association between being a female and nutritional status. Also, the proportion of underweight and overweight/obesity decreased as age of the elderly increased. In the study of Coqueiro *et al.* (2010), the prevalence of underweight was higher in older age groups, while the prevalence of overweight was higher in younger age groups. However, other existing literature showed that older age groups have poorer nutritional status compared with younger age groups (Kyle *et al.*, 2002; Forster & Gariballa, 2005; Agarwalla *et al.*, 2015).

Among the underweight elderly, many of them had no formal education, while many of the overweight/obese attained elementary education. In the study of Rawal *et al.* (2018), the elderly who had no education were more likely to be underweight and less likely to be overweight or obese compared to those who were at least college graduates. Moreover, Poda *et al.* (2019) found that no formal education was positively associated with undernutrition in older adults. Similar to the other studies' results (Poda *et al.*, 2019; Rawal *et al.*, 2018; Pradeepa *et al.*, 2015; Katulanda *et al.*, 2010), this study found that the prevalence of overweight/obesity was higher among the elderly who were actively working compared to those with no occupation or low earners. However, other research showed otherwise; those with no or lower income were more likely to be underweight than overweight/obese (Ferdous *et al.*, 2009; Han, Li & Zheng, 2009; Saikia & Mahanta, 2013).

This study also showed that most elderly who did not smoke and were non-alcoholic fell under the normal nutritional status classification. Nonetheless, a greater portion of malnourished elderly who smoked (former smoker and current smoker) were assessed as underweight. In contrast, more elderly Filipinos with malnutrition and consumed alcohol (alcoholic and drinks alcohol occasionally) were overweight/obese. Research has shown that nicotine in cigarettes increases metabolic rate (WHO, 1995) and reduces appetite (Chiolero *et al.*, 2008), which results in lower weight (Fares *et al.*, 2012). On the other hand, alcohol can stimulate food intake (Yeomans, 2010), which further results in weight gain.

It can also be observed that more elderly Filipinos with normal nutritional status had adequate intakes of iron, thiamine, and vitamin A. Looking at those with malnutrition, there were more overweight/obese than underweight elderly who had an adequate intake of iron, niacin, thiamine, and vitamin A. A greater portion of the underweight population was observed to lack an adequate niacin intake. In the study of Baugreet *et al.* (2017), inadequate macro- and micronutrient intakes, which is a result of low food intake in older adults

(Hickson, 2006), contributed to weight loss and malnutrition. However, Leslie & Hankey (2015) reported that shortage in micronutrient intakes was accompanied by a high incidence of overweight and obesity, which according to Astrup & Bugel (2019), is possibly a result of poor diet quality (i.e. overconsumption of high-calorie, low-nutrient processed foods).

According to existing studies (Chavarro-Carvajal *et al.*; 2015, Peng *et al.*, 2015; Poda *et al.*, 2019), health conditions and comorbidities contribute to malnutrition in older adults, such as diabetic elderly patients having a higher risk of suboptimal nutrition (Sanz-Paris & Lardies-Sanchez, 2019). In terms of the elderly's health conditions, a greater portion of those who were overweight/obese had diabetes, dyslipidaemia, and hypertension compared to those who were underweight. This is similar with the findings of Lu *et al.* (2018) where elderly patients who were hypertensive, insulin resistant, and had lower high-density lipoprotein cholesterol levels had higher BMI. Specifically, obesity is closely associated with systematic hypertension, glucose intolerance, diabetes mellitus, and dyslipidaemia (Ho *et al.*, 2001; Jonsson *et al.*, 2002; Dalton *et al.*, 2003). Both systolic and diastolic blood pressure values are linearly correlated with BMI (Mungreiphy, Kapoor & Sinha, 2011; Landi *et al.*, 2018). Irregularities in lipid metabolism are also very common in obese individuals (Feingold & Grunfeld, 2000).

Meanwhile, more underweight elderly Filipinos were anaemic compared to those who were overweight/obese. Gupta *et al.* (2011) and Ramachandra & Kasthuri (2008) reported that underweight elderly had a higher prevalence of anaemia. Anaemic elderly individuals have low dietary, energy, and protein intakes, resulting in lower quantity of food consumption (Gupta *et al.*, 2020). Furthermore, anaemia among the elderly has been shown to play a role in the development of frailty, a condition characterised by weight loss, weakness, impaired mobility, and poor balance (Kikuchi, Inagaki & Shinagawa, 2001; Woodman, Ferrucci & Guralnik, 2005).

Influencing factors

The fitted model indicated that the likelihood of an elderly to become underweight was higher if he/she was ≥ 70 years old. As one ages, there will be more hormones that decrease appetite and fewer neurotransmitters to excite the appetite, which cause the elderly to eat less. Consequently, because of inadequate intake, undernutrition among the elderly is often part of the general decline (Zagaria, 2010). Also, ageing in humans is accompanied by changes (Forster & Gariballa, 2005), such as reduced sense of smell and taste, oral cavity problems, and declined cognitive and functional capacities (Population Reference Bureau, 2007), which may further result to being underweight (Fares *et al.*, 2012).

Meanwhile, an elderly individual was more likely to be underweight if he/she had anaemia. This result is consistent with the study of Imai *et al.* (2016) where they found that anaemic subjects tended to have lower BMI. This may be due to nutrient deficiency such as haemoglobin and iron count. These observations are similar with previous studies, specifically in the study of Poda *et al.* (2019) wherein characteristics such as age >70 years, gender, uneducated level, low income, and having anaemia were positively associated with undernutrition among older adults.

Regarding nutrient intake, it was more likely that an elderly will be underweight if one has inadequate intake of vitamin A. Some of the common reasons cited for inadequate nutrient intake were problems in chewing and swallowing, digesting, and absorbing nutrients (Chernoff, 2005). Other reasons could be the incapacity of the elderly to make decisions about food intake and the lack

of financial support (Agarwalla *et al.*, 2015).

Furthermore, this study found that an elderly with hypertension was less likely to be underweight. A similar finding was reported in the studies of Assumpcão *et al.* (2018) and Francisco *et al.* (2019) where being underweight was less prevalent among hypertensive older adults.

In the case of being overweight/obese, having attained elementary, high school, or at least college education level, and having hypertension, diabetes, and dyslipidaemia were found as significant determinants. Education may be connected to the wealth of an individual. Normally, the higher the educational attainment, the higher the income; therefore, they are able to meet and even exceed the recommended food intake (Ahmed & Haboubi, 2010). The same result was revealed by the studies of Barreto, Passos & Lima-Costa (2003), Bovet *et al.* (2008), and Wang *et al.* (2009) wherein they observed that education played a role in the nutritional status of the elderly. The higher the educational attainment, the higher the income, and more knowledgeable individuals were about nutritional needs; thus, they were able to consume, meet, and even exceed the recommended food intake.

Likewise, results also showed that it was more likely for an elderly to be overweight if he/she had dyslipidaemia, since this said disease is about an abnormal amount of lipids like triglycerides and cholesterol (bad and good) in the body which affects nutritional status. Similar to reports from previous literature, if an elderly has hypertension, their BMI is expected to be higher. Obesity is associated with hypertension since body fats affect systolic and diastolic blood pressure, and hypertension is associated with numerous other diseases that can affect overall health and life expectancy (Delaney, 2009). This is also supported by the studies of Cameron *et al.* (2008), Srinivasan *et al.* (2009), and Hsieh & Muto (2006) whose results showed that being overweight and being obese are accompanied by cardiovascular disease risk, such as hypertension, dyslipidaemia, diabetes mellitus, and insulin resistance.

In contrast, having anaemia reduced the likelihood of an elderly becoming overweight/obese. This is consistent with the result of the fitted model for underweight, in which the likelihood of the latter was higher in the presence of anaemia.

The strong point of this study was that the model constructed was based on the nationwide data obtained from the 8th NNS conducted by FNRI, representing the elderly in the Philippines. The limitation of the study was that the dependent variable considered was the nutritional status of elderly, based on BMI, to address the primary objective of the study. Conclusions made from the study reflect only nutritional status as a response characteristic, while clinical and health, dietary, and socioeconomic characteristics of the elderly were explanatory variables. Any possible comorbidities between the dependent and the considered explanatory variables were not considered in the study.

CONCLUSION AND RECOMMENDATION

This study determined the nutritional status of the elderly based on their BMI across some considered factors and identified possible influencing factors based on socioeconomic, clinical and health conditions, and nutrient intakes using the 2013 NNS data. It is important to note that all of the health conditions included in this study influenced the nutritional status of the elderly. The odds of becoming overweight increased if the elderly had diabetes, dyslipidaemia, and hypertension. While the odds of being underweight was higher if an elderly had anaemia. Although anaemia, diabetes

and dyslipidaemia are not as prevalent as hypertension, necessary actions must be implemented to assess these risk factors as these affect the nutritional status of Filipino elderly in a negative manner. Despite the high percentage of elderly with adequate nutrient intake, it is also important to note that nutrient intake was a determinant of nutritional status among the elderly population, especially vitamin A intake. Thus, elders should consume foods that are rich with such nutrient.

This study will be helpful in addressing the issue on malnutrition by finding the factors that influence nutritional status of the elderly. Knowing the factors will help the elderly become more aware and conscious of their health and nutrient intakes to prevent malnutrition that can worsen their health conditions. Also, the concerned institutions would be able to strengthen their approach and implementation or even provide relevant and timely policies and programmes using the factors that were found to be significantly associated with the nutritional status among Filipino elderly. Particularly, strategies on how to improve the health conditions and dietary intake of Filipino elderly must be implemented to improve their nutritional status. This study could also be used as the basis for future studies as malnutrition in the elderly is not popular in the Philippines.

Nutritional status of the elderly could be examined comprehensively based on one's anthropometric measurement, medical history, and nutritional history such as appetite, change in food intake, and weight change (JASPEN, 2013). This study was carried out to characterise the malnourished elderly based only on anthropometric measurement, which was BMI, using the 2013 NNS data, with the cutoff values recommended by WHO. The accuracy of BMI depended on the measurement that was done by the institute who conducted the survey. Also, to identify determinants of malnutrition among Filipino elderly, only socioeconomic, health and clinical, and dietary data available in the 2013 NNS were considered. Therefore, it is recommended to use more recent data as there may be variations in the determinants of nutritional status of Filipino elderly. Besides that, it is also recommended to include other components from the survey that may have a relationship with the nutritional status of elderly. Future studies can consider factors such as housing characteristics and living arrangements for these may contribute to the nutritional status of elderly. Psychological factors that are very prevalent among the elderly and are affecting their eating habits, as well as eating disorders, may also be considered for a more comprehensive perspective to adequately assess and interpret the nutritional status of elderly people. Similarly, psychological factors, such as depression and loneliness that affect the nutritional status of elderly can also be studied. Future studies can also take into account other medical factors such as mouth pain, chewing and swallowing disorders and visual or hearing impairments. Finally, residential status (urban or rural) can also be considered as one of the explanatory variables in future related studies, with the consideration of lifestyle differences of people residing in the urban and rural areas, and in the healthcare systems present in their areas.

Acknowledgement

The authors are grateful to the Food and Nutrition Research Institute – Department of Science and Technology, Philippines for the 2013 National Nutrition Survey data.

Authors' contributions

NAT, conceptualised, designed and prepared the manuscript; RLCA, conducted data analysis and reviewed related articles; GCN, conducted review of related literatures. All authors interpreted the results of analysis, read and approved the manuscript.

Conflict of interest

The authors declared no conflict of interest.

References

Agarwalla R, Saikia AM & Baruah R (2015). Assessment of the nutritional status of the elderly and its correlates. *J Fam Community Med* 22(1):39-43.

Ahmed T & Haboubi N (2010). Assessment and management of nutrition in older people and its importance to health. *Clin Interv Aging* 5:207-216.

Assumpção D, Borim FSA, Francisco PMSB & Neri AL (2018). Fatores associados ao baixo peso em idosos comunitários de sete cidades brasileiras: Estudo FIBRA. *Cien Saude Colet* 23(4):1143-1150.

Astrup A & Bugel S (2019). Overfed but undernourished: recognizing nutritional inadequacies/deficiencies in patients with overweight or obesity. *Int J Obes* 43:219-232.

Barcenas ML (2004). The Development of the 2003 Master Sample (MS) for Philippine Household *Surveys*. 9th National Convention on Statistics, Philippines.

Barreto SM, Passos VM & Lima-Costa MF (2003). Obesity and underweight among Brazilian elderly: the Bambuí Health and Aging Study. *Cad Saude Publica* 19(2):605-612.

Baugreet S, Hamill RM, Kerry JP & McCarthy SN (2017). Mitigating nutrition and health deficiencies in older adults: a role for food innovation? *J Food Sci* 82(4):848-855.

Boscatto EC, Duarte MD, Coqueiro RD & Barbosa AR (2013). Nutritional status in the oldest elderly and associated factors. *Associação Médica Brasileira* 59(1):40-47.

Boulos C, Salameh P & Barberger-Gateau P (2013). The AMEL study, a cross sectional population-based survey on aging and malnutrition in 1200 elderly Lebanese living in rural settings: Protocol and sample characteristics. *BMC Public Health* 12(13):573.

Bovet P, Chiolero A, Shamlaye C & Paccaud F (2008). Prevalence of overweight in the Seychelles: 15 year trends and association with socio-economic status. *Obes Rev* 9(6):511-517.

Cameron AJ, Boyko EJ, Sicree RA, Zimmet PZ, Söderberg S, Alberti KGMM, Tuomilehto J, Chitson P & Shaw JE (2008). Central obesity as a precursor to the metabolic syndrome in the AusDiab study and Mauritius. *Obesity (Silver Spring)* 16:2707–2716.

Chavarro-Carvajal D, Reyes-Ortiz C, Samper-Ternent R, Arciniegas AJ & Gutierrez CC (2015). Nutritional assessment and factors associated to malnutrition in older adults: a cross-sectional study in Bogotá, Colombia. *J Aging Health* 27:304-319.

Chernoff R (2005). Micronutrient requirements in older women. *Am J Clin Nutr* 81(5):1240S-1245S.

Chiolero A, Faeh D, Paccaud F & Cornuz J (2008). Consequences of smoking for body weight, body fat distribution, and insulin resistance. *Am J Clin Nutr* 87:801-809.

Coqueiro RDS, Barbosa AR & Borgatto AF (2010). Nutritional status, health conditions and socio-demographic factors in the elderly of Havana, Cuba: Data from Sabe Survey. *J Nutr Health Aging* 14:803-808.

Dalton M, Cameron AJ, Zimmet PZ, Shaw JE, Jolley D, Dunstan DW, Welborn TA & AusDiab Steering Committee (2003). Waist circumference, waist-hip ratio and body mass index and their correlation with cardiovascular disease risk factors in Australian adults. *J Intern Med* 254(6):555-563.

Delaney J (2009). *In: Hypertension and Obesity: How Weight-loss Affects Hypertension*. From https://www.obesityaction.org/community/article-library/hypertension-and-obesity-how-weight-loss-affects-hypertension/ [Retrieved December 1, 2019].

Fares D, Barbosa AR, Borgatto AF, Coqueiro RS & Fernadez MH (2012). Factors associated with the nutritional status of the elderly in two regions of Brazil. *Rev Assoc Med Bras* 58(4):434-441.

FNRI-DOST (2013). *Philippine Nutrition Facts and Figures 2013*. From http://enutrition.fnri.dost.gov.ph/assets/uploads/publications/Overview_8thNNS_050416.pdf [Retrieved November 16, 2019].

Feingold KR & Grunfeld C (2000). Obesity and Dyslipidemia. In KR Feingold, B Anawalt, A Boyce *et al.* (eds.). *Endotext.* MDText.com, Inc. South Dartmouth.

Ferdous T, Kabir ZN, Wahlin A, Streatfield K & Cederholm T (2009). The multidimensional background of malnutrition among rural older individuals in Bangladesh - A challenge for the Millennium Development Goal. *Public Health Nutr* 12:2270–2278.

Forster S & Gariballa S (2005). Age as a determinant of nutritional status: A cross sectional study. *Nutr J* 4:28.

Francisco P, Assumpcão D, Borim F & Malta D (2019). Prevalence and factors associated with underweight among Brazilian older adults. *Ciência & Saúde Coletiva* 24(7):2443-2452.

Gupta VK, Maria AK, Kumar R, Bahia JS, Arora S, Singh R, Shelza & Gupta V (2011). To study the prevalence of anaemia in young males and females with respect to the age, body mass index (BMI), activity profile and the socioeconomic status in rural Punjab. *J Clin Diagn Res* 5(5):1020-1026.

Gupta A, Ramakrishnan L, Pandey RM, Sati HC, Khandelwal R, Khenduja P & Kapil U (2020). Risk factors of anemia amongst elderly population living at high-altitude region of India. *J Family Med Prim Care* 9(2):673–682.

Han Y, Li S & Zheng Y (2009). Predictors of nutritional status among community-dwelling older adults in Wuhan, China. *Public Health Nutr* 12:1189–1196.

HelpAge International (2012). *In: Ageing population in the Philippines*. From https://ageingasia.org/ageing-population-philippines/ [Retrieved December 1, 2019].

Hsieh SD & Muto T (2006). Metabolic syndrome in Japanese men and women with special reference to the anthropometric criteria for the assessment of obesity: Proposal to use the waist-to-height ratio. *Prev Med* 42:135–139.

Hickson M (2006). Malnutrition and ageing. *Posgrad Med J* 82:2-8.

Ho SC, Chen YM, Woo JL, Leung SS, Lam TH & Janus ED (2001). Association between simple anthropometric indices and cardiovascular risk factors. *Int J Obes Relat Metab Disord* 25(11):1689-1697.

Imai E, Nakade M, Tsuboyama K & Takimoto H (2016). Improved Prevalence of anemia and nutritional status among Japanese elderly participants in the National Health and Nutritional Survey Japan, 2003-2009. *Journal of Nutrition & Food Sciences* 50-62.

JASPEN (2013). *JASPEN guidelines on parenteral and enteral nutrition. 3rd ed.* Japanese Society for Parenteral and Enteral Nutrition. Shorinsha Inc., Tokyo.

Jonsson S, Hedblad B, Engstrom G, Nilsson P, Berglund G & Janzon L (2002). Influence of obesity on cardiovascular risk. Twenty-three-year follow-up of 22,025 men from an urban Swedish population. *Int J Obes Relat Metab Disord* 26(8):1046-5103.

Katulanda P, Jayawardena M, Sheriff M, Constantine G & Matthews D (2010). Prevalence of overweight and obesity in Sri Lankan adults. *Obes Rev* 11(11):751–756.

Kyle UG, Unger P, Mensi N, Genton L & Pichard C (2002). Nutrition status in patients younger and older than 60 y at hospital admission: A con- trolled population study in 995 subjects. *Nutrition* 18:463–469.

Kikuchi M, Inagaki T & Shinagawa N (2001). Five-year survival of older people with anemia: variation with hemoglobin concentration. *J Am Geriatr Soc* 49(9):1226–8.

Landi F, Calvani R, Picca A, Tosato M, Martone AM, Ortolani E, Sisto A, D'Angelo E, Serafini E, Desideri G, Fuga MT & Marzetti E (2018). Body mass index is strongly associated with hypertension: Results from the Longevity Check-Up 7+ Study. *Nutrients* 10(12):1976.

Leslie W & Hankey C (2015). Aging, nutritional status and health. *Healthcare (Basel)* 3(3):648-658.

Lu C, Li X, Ming-Ya W & Yu-Guang H (2018). Obesity paradox among elderly patients with coronary artery disease undergoing non-cardiac surgery. *J Geriatr Cardiol* 15:598-604.

Ly KA, Ton TGN, Ngo QV & Fitzpatrick AL (2013). Double burden: a cross-sectional survey assessing factors associated with underweight and overweight status in Danang, Vietnam. *BMC Public Health* 13: 35.

Marengoni A, Winblad B, Karp A & Fratiglioni L (2008). Prevalence of chronic diseases and multimorbidity among the elderly population in Sweden. *Am J Public Health* 98(7):1198–2000.

Mungreiphy NK, Kapoor S & Sinha R (2011). Association between BMI, blood pressure, and age: Study among Tangkhul Naga Tribal males of Northeast India. *J Anthropol* 2011:1-6.

Panigrahi AK (2009). *Determinants of Living Arrangements of Elderly in Orissa.* The Institute for Social and Economic Change 2009, Bangalore. From http://www.isec.ac.in/WP%20228%20-%20Akshaya%20Kumar%20Panigrahi.pdf [Retrieved December 01, 2019].

Peng LN, Cheng Y, Chen LK, Tung HH, Chu KH & Liang SY (2015) Cognition and social-physiological factors associated with malnutrition in hospitalized older adults in Taiwan. *J Nurs Res* 23:1-5.

Poda GG, Hsu CY, Rau HH & Chao JCJ (2019). Impact of socio-demographic factors, lifestyle and health status on nutritional status among the elderly in Taiwan. *Nutr Res Pract* 13(3):222-229.

Population Reference Bureau (2007) *Underweight, undernutrition, and the aging. Today's Res Aging.* From http://www.prb.org/pdf07/TodaysResearchAging8.pdf [Retrieved May 15, 2020].

Pradeepa R, Anjana RM, Joshi SR, Bhansali A, Deepa M, Joshi PP, Dhandania VK, Madhu SV, Rao PV, Geetha L, Subashini R, Unnikrishnan R, Shukla DK, Kaur T, Mohan V, Das AK & the ICMR-INDIAB Collaborative Study Group (2015). Prevalence of generalized & abdominal obesity in urban & rural India- the ICMR—INDIAB Study (Phase-I) [ICMR—INDIAB-3]. *Indian J Med Res* 142(2):139–50.

Ramachandra SS & Kasthuri A (2008). Anaemia in the elderly who resided in a south Indian rural community. *Indian Journal for the Practicing Doctor* 5(4):2-7.

Rawal LB, Kanda K, Mahumud RA, Joshi D, Mehata S, Shrestha N, Poudel P, Karki S & Renzaho A (2016). Prevalence of underweight, overweight and obesity and their associated risk factors in Nepalese adults: data from a Nationwide Sruvey. *PLos One* 13(11): e0205912. doi: 10.1371/journal.pone.0205912. eCollection 2018.

Saeidlou SN, Merdol TK, Mikaili P & Bektas Y (2011). Assessment of the nutritional status and affecting factors of elderly people living at six nursing home in Urmia, Iran. Part I. *Int J Acad Res* 3(1):173-181.

Saikia A & Mahanta N (2013). A study on nutritional status of elderly in terms of body mass index in Urban Slums of Guwahati City. *J Indian Acad Geriatr* 9:11–14.

Sanz-París A & Lardiés-Sánchez B (2019). Nutritional Status in Malnourished Older Diabetics. In Preedy V & Patel V (eds). *Handbook of Famine, Starvation, and Nutrient Deprivation*. Springer, Cham.

Selvamani Y & Singh P (2018). Socioeconomic patterns of underweight and its association with self-rated health, cognition and quality of life among older adults in India. *PLos One* 13(3):e0193979. doi: 10.1371/journal.pone.0193979. eCollection 2018.

Shibata Yosuke, Toshiyuki Ojima, Mieko Nakamura, Kazuyo Kuwabara, Naoko Miyagawa, Yoshino Saito, Yasuyuki Nakamura, Yutaka Kiyohara, Hideaki Nakagawa, Akira Fujiyoshi, Aya Kadota, Takayoshi Ohkubo, Tomonori Okamura, Hirotsugu Ueshima, Akira Okayama, Katsuyuki Miura (2019). Associations of Overweight, Obesity, and Underweight With High Serum Total Cholesterol Level Over 30 Years Among the Japanese Elderly: NIPPON DATA 80, 90, and 2010. *Journal of Epidemiology* Volume 29 Issue 4 Pages 133-138. do: https://doi.org/10.2188/jea.JE20170229

Srinivasan SR, Wang R, Chen W, Wei CY, Xu J & Berenson GS (2009). Utility of waist-to-height ratio in detecting central obesity and related adverse cardiovascular risk profile among normal weight younger adults (from the Bogalusa Heart Study). *Am J Cardiol.* 104:721–724.

Wang Y, Chen HJ, Shaikh S & Mathur P (2009). Is obesity becoming a public health problem in India? Examine the shift from under- to overnutrition problems over time. *Obes Rev* 10(4):456-474.

WHO/NCHS (1978). *1978 WHO/NCHS Growth References*. WHO, Geneva.

WHO (1995). *Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. Technical Report Series Nº 854*. World Health Organization, Geneva.

WHO (2018). *In: Ageing and health*. World Health Organization. From https://www.who.int/news-room/fact-sheets/detail/ageing-and-health [Retrieved December 01, 2019].

Woodman R, Ferrucci L & Guralnik J (2005). Anemia in older adults. *Curr Opin Hematol* 12(2):123–8.

Yeomans MR (2010). Alcohol, appetite and energy balance: is alcohol intake a risk factor for obesity? *Physiol Behav* 100:82–89.

Zagaria MAE (2010). *In: Vitamin deficiencies in seniors*. US Pharmacist. From https://www.uspharmacist.com/article/vitamin-deficiencies-in-seniors [Retrieved November 10, 2019].

Mal J Nutr 26(3): 333-340, 2020

Validation and dimensional analysis of the eating behaviour pattern questionnaire among Malaysian university students

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ABSTRACT

Introduction: Eating behaviour pattern is among the key behavioural factors that contribute to eating disorders. Hence, to evaluate the psychometric characteristics of the Eating Behaviour Pattern Questionnaire (EBPQ) that is used in epidemiological studies to measure the relationship between health outcomes and eating behaviour patterns, this study aimed to validate the adopted version of the EBPQ and to check the validity and reliability of this tool in University of Malaya, Malaysia. **Methods:** Exploratory factor analysis (EFA) was used to determine the most appropriate factor structure of EBPQ. Moreover, structural equation modelling (SEM) and confirmatory factor analysis (CFA) were applied to examine the convergent and discriminant validity of EBPQ. As for the participants of the study, multi-stage random sampling was used and 200 students (109 females and 91 males) from University of Malaya were chosen. **Results:** The EFA yielded nine components of EBPQ including emotional eating, eating outside, cultural habit, low-fat eating, meal skipping, snacking, healthy eating, planning for food and sweets, which explained 67.7% of the total variance. Furthermore, the Cronbach's α was about 0.8 for all components, which exhibited a high internal consistency among the obtained components. The results showed that the questionnaire had sufficient convergent and discriminant validity. **Conclusion:** The EBPQ was proven to be a reliable tool to measure the eating behaviour patterns in Malaysian university students. The presence of adequate validity and reliability supports this instrument's psychometric properties for future studies.

Keywords: Eating Behaviour Pattern Questionnaire, exploratory factor analysis, confirmatory factor analysis, structural equation modelling

INTRODUCTION

Recently, in both developed and developing countries, chronic diseases cause premature deaths and significant disabilities because of the changes in dietary patterns, eating behaviour,

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doi: https://doi.org/10.31246/mjn-2020-0005

and lifestyle (Salekzamani, Asghari-Jafarabadi & Dehghan, 2015). Behavioural factors such as eating behaviour pattern, is one of the most influential factors of weight gain and obesity (Chong *et al.*, 2016). Therefore, modifying these main determinants of chronic diseases could decrease diet-related diseases.

The Eating Behaviour Pattern Questionnaire (EBPQ) is used in epidemiological studies to measure the relationship between eating behaviour patterns and health outcomes, as well as to assess emotional, restrained and external eating behaviours (Van Strien et al., 1986; Cebolla et al., 2014; Dutton & Dovey, 2016).

This questionnaire was adopted from previous studies with 51 items (Salekzamani et al., 2015; Schlundt et al., 2003). No study has yet examined the dimensions of EBPQ in context of Malaysian university students. Hence, this study aims to evaluate the dimensional structure of the adopted version of the EBPQ among Malaysian students, and to assess the instrument's reliability and validity.

MATERIALS AND METHODS

Study design

Structural equation modelling (SEM) is one of the complete and flexible techniques for testing and estimating the structural model of the overall relations among the dimensions of eating behaviour pattern questionnaire. In this study, the psychometric characteristics of EBPQ were checked through parallel analysis (PA) and exploratory factor analysis (EFA). EFA was applied to evaluate the structure and dimensions of the instrument, and confirmatory factor analysis (CFA) was used to assess the measurement model to test its convergent validity and construct reliability. Content validity was done through an expert panel review.

Sample size and sampling method

The participants were randomly selected from University of Malaya (semesters I and II, 2016 and 2017) through multi-stage random sampling technique (Cohen, 2007), with diverse socioeconomic status and without known physical or mental illnesses. A total of 17 faculties within University of Malaya was chosen. First, five faculties were randomly selected based on the highest percentage of students enrolled in each faculty. Second, the portion size and number of samples from different faculties were determined. Third, five departments were randomly chosen from each faculty and the number of classes for each semester was obtained from the administration office of each department. Fourth, the classes were randomly selected and finally the participants were randomly chosen among the local students. A package including the EBPQ, a consent form and information sheet were distributed among the participants. They were asked to complete the questionnaires individually and fill up a self-report demographic questionnaire about their age, educational level (Bachelor, Master, or Doctor of Philosophy degree), marital status (single or married), as well as their income. Other information regarding their weight and height were also self-reported.

The sufficient sample size for factor analysis and SEM was calculated using the power analysis method (Soper, 2015). Accordingly, the amount of β, α, number of latent variables and the number of indicators were fixed. By considering β=0.80, number of latent variables=9, number of indicators=51 items and α=0.05, the least number of sample calculated for partial least squares structural equation modelling (PLS-SEM) equaled to 200.

Ethical approval

Ethical approval was obtained from the Faculty of Medicine, University of Malaya, [UM.TNC2/RC/H&E/UMREC-63].

Study instruments

The original EBPQ used a 5-point Likert scale, from strongly disagree to strongly agree, to evaluate factors on eating behaviour patterns. It consisted of 51 items covering six factors: low-fat eating (11 items), snacking and convenience (10 items), emotional eating (8 items), planning ahead (6 items), meal skipping (7 items), and cultural-lifestyle behaviour (9 items). It also included a socio-demographic part encompassing information on age, gender, marital status, educational level and employment status. Statistical analysis was performed using the SPSS (ver. 23; Inc., Chicago, IL, USA) and Smart PLS (ver.3) was used for CFA analysis.

Dimensional analysis

Factor analysis was used to determine the correlation among the variables in a dataset by using Eigenvalues (Besnoy *et al.*, 2016), which is frequently employed to argue for primary latent factors and/or to validate questionnaires. To signify the number of factors/components, PA was used to reduce type I error as it gives an excessive number of factors. The PA suggested nine factors for the EBPQ, extracted through comparing the Eigenvalues of the actual data and the Eigenvalues of the simulated data (Çokluk & Koçak, 2016).

Exploratory factor analysis

The Kaiser–Meyer–Olkin (KMO) value was over 0.82 for unobserved variables, signifying that the data were appropriate for factor analysis. Accordingly, EFA was performed through the principal axis factoring (PAF) extraction method and the Promax Rotation. Loading values above 0.4 were considered as satisfactory (Chong *et al.*, 2016), while the number of factors (components) was identified based on the PA results.

Reliability

All statistical analyses were done at 95% confidence level. Cronbach's α must be >0.7 and the item-total correlation should be >0.4 for each item. Cronbach's α was calculated to determine the scale's internal consistency for each dimension separately.

Confirmatory factor analysis measurement model

After establishing the components by EFA, the confirmatory factor analysis (CFA) was used to confirm each dimension and that the related items have sufficient construct validity through measurement model. In SEM analysis, measurement model is used to verify the convergent and discriminant validity. The measurement model deals with the relations between the latent (each component) and observed variables (related questions). It tests the reliability of the observed variables used to assess the latent variables. The CFA is used to assess the relationship between the indicators and associated latent variables. If the measurement model poorly fits the data, this means that some of the observed indicator variables are not reliable, thus preventing the researcher from proceeding to analyse the structural model. The items with low factor loadings are excluded from the measurement model. Moreover, when the fitness indices have reached the requirement level, the construct validity is achieved.

Convergent validity

Convergent and discriminant validity are the two main parts of CFA analysis. The convergent validity denotes the extent to which the indicators set can measure a construct. It is possible to evaluate the convergent validity at construct level through the average variance extracted.

Therefore, composite reliability (CR) >0.7 is acceptable. The average variance extracted (AVE) should be ≥0.5 (Hair Jr *et al.*, 2016).

Discriminant validity

The discriminant validity reveals that each construct measurement should be different from other constructs. Therefore, for assessing the discriminant validity, the Fornell-Larcker criterion was used (Fornell & Larcker, 1981).

RESULTS

Demographic characteristics are reported in Table 1. Exploratory factor analysis showed that a total of nine constructs were extracted from the data through PAF extraction method and the Promax Rotation method. The total variance for the EBPQ was 67.7%. The first component or emotional eating with seven items included about 10.3% of the total variance. This percentage was followed by eating outside at about 9.0% (six items), cultural habit (five items) at 7.0%, low-fat eating (six items), meal skipping (five items), snacking (five items), healthy eating (five items), planning for food (five items), and sweets (four items).

Cronbach's α for all the components was satisfactory (α>0.8). The emotional eating sub-scale consisted of eight items (α=0.933). The next components were those with six items, including "low-fat eating" (α=0.910), "cultural habit" (α=0.923) and "eating outside" (α=0.932). The rest were components with five items, including "healthy eating" (α=0.903), "snacking" (α=0.908), "planning for food" (α=0.899) and "meal skipping" (α=0.937). The "sweets" component had four items (α=0.933).

SEM analysis showed that all the items based on the CFA were aligned to the established components by EFA. CFA analysis also revealed that all

Table 1. Demographic characteristics of participants, N=200

Characteristics	*Mean±SD*	*n (%)*
Age (years)	27.2±3.4 Range (22-36 years)	
BMI (kg/m^2)	23.8±4.95 Range (16.0-55.2)	
Gender		
Male		91 (45.5)
Female		109 (54.5)
Educational Level		
Diploma		2 (1.0)
Bachelor		134 (67.0)
Master		55 (27.5)
Doctor of Philosophy		9 (4.5)
Marital status		
Single		132 (66.0)
Married		68 (34.0)
Occupational status		
Employed		18 (4.0)
Unemployed		182 (91.0)

Table 2. Outer loading value and convergent validity for EBPQ

Items	*Outer Loading*	*CR*	*AVE*
Eating outside		0.939	0.719
EBP1	0.846		
EBP13	0.832		
EBP42	0.856		
EBP43	0.875		
EBP44	0.858		
EBP50	0.820		
Emotional eating		0.941	0.690
EBP2	0.854		
EBP8	0.794		
EBP9	0.849		
EBP14	0.826		
EBP19	0.828		
EBP27	0.884		
EBP32	0.776		
Skipping meal		0.899	0.654
EBP17	0.897		
EBP25	0.391		
EBP36	0.881		
EBP37	0.870		
EBP48	0.882		
Planning for food		0.812	0.465
EBP7	0.646		
EBP20	0.641		
EBP26	0.769		
EBP35	0.637		
EBP47	0.707		
Snacking		0.931	0.731
EBP5	0.858		
EBP10	0.882		
EBP16	0.848		
EBP21	0.877		
EBP41	0.809		
Low-fat eating		0.931	0.691
EBP3	0.781		
EBP4	0.807		
EBP11	0.835		
EBP29	0.890		
EBP39	0.857		
EBP49	0.814		
Sweets		0.953	0.834
EBP12	0.926		
EBP30	0.925		
EBP40	0.898		
EBP46	0.903		
Healthy eating		0.928	0.721
EBP6	0.850		
EBP18	0.900		
EBP22	0.846		
EBP24	0.848		
EBP45	0.798		

constructs (components) had sufficient internal consistency, convergent and discriminant validity.

Indeed, the factor loading results supported the results of the factor analysis. All outer loadings were >0.700. However, item 38 (from low-fat eating), item 8 (from emotional eating) and item 51 were removed as their loading values were <0.400 (Table 2). The indicator reliability was assessed by outer loadings, yet, Cronbach's α is the conventional criterion for internal consistency. Results indicated that both criteria (CR and Cronbach's α) were satisfactory and that the instrument had sufficient internal consistency.

According to Table 2, CR was in the range of 0.812 to 0.933. CR was introduced to measure internal consistency reliability. AVE was >0.650 for all constructs, except for planning for food. However, if the AVE value was not satisfactory, the researcher may decide to keep or remove that particular construct. In this case, if the CR was >0.7, then that construct may be retained (Hair Jr *et al.*, 2016). The convergent validity was assessed through satisfactory level of CR and AVE. Therefore, each set of specific questions could only measure the specific component (i.e., four questions specifically could measure the sweet component).

The discriminant validity was assessed. According to the results of Fornell-Larcker method for each construct, the AVE was more than every squared correlation between the constructs (Table 3). Consequently, all constructs in the measurement model, which were based on the questionnaire (EBPQ), had sufficient discriminant validity, which meant that each component measured different concepts.

DISCUSSION

The current study enjoyed novelty in terms of presenting the adopted version of the EBPQ among Malaysian students. The strong point of this study was using advanced methods of analysis such as parallel analysis for psychometric analysis, power analysis to apply adequate sample size and SEM analysis.

The components of EBPQ were determined, and the validity and reliability of EBPQ were checked. Using the exploratory factor analysis, components of EBPQ were extracted including items describing eating behaviour patterns that were related to unhealthy and healthy eating behaviours. The final EBPQ was reconstructed with 48 items. Three items including items 8, 38 and 51 were removed due to factor loadings <0.400. These findings were in line with

Table 3. Discriminant validity

EBPQ	*EM*	*HE*	*EO*	*S*	*MS*	*SN*	*LF*	*PL*	*CH*
Emotional eating	0.685								
Healthy eating	0.019	0.806							
Eating outside	0.229	-0.123	0.729						
Sweets	0.429	0.166	0.299	0.754					
Meal skipping	0.250	0.311	0.105	0.359	0.756				
Snacking	0.594	-0.035	0.374	0.361	0.222	0.768			
Low-fat eating	0.053	0.141	0.066	-0.017	0.074	0.129	0.687		
Planning food	-0.043	0.150	0.001	0.193	0.101	-0.017	0.383	0.662	
Cultural habits	0.271	0.031	0.227	0.277	0.172	0.241	-0.016	0.140	0.698

EM: emotional eating; HE: healthy eating; EO: eating out; SB: sweets; MS: meal skipping; SN: snacking; LF: low-fat eating; PL: planning food; CH: cultural habits

the original factor structure (Van Strien *et al.*, 1986). Similarly, in another study, these three items were also removed from further analysis due to issues with factor structure (Cebolla *et al.*, 2014). The original EBPQ was established with six factors (Schlundt 2003).

Similarly, the "low-fat eating" sub-scale was split into healthy eating and low-fat eating (Kee *et al.*, 2008). The "snacking and convenience" factor was split into three sub-scales - snacking, eating out, as well as sweets. Therefore, the nine patterns of eating behaviours identified were (1) emotional eating, (2) eating outside, (3) cultural habits, (4) low-fat eating, (5) meal skipping, (6) snacking, (7) healthy eating, (8) planning for food and (9) sweets. Cronbach's α revealed a high internal consistency among the items of each component. Independent factors in the EBPQ denoted that multiple dimensions characterised youth eating behaviours, while previous studies have used the EBPQ to show a unitary construct (Goldbacher *et al.*, 2012). It might be concluded that the EBPQ does not replace traditional dietary assessment methods. Instead, it is a measurement of eating patterns that is possibly pertinent to disease prevention and health outcomes.

Another aim of this study was to assess the internal structure of the EBPQ and to evaluate the instrument's validity and reliability. The result showed that the EBPQ has adequate psychometric characteristics and can be used in clinical practice to better understand eating behaviour patterns. Moreover, the discriminant validity was assessed and the results indicated that the nine-factor EBPQ has adequate discriminant validity. Therefore, the individual differences in choosing healthy or unhealthy eating behaviour pattern may not reflect anything more than a general eating behaviour pattern. The results of discriminant validity also showed that each unique dimension of EBPQ was distinct from one another. The findings were consistent with those of a similar nature (Salekzamani *et al.*, 2015). The findings verified that the adopted version of the EBPQ had the theoretical factor structure. Furthermore, previous evaluations of the EBPQ's factor structure were limited to the samples of normal weight children and binge-eating women with low diversity (Schlundt *et al.*, 2003). This research presented good information about the factor structure in a more heterogeneous sample.

CONCLUSION

The EBPQ was a suitable tool for measuring the eating behaviour pattern of the participants and it was consistent throughout. However, the exclusion criteria (e.g., the absence of significant medical conditions and the ability to be physically active) limited the possibility of generalising these findings to the general public. Thus, future direction for similar studies is to apply EBPQ in larger sample sizes containing all categories of the society. The findings could be used for further statistical and epidemiological research to understand the psychometric characteristics of research instruments.

Acknowledgement

Not applicable.

Authors' contribution

MK, involved in sample collection, data analysis, computational analyses, result interpretation, manuscript drafting and revision; AAS, designed and supervised the study, collected the samples, drafted, revised and critically reviewed the manuscript; AFM, designed and supervised the study and critically reviewed the manuscript; MD, performed computational analyses and involved in data analysis, result interpretation, and manuscript revision, designed and supervised the study and critically reviewed the manuscript. All authors have final approval on the manuscript to be published.

Conflict of interest

This manuscript has not been published elsewhere and is not under consideration by other journals. All authors have approved the manuscript and agree with submission to the Malaysian Journal

of Nutrition. We declare that there is no conflict of interest regarding the publication of this study.

References

Besnoy KD, Dantzler J, Besnoy LR & Byrne C (2016). Using Exploratory and Confirmatory Factor Analysis to Measure Construct Validity of the Traits, Aptitudes, and Behaviors Scale (TABS). *J Educ Gift* 39(1):3-22.

Cebolla A, Barrada J, Van Strien T, Oliver E & Baños R (2014). Validation of the Dutch Eating Behavior Questionnaire (DEBQ) in a sample of Spanish women. *Appetite* 73:58-64.

Chong, M.F.F., Ayob, M.N.I.M., Chong, K.J., Tai, E.S., Khoo, C.M., Leow, M.K.S., Lee, Y.S., Tham, K.W., Venkataraman, K., Meaney, M.J. and Wee, H.L (2016). Psychometric analysis of an eating behaviour questionnaire for an overweight and obese Chinese population in Singapore. *Appetite* 101:119-124.

Cohen, L., Manion, L., & Morrison, K, (2007). *Research methods in education*. Taylor and Francis Group, Routledge, London and Newyork.

Çoklu Ö & Koçak D (2016). Using Horn's Parallel Analysis Method in Exploratory Factor Analysis for Determining the Number of Factors. *Educational Sciences: Theory & Practice* 16(2):537-551.

Dutton E and Dovey TM (2016). Validation of the Dutch Eating Behaviour Questionnaire (DEBQ) among Maltese women. *Appetite*: 107:9-14.

Fornell C & Larcker DF (1981). Evaluating structural equation models with unobservable variables and measurement error. *J Mark Res* 18(1):39-50.

Goldbacher E, Grunwald H, LaGrotte C, Klotz A, Oliver T, Musliner K & Foster G (2012). Factor structure of the Emotional Eating Scale in overweight and obese adults seeking treatment. *Appetite* 59(2):610-615.

Hair Jr JF, Hult GTM, Ringle C & Sarstedt M (2016). *A primer on partial least squares structural equation modeling (PLS-SEM)* (pp. 105-109). Sage Publications, California.

Kee CC, Jamaiyah H, Safiza MN, Geeta A, Khor GL, Suzana S, Jamalludin AR, Rahmah R, Ahmad AZ & Ruzita AT (2008). Abdominal Obesity in Malaysian Adults: National Health and Morbidity Survey III (NHMS III, 2006). *Mal J Nutr* 14(2):125-135.

Salekzamani S, Asghari-Jafarabadi M & Dehghan P (2015). Validity, Reliability and Feasibility of the Eating Behavior Pattern Questionnaire (EBPQ) among Iranian female students. *Health Health Promot Perspect* 5(2):128.

Schlundt DG, Hargreaves MK & Buchowski MS (2003). The eating behavior patterns questionnaire predicts dietary fat intake in African American women. *J Am Diet Assoc* 103(3):338-345.

Soper DS (2015). A-priori sample size calculator for structural equation models. From http:// www. danielsoper. com/statcalc [Retrieved December 12 2015] [Software].

Van Strien T, Frijters JE, Bergers G & Defares PB (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *J Eat Disord* 5(2):295-315.

Mal J Nutr 26(3): 341-351, 2020

'MAPAGI' video game upgraded breakfast attitude among urban elementary school children in West Jakarta, Indonesia

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ABSTRACT

Introduction: Skipping breakfast may contribute to poor academic and nutritional status among school children. The current study aimed to determine the effect of the 'MAPAGI' (*Makan Pagi Bergizi*) interactive video game on elementary student's breakfast knowledge and attitude. **Methods:** This was a quasi-experimental equivalent group study with a pre-post test control group design. In total, 228 students aged 9-11 years were drawn by proportional stratified random sampling from two urban schools and were distributed equally into intervention (IG) and control groups (CG). Both groups were administered with similar printed media for 10-15 minutes. Video game was delivered only to IG for two consecutive days, 30 minutes each day. Pre-test (PT0) was performed a day before leaflet administration, while post-test was performed twice – after leaflet administration (post-test 1/ PT1) and a week after the last video game (post-test 2/PT2). Paired, independent *t*-test and analysis of covariance (ANCOVA) were employed to answer the research questions. **Results:** The mean changes (PT1-PT0 and PT2-PT0) in knowledge score for IG (4.82±2.53 and 3.25±2.47) significantly differed compared to CG (1.75±2.66 and 1.25±2.69). The mean changes in attitude score for IG (7.16±7.17 and 7.34±7.11) also significantly differed compared to CG (2.83±6.58 and 2.64±6.90). After adjustment for potential confounding factors, there was still a significantly greater score in children's knowledge and attitude after a week's administration of MAPAGI video game in IG. **Conclusion:** 'MAPAGI' improved school children's knowledge and attitude, which may lead to the good behaviour of having breakfast.

Keywords: Breakfast, nutrition education, knowledge, attitude, video game

INTRODUCTION

School-age children who skip breakfast will tend to have poor academic performance (Adolphus, Lawton & Dye, 2013; Kawafha, 2013; Smith *et al.*, 2017) and nutritional status (Garg, Rajesh & Kumar, 2014), as well as a higher risk of metabolic syndrome in adulthood (Shafiee *et al.*, 2013). Ironically, in Indonesia, 20-40% of elementary school children skip their breakfast meals. Lack of knowledge and wrong assumption of breakfast are still the main reasons for skipping breakfast (Kigaru *et al.*, 2015). Studies showed that children with a lack of knowledge on breakfast ranged from 30.0-47.8% (Irnani & Sinaga, 2017), while among those with good knowledge, there were still some who assumed that junk food can be a

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doi: https://doi.org/10.31246/mjn-2019-0127

meal for a healthy breakfast (Garg *et al.,* 2014; Kigaru *et al.*, 2015). A recent study reported (Permaesih & Rosmalina, 2017) that 77.5% of school-age children (6-12 years old) had breakfast but in a low variety of food groups. Among those who had breakfast, 72.3% consumed only the cereal food group, while 49.6% consumed three food groups that composed of cereal, animal protein and oil (fried).

Nutrition and health education is one of the best interventions to encourage healthy eating habits (CDC, 2012). Moreover, a systematic review reported that nutrition-health education is proven to improve knowledge, attitude and eating habit, as well as nutritional status of children and adolescents (Silveira *et al.*, 2011).

Particularly in Indonesia, several studies had been conducted to improve the eating habits of children by using media such as printed materials (Angkasa *et al.*, 2017; Nuryanto *et al.*, 2014), animated media (Briawan, Ekayanti & Koerniawati, 2013), puppet toy show (Briawan *et al.*, 2013), and role-play (Maduretno, Wirawan & Setijowati, 2015). Several channels such as attached media (self-reading) (Angkasa *et al.*, 2017; Nuryanto *et al.*, 2014) and the involvement of teachers and parents (Eliassen, 2011; Nuryanto *et al.*, 2014) were also used to deliver nutrition and health education. These studies found significant increment in knowledge (Angkasa *et al.*, 2017; Nuryanto *et al.*, 2014), attitude (Briawan *et al.*, 2013; Maduretno *et al.*, 2015; Nuryanto *et al.*, 2014) and eating habits (Briawan *et al.*, 2013; Maduretno *et al.*, 2015) scores after administering either media alone or both media with the involvement of teachers and parents. However, these studies did not control for confounding factors such as children's sex and parental characteristics (Angkasa *et al.*, 2017; Briawan *et al.*, 2013; Maduretno *et al.*, 2015; Nuryanto *et al.*, 2014). Moreover, the nutrition education methods and media depended on the attendance of the researchers. Printed media, animated media such as PowerPoint, or role-play and puppet show are dependent on the instruction and explanation from the researchers. Thus, the development of media that can be self-explained and self-instructed, as well as can be played in individual or team mode are needed.

Video game is one of the alternative media that can fulfil these requirements. '*Makan Pagi Bergizi*' (MAPAGI) or 'Nutritious Breakfast Meal' is one of such examples that had already been developed from our previous study (Pratiwi, 2015). The current study aimed to examine the effect of MAPAGI games as one of the teaching media in modifying the knowledge and attitude of school children towards nutritious breakfast habits. This game can be incorporated in elementary school courses, especially the ones related to nutrition and health such as natural science (biology and environment, *ilmu pengetahuan alam*), sport or basic computer science for children. Eventually, this study also tried to find the adjusted score for the group that was assigned to MAPAGI games against the group which was not assigned to the intervention.

MATERIALS AND METHODS

Study design

This was a quasi-experimental study conducted in two urban schools in West Jakarta in January 2017. The schools were chosen purposively, focusing particularly on those which have computer facilities.

Participants and recruitment

Participants were children aged 9-12 years old who were formally registered

in the targeted schools, fulfilled the inclusion criteria and were permitted by their parents (written informed consent) to join the study. Inclusion criteria were a) able to operate a personal computer/ laptop, b) present in all observation stages, and c) able to communicate normally. In total, 228 students were involved in the study, which comprised of 114 from one school in the control arm and 114 from another school in the intervention arm. The sample size was determined by two independent mean differences, with α=0.05, power=0.95 and effect size 0.481 from a previous study (Pratiwi, 2015). Samples were drawn proportionally by stratified random sampling.

Data collection

The primary data were collected by twelve trained enumerators using a structured and previously pre-tested questionnaire. Besides student's knowledge and attitude on breakfast, the questionnaire also inquired on parental education and working status, which may be associated with children's breakfast behaviours. The two groups in this study received nutrition education using leaflets and posters, while the intervention group was given an additional video game media. The day before nutrition education, the intervention and control groups were given a pre-test (PT0). The next day, both groups received nutrition education using IEC (information, education and communication) media with the same materials for a duration of 10 to 15 minutes. In the intervention group, video game was provided on two consecutive days and was played for 30 minutes each day. Post-test 1 (PT1) was done 30 minutes after the intervention was given, while post-test 2 (PT2) was done 1 week later (Figure 1). The main purpose of PT2 was to examine the short versus long-term memory or the amount of information that were still remembered by the children.

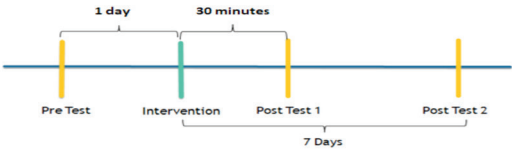
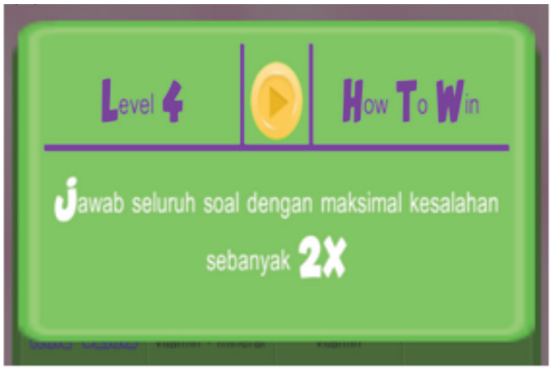


Figure 1. The flow of the study

MAPAGI video game

This game is an internet-based video game that needs an internet connection and can be self-administered. Detailed description of the game is provided in our previous study (Pratiwi, 2015). The game consisted of 10 levels. Levels 1 and 5 contained a challenge of choosing the right picture. Levels 2 and 9 contained 'guessing words'. In Levels 3 and 7, children were directed to fill the My Plate (the recommended portion of food groups in a plate). Levels 4 and 8 contained a brief question. In Level 6, children were instructed to choose healthy food versus junk food. At last, Level 10 contained a bonus level. At Level 10, the player is provided with a free game related to adventure. This game can be started by enrolling the player's name. Player can choose a preferred male or female icon (Figure 2a). There is a brief instruction on how to play each level (Figure 2b). Each level can be completed by an optimum score (Figure 2c). The score is dependent on several questions. If the player gets a high score, he/she will get a card and can then unlock other levels. The cards contained nutrition and health materials (Figure 3a-b) that can be read before continuing to the next level. In this study, since the computers in both schools were limited, the children were divided into two sessions, with two to three students in a group at each session.

(a)



(b)

(c)

Figure 2. (a) starting window; (b) window of Level 4 MAPAGI; (c) one of the Level 4 questions

Figure 3. (a) View of card after completing Level 4; (b) View of card after completing Level 3

Data presentation and statistical analyses

Parental and children characteristics were presented descriptively by *n* (%). Total knowledge score was produced from a cumulative of correct answers. For each question, a correct response was coded as 1 and an incorrect response as 0 hence maximum score was 25. The responses for attitude questions were: strongly agree, agree, disagree, and strongly disagree, and they were coded as 4, 3, 2, and 1 respectively. The maximum score for attitude questions was 80.

Both knowledge and attitude scores were examined by paired and independent *t*-test. Paired *t*-test was used for examining within-group mean difference, while independent *t*-test was used for examining between-group (intervention versus control) mean difference. For continuous data, normality distribution was determined by the Kolmogorov-Smirnov test (normal if $p>0.05$). Descriptive statistics for continuous data were expressed as mean and standard deviation for normally distributed data, and median (IQR, interquartile range, 25th-75th

Table 1. Children and parental characteristics (n=228)

Variables	*Groups*						
	IG			*CG*			
	n	*%*	*Median (Q25th-Q75th)*	*n*	*%*	*Median (Q25th-Q75th)*	*p-value*†
Children's age, year			10.00 (10.0-11.0)			10.00 (9.0-10.0)	0.030*
9	18	15.8		30	26.3		
10	64	56.1		62	54.4		
11	32	28.1		22	19.3		
Children's Sex							
Male	54	47.4		53	40.0		0.894
Female	60	52.6		61	60.0		
Father's schooling years							
>12	81	71.1		87	76.3		0.367
≤12	33	28.9		27	23.7		
Mother's schooling years							
>12	70	61.4		86	75.4		0.023
≤12	44	38.6		28	24.6		
Father's working status							
Not working	3	2.6		1	0.9		
Private sector	92	80.7		91	79.8		0.529
Public sector	19	16.7		22	19.3		
Mother's working status							
Not working	47	41.2		55	48.2		
Private sector	55	48.2		45	39.5		0.410
Public sector	12	10.5		14	12.3		

IG= intervention group; CG= control group

†Chi-square test

*significant at $p<0.05$; Mann-Whitney U-test

quartile) for not normally distributed data. Analysis of covariance (ANCOVA) test was performed to have adjusted differences between groups towards potential confounding variables. Confounding variables potentially came from variations in children age, parental characteristics such as education level and working status, hence Mann-Whitney U-test and Chi-square were used to determine these confounding factors.

Ethical approval

The current study obtained ethical approval from the Faculty of Health Sciences, Universitas Esa Unggul under the serial number 023/FIKES/X/2016. Permission was also obtained from the school headmaster, teacher and students' parents.

RESULTS

The characteristics of the school children and their parents are shown in Table 1 and are reported as *n* (%). The sample population's age ranged from 9-11 years old, with more than half of the children aged ten years old for both groups (IG=56.1% vs. CG=54.4%). Across the groups, the children's sex distribution was almost equal (IG=52.6% vs. CG=60%), whereby female composed more than half of the samples. Most parents had completed 12 years of schooling, whereby fathers' schooling years were relatively higher than the mothers' across the groups. Related to working status, most fathers (IG=96.4% vs. CG=99.1%) were working and more than half of the mothers were working (IG=58.7% vs. CG=51.8%). Statistically, only the mother's schooling years was potentially a confounding variable (p=0.023). However, since children's age and sex were mostly associated with their acceptance of educational materials, thus both variables were considered to be confounding variables.

Table 2 shows the children's knowledge and attitude scores on the importance of having breakfast before (pre-test/PT0), after 30 minutes (PT1) and 7 days after (PT2) the administration of nutrition education among intervention and control groups. Both groups were administered with printed and PowerPoint nutrition education materials, but only the intervention group was administered with the MAPAGI interactive video game. Except for pre-test (PT0 IG vs. PT0 CG), there was a significant difference in knowledge score between PT1 vs. PT0, PT2 vs. PT0 and PT2 vs. PT1 within each group. The mean difference between the mean changes of PT1 vs. PT0 (change 1), between the intervention group (4.82±2.53) and control group (1.75±2.66) was 3.08±0.34 points and was statistically significant. The mean differences (standard deviation, SD) for change 2 and change 3 between both groups decreased to 2.00 (0.34) and 1.07 (0.28), respectively. After adjustment for children's sex, age, and mother's education status, we found a significant difference in knowledge score between groups at all observed times. However, except for PT1 and change 3, the mean difference of others decreased by about 0.4-0.9 points, but was still statistically significant. Related to the attitude score on the importance of having breakfast, except for change 3, the mean difference of change 2 (4.70±0.93) was greater than change 1 (4.32±0.91) and both were statistically significant. Within each group, there were significant differences between PT1 vs. PT0 and PT2 vs. PT0. However, the mean changes in attitude score for the intervention group (change 1 = 7.16±7.17, change 2 = 7.34±7.11) were almost three-fold to that of the

Table 2. Pre-and post-test scores of school children's knowledge and attitude on the importance of having breakfast among intervention and control groups (n=228)[†]

Variables	*Unadjusted*			*p-value*	*Adjusted*[‡‡]			*p-value*[§§]
	IG (N=114)	*CG (N=114)*	*Mean Diff (IG-CG)*[‡‡]		*IG (N=114)*	*CG (N=114)*	*Mean Diff (IG-CG)*	
Knowledge[‡], score								
Pre-test (PT0)	15.89±2.73	16.59±2.86	0.69±0.37	0.063[††]	15.87±0.25	16.62±0.25	-0.75±0.36	0.036
Post-test 1 (PT1)	20.72±2.74	18.33±3.29	2.38±0.40	0.001[††]	20.67±0.26	18.38±0.26	2.29±0.37	0.001
Post-test 2 (PT2)	19.14±2.54	17.83±3.53	1.30±0.41	0.002[††]	19.07±0.27	17.89±0.27	1.18±0.38	0.003
Change 1 (PT1-PT0)	4.82±2.53	1.75±2.66	3.08±0.34	0.001[††]	4.80±0.25	1.76±0.25	3.04±0.35	0.001
Change 2 (PT2-PT0)	3.25±2.47	1.25±2.69	2.00±0.34	0.001[††]	3.20±0.24	1.28±0.24	1.93±0.35	0.001
Change 3 (PT2-PT1)	- 1.58±2.23	- 0.50±2.06	1.07±0.28	0.001[††]	-1.59±0.20	-0.48±0.20	-1.11±0.29	0.001
p-value PT1 vs. PT0	0.001[¶]	0.001[¶]						
p-value PT2 vs. PT0	0.001[¶]	0.001[¶]						
p-value PT2 vs. PT1	0.001[¶]	0.011[¶]						
Attitude[§], score								
Pre-test (PT0)	62.14±6.86	67.15±6.18	5.00±0.87	0.001[††]	62.30±0.61	66.98±0.61	-4.69±0.86	0.001
Post-test 1 (PT1)	69.30±6.75	69.98±7.33	0.68±0.93	0.465[††]	69.35±0.66	69.93±0.66	-0.58±0.95	0.540
Post-test 2 (PT2)	69.48±6.94	69.79±7.50	0.30±0.96	0.749[††]	69.49±0.68	69.78±0.68	-0.28±0.97	0.775
Change 1 (PT1-PT0)	7.16±7.17	2.83±6.58	4.32±0.91	0.001	7.05±0.65	2.94±0.65	4.10±0.93	0.001
Change 2 (PT2-PT0)	7.34±7.11	2.64±6.90	4.70±0.93	0.001	7.19±0.66	2.79±0.66	4.41±0.95	0.001
Change 3 (PT2-PT1)	0.18±2.52	-0.19±5.26	0.38±0.55	0.492	0.14±0.39	-0.15±0.39	0.30±0.56	0.591
p-value PT1 vs. PT0	0.001[¶]	0.001[¶]						
p-value PT2 vs. PT0	0.001[¶]	0.001[¶]						
p-value PT2 vs. PT1	0.438[¶]	0.696[¶]						

IG= intervention group; CG= control group

[†]All values presented as mean±*SD*, otherwise indicated

[‡]Knowledge was derived from 25 multiple choice questions related to breakfast definition, balance diet at breakfast meal, effect of skipping breakfast, nutrients function classification, identification of food types for breakfast meal, self-determined breakfast meal. Maximum score was 25.

[§]Attitude was derived from 10 positive statements and 10 negative statements related to definition, benefit and completeness of healthy breakfast meal, capability to determine their breakfast meal. Maximum score was 80.

[¶]Paired *t*-test between pre-test and post-test 1

[††]Independent *t*-test between two groups

[‡‡]Mean difference, presented as mean±standard error

[§§]ANCOVA adjusted for children's sex, age and mother's education status. All statistical tests were significant if *p*-value <0.05; PT0, PT1 and PT2 were measured a day before first visit, 30 minutes after education session at first day, and seven days after first visit, respectively.

control group (change 1 = 2.83±6.58, change 2 = 2.64±6.90). After adjustment for confounding variables, the mean differences (SD) for change 2 and change 1 decreased to 4.10 (0.93) and 4.41 (0.95) respectively, but both were statistically significant. No significant difference was observed for attitude score in change 3 between the intervention and control group.

DISCUSSION

In the present study, we found that the MAPAGI video game significantly improved school children's knowledge and attitude on the importance of having breakfast after adjustment for children's sex, age and mother's education status. This finding is in line with other studies such as Johnson-Glenberg, Savio-Ramos & Henry (2014) who reported an increment in nutrition knowledge scores among 20 elementary school children in the United States after getting an "Alien Health" video game.

The effectiveness of video games in increasing the children's nutrition knowledge was also found by Schneider *et al.* (2012) in Messachusett-New England. They administered "Fitter Critters" towards 97 school-age children. Other studies in Indonesia found a significant increment in children's hygiene and sanitation after administration of a video game (Mawaddatin, 2015). These studies showed that video game can be a good alternative media for nutrition education to modify school-age children's eating habits. Parisod *et al.* (2014) and Ballesteros *et al.* (2017) emphasised that video games are an effective nutrition education tool for children to improve their knowledge and also give them good impact on their short and long-term memory. Most studies found that video game is an effective media to improve children's knowledge and attitude since children will learn about the concept easily, able to imagine, describe and even to test the concept (Angkasa *et al.*, 2017).

However, in our study, it was observed that the mean differences in change (Change 1, Change 2, Change 3) of knowledge scores for both groups tended to reduce, while the change in the mean differences for children's attitude scores tended to increase. This is almost similar to Vardanjani *et al.* (2015) who found that the follow-up test scores of their sample population's knowledge and attitude were lower than pre-test for both groups (intervention vs. control). In the end, they concluded that the intervention was effective since performance about junk food among samples improved significantly compared with the control group. We assumed that the reduction in knowledge score was part of the internalisation process since attitude score increased. Kigaru *et al.* (2015) explained that knowledge alone is not sufficient to change the students' behaviours and there is a need for a positive attitude to be shaped properly.

In the current study, attitude did not change significantly over seven days of the first post-test (PT1). However, we found an overall change trend in the IG group, which showed a positive increment (7.05 to 7.19), while it was conversely shown in CG (2.94 to 2.79). Based on the Knowledge-Attitude-Behaviour (KAB) Model, change in attitude needs some period of time (Baranowski *et al.*, 2003), so considering 'the overall change trend', we assumed children in the MAPAGI group had a better, durable and positive attitude compared with their counterparts.

MAPAGI video game can be considered as an effective nutrition education media because it promotes learning experience for children. This game was designed to have several levels

for children to complete. Each level contained stratified-learning objectives that may trigger the student to remember, understand and evaluate (Bloom's Taxonomy) their breakfast knowledge and attitude. Apart from that, the video game is a media which is appropriate for the characteristics of current children where digital technology such as hand phones, tablets, and computers are involved in daily activities. Video game, as a nutrition education media/tool, has its function to simplify complex concepts, thus helping to achieve good learning process (Neiger *et al.*, 2012).

Several mechanisms may apply in explaining the greater scores achieved in both knowledge and attitude for the MAPAGI game group compared to its counterpart. Firstly, the video game presented breakfast concept by involving several body senses such as audio (listening), visual (watching) and kinesthetic (interactive finger touch) compared to the control group which was only intervened with a printed leaflet. Studies confirmed that the more senses are involved during the learning process, the better the students can remember, understand and even evaluate the concept (Angkasa *et al.*, 2017; Ballesteros *et al.*, 2017; Parisod *et al.*, 2014). Secondly, group discussion which occurred during the game enabled students to test his/her own knowledge and attitude towards others. This discussion enabled them to question and answer each other, thus resulted in a convincing conclusion towards the concept. Thirdly, repetition in playing the games increased children's memory and developed their imagination (Mawaddatin, 2015).

Amongst the strengths, the current study had taken into account demographic characteristics (children's sex and age, parent's education and working status) as suggested by Baranowski *et al.*, (2003) and had provided two post-tests to explore the short and long term memory of school children's knowledge and attitude. A short coming of the current study is that the effects of the effects of the video game were not observed for a longer period as any improvement in eating behaviour and dietary pattern are expected to require a longer time of nutrition education.

CONCLUSION

MAPAGI video game is a good nutrition education tool to promote good knowledge and attitude on the importance of having breakfast among school children. However, we suggest future study to use longer observation time and include the observation of a change in dietary patterns of the children.

Acknowledgment

The authors would like to thank all teachers, parents and children who were involved in this research. Their solid cooperation made this research possible. The current study was funded by Universitas Esa Unggul and its publication has been also supported by the PT Anta Citra through Gizi dan Kesehatan Sekolah (GISEL) Program @ giselprogram.

Authors' contribution

DA, designed the study, prepared literature reviews and equipments, coordinated and supervised data collection and data cleaning, further analysed and interpreted the data, prepared the manuscript, supervised RAP in data collection and cleaning; RAP, designed the study, prepared literature reviews and equipments, coordinated data collection, further analysed and interpreted the data, and prepared the manuscript; IJ, designed the study, prepared literature reviews and equipments, coordinated and supervised data collection and data cleaning, further analysed and interpreted the data, and prepared the manuscript; gave valuable inputs on design and statistical analysis. All authors revised and approved the final manuscript before submission.

Conflict of interest

The authors declare that they have no competing interest.

References

Adolphus K, Lawton CL & Dye L (2013). The effects of breakfast on behavior and academic performance in children and adolescents. *Front Hum Neurosci* 7:425.

Angkasa D, Sitoayu L, Putri VR & Mulyadi M (2017). Peduli Sarapan Dan Makanan Sehat, Serta Higiene Dan Sanitasi Lingungan Sekolah Pada Siswa Sekolah Dasar Di Kecamatan Sepatan Timur. *Jurnal Pengabdian Masyarakat AbdiMas* 3(2):19-27.

Ballesteros S, Mayas J, Ruiz-Marquez E, Prieto A, Toril P, de Leon LP, de Ceballos M & Avilés JMR (2017). Effects of video game training on behavioral and electrophysiological measures of attention and memory: protocol for a randomized controlled trial. *JMIR Res Protoc* 6(1):e8.

Baranowski T, Cullen KW, Nicklas T, Thompson D & Baranowski J (2003). Are current health behavioral change models helpful in guiding prevention of weight gain efforts? *Obes Res* 11(S10):23S-43S.

Briawan D, Ekayanti I & Koerniawati RD (2014). Pengaruh media kampanye sarapan sehat terhadap perubahan pengetahuan, sikap, dan kebiasaan sarapan anak sekolah dasar di Kabupaten Bogor. *J Gizi Pangan* 8(2):115–122.

CDC (2012). *Parent engagement: Strategies for involving parents in school health*. Centers for Disease Control and Prevention, Atlanta.

Eliassen EK (2011). The impact of teachers and families on young children's eating behaviours. *Young Children* 66(2):84–89.

Garg M, Rajesh V & Kumar P (2014). Effect of breakfast skipping on nutritional status and school performance of 10–16 years old children of Udupi district. *Health Popul Perspect Issues* 37(3&4):98-117.

Irnani H & Sinaga T (2017). Pengaruh pendidikan gizi terhadap pengetahuan, praktik gizi seimbang dan status gizi pada anak Sekolah Dasar. *J Gizi Indonesia (The Indonesian Journal of Nutrition* 6(1):58-64.

Johnson-Glenberg MC, Savio-Ramos C & Henry H (2014). "Alien Health": A nutrition instruction exergame using the kinect sensor. *GAMES FOR HEALTH: Research, Development, and Clinical Applications* 3(4):241–251.

Kawafha M (2013). Impact of skipping breakfast on various educational and overall academic achievements of primary schoolchildren in Northern of Jordan. *Aust J Basic Appl Sci* 7(7):155–160.

Kigaru DMD, Loechl C, Moleah T, Macharia-Mutie CW & Ndungu ZW (2015). Nutrition knowledge, attitude and practices among urban primary school children in Nairobi City, Kenya: a KAP study. *BMC Nutrition* 1(1):44.

Maduretno IS, Wirawan NN & Setijowati N (2015). Niat dan perilaku pemilihan jajanan anak sekolah yang mendapat pendidikan gizi metode ceramah dan TGT. *IJHN* 2(1):23–37.

Mawaddatin PF (2015). Pengaruh imaginative pretend play dengan media video animasi: pengetahuan dan sikap perilaku hidup bersih dan sehat. *THE SUN* 2(1):38–46.

Neiger BL, Thackeray R, Van Wagenen SA, Hanson CL, West JH, Barnes MD & Fagen MC (2012). Use of social media in health promotion: purposes, key performance indicators, and evaluation metrics. *Health Promot Pract* 13(2):159–164.

Nuryanto N, Pramono A, Puruhita N & Muis SF (2014). Pengaruh pendidikan gizi terhadap pengetahuan dan sikap tentang gizi anak Sekolah Dasar. *J Gizi Indonesia* 3(1):32–36.

Parisod H, Pakarinen A, Kauhanen L, Aromaa M, Leppänen V, Liukkonen TN, Smed J & Salanterä S (2014). Promoting children's health with digital games: A review of reviews. *GAMES FOR HEALTH: Research, Development, and Clinical Applications* 3(3):145–156.

Permaesih D & Rosmalina Y (2017). Keragaman Bahan Makanan untuk Sarapan Anak Sekolah di Indonesia. *Gizi Indonesia* 39(1):25–36.

Pratiwi RA (2015). *Pengaruh Penyuluhan Menggunakan Media Video Game Terhadap Pengetahuan, Sikap, Konsumsi Energi dan Protein Makan Pagi Pada Murid SDN 177 Dan SDN 187 Palembang* (Karya Tulis Ilmiah). Poltekkes Kemenkes Palembang, Palembang.

Schneider KL, Ferrara J, Lance B, Karetas A, Druker S, Panza E, Olendzki B, Andersen V & Pbert L (2012). Acceptability of an online health videogame to improve diet and physical activity in elementary school students: "Fitter Critters". *GAMES FOR HEALTH: Research, Development, and Clinical Applications* 1(4):262–268.

Shafiee G, Kelishadi R, Qorbani M, Motlagh ME, Taheri M, Ardalan G, Taslimi M, Poursafa, P, Heshmat R & Larijani B (2013). Association of breakfast intake with cardiometabolic risk factors. *Jornal de Pediatria* 89(6):575–582.

Silveira JA, Taddei JA, Guerra PH & Nobre MR (2011). Effectiveness of school-based nutrition education interventions to prevent and reduce excessive weight gain in children and adolescents: a systematic review. *Jornal de Pediatria* 87(5):382–392.

Smith KJ, Blizzard L, McNaughton SA, Gall SL, Breslin MC, Wake M & Venn AJ (2017). Skipping breakfast among 8-9 year old children is associated with teacher-reported but not objectively measured academic performance two years later. *BMC Nutrition* 3(1):86.

Vardanjani AE, Reisi M, Javadzade H, Pour ZG & Tavassoli E (2015). The Effect of nutrition education on knowledge, attitude, and performance about junk food consumption among students of female primary schools. *J Edu Health Promot* 4:53. doi: 10.4103/2277-9531.162349.

Mal J Nutr 26(3): 353-367, 2020

Effect of polydextrose-containing beverage on bowel habits and gastrointestinal symptoms of constipated subjects: a pilot study

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ABSTRACT

Introduction: Indonesians have a low intake of dietary fibre, a key component for an increased incidence in constipation. Available data have documented the benefits of polydextrose (PDX) in healthy subjects. However, data on constipated subjects are lacking. This study aimed to investigate the effect of consuming a PDX (prebiotic) beverage on bowel habits and gastrointestinal symptoms of constipated subjects over seven days. **Methods:** This was a randomised, non-blinded, non-placebo-controlled parallel design study involving 24 subjects, divided equally into two groups. Group A (active control group) consisted of 12 subjects, consuming one serving size of 6g PDX beverage. While Group B (intervention group) consisted of 12 subjects, consuming two servings of the same product, containing 12g PDX beverage. Changes in bowel habits (constipation score, stool frequency and stool consistency) and gastrointestinal symptoms (abdominal pain, bloating and flatulence) were monitored. **Results:** Within seven days, Group B showed 4.9% more reduction in overall constipation mean score than that of Group A. Positive improvement in gastrointestinal symptoms were reported: i.e. abdominal pain (ΔM = -0.08±0.43), bloating (ΔM = -0.29±0.37) and flatulence (ΔM = -0.17±0.47). Majority of subjects had desirable stool frequency (87.5%, >3 defecations/week) and stool consistency (58.3%, type 4). These improvements were due to the fact that PDX provides physiological effects consistent with prebiotic fibre, which alters the gut microbiota composition during the fermentation cycle in the large intestine. **Conclusion:** Findings of this study suggested that daily PDX beverage consumption effectively improved bowel habits, with fewer constipated subjects reporting of gastrointestinal symptoms.

Keywords: Bowel habits, constipation, dietary fibre, gastrointestinal symptoms, polydextrose

INTRODUCTION

Gastrointestinal disorders, such as constipation, continue to be one of the public health issues worldwide. The prevalence of this phenomenon can vary depending on geographical regions, ranging from 0.7%–29.6% in children, and from 2.0%–35.0% among adults in Europe, Oceania, and North America (Mugie, Benninga & Di Lorenzo, 2011). In developing countries like Malaysia and Indonesia, the prevalence of

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doi: https://doi.org/10.31246/mjn-2019-0052

constipation is quite high at 32.3% and 58.0%, respectively (Wahab *et al.,* 2019; Yudiyanto, 2018). It was reported that constipation afflicted a wide age range, starting at age 60 years (Wahab *et al.*, 2019) or even earlier (12-17 years old) (Yudiyanto, 2018).

Constipation is generally described based on subjective-reported symptoms, which commonly include unsatisfactory condition due to infrequency in defecation (<3 times a week), difficulty in passing stool (severity of false alarm), and feeling of incomplete evacuation (Chan *et al.*, 2005). Its pathogenesis is influenced by many factors, amongst them genetic susceptibility, socioeconomic status, dietary type or daily behaviour (Forootan, Bagheri & Darvishi 2018).

Prior to the introduction of prebiotics in modifying gut microbiota, treatment of constipation in children and adults ranged from toilet training, acupuncture therapy to therapeutic measures like laxative use, polyethylene glycol or bisacodyl (Philichi, 2018; Mounsey, Raleigh & Wilson, 2015). A recent study indicated that the initial management of constipation should be controlled at primary intervention, especially by adjusting lifestyle and dietary habits (Forootan, Bagheri & Darvishi, 2018).

There is emerging evidence supporting that dietary habits can alter the composition of gut microbiota, thus leading to changes in defecation frequency and consistency (Lee *et al.* 2017). For instance, additional fibre intake, both soluble and insoluble, is one of the most effective dietary approaches in reducing constipation (Chey, 2017). Scientific evidences have also demonstrated that polydextrose (PDX), a soluble prebiotic fibre, bulking agent and humectant can potentially improve faecal bulk, soften the stools and increase the number of defecation (Ibarra *et al.*, 2019; Do Carmo *et al.*, 2016). Various studies have documented the positive effect of PDX intake on constipation. A study led by Costabile *et al.* (2012) conducted on 31 healthy adults concluded that the administration of PDX significantly improved bowel function, reduced abdominal discomfort and softened stool consistency. Another study reported that a 2-week regular consumption of PDX greatly improved bowel function by decreasing the feeling of incomplete bowel evacuation and judgement of constipation compared to baseline time point (Ibarra *et al.*, 2019).

Nevertheless, majority of data used healthy subjects as subjects under intervention. Data on the benefits of PDX in improving defecation among subjects experiencing constipation are lacking. Therefore, our study was designed with the main objective to investigate the effect of consuming a PDX (prebiotic) beverage on bowel habits and gastrointestinal symptoms in constipated subjects, which builds on the strength of evidence regarding the benefits of prebiotics in improving bowel habits.

MATERIALS AND METHODS

Study design and population

A randomised, non-blinded, non-placebo-controlled trial with a parallel seven-day regular dose-response study on polydextrose (6g vs. 12g) was carried out in January 2019 at PT. Amerta Indah Otsuka and PT. Otsuka Distribution, Indonesia. The study was non-blinded because we aimed to investigate dose responses of PDX in alleviating constipation. Furthermore, we used products available in the market. The study procedure included three phases.

Phase 1 (screening and recruitment phase, day -14)

A total of 323 subjects were recruited from three different sets of PT work place – Amerta Indah Otsuka: Head Office (Jakarta), Pasar Rebo, and Tangerang

branches. Subjects aged 20-45 years and had experienced constipation in the past two weeks (*n*=313) were considered for further assessment based on inclusion and exclusion criteria. Also, to minimise selection bias and avoid conflict of interest, detailed explanations were provided to the recruited Otsuka employees, including (i) the participation was voluntary, (ii) no management pressure involved, (iii) non-blinded for subjects and outcome investigator (LH).

Phase 2 (baseline, day 0)

This phase aimed to assess bowel habits, gastrointestinal symptoms, and dietary intake of subjects upon the fulfilment of inclusion and exclusion criteria. The inclusion criteria were subjects with a normal body mass index (BMI) of 18.5–24.9 kg/m^2 (WHO, 2020), did not consume probiotics or prebiotics in the past three months and considered having constipation as diagnosed by the Chinese Constipation Questionnaire (CCQ). Pregnant or lactating women, subjects with a health problem, e.g. diabetes, hypertension, or diarrhoea, or currently using a laxative or other medication likely to affect PDX's mechanism of action and known nature of the product intervention were excluded from the study.

Prior to the study, a brief explanation on the purpose and overall conduct of the study was given, and individual informed consent was signed. The study protocol was approved by the Research Ethics Committee of Atma Jaya Catholic University (No. 1850/III/LPPM-PM.10.05/12/2018).

A total of 313 subjects willingly participated in the study. The principal investigator (NI) visited all work places for screening of eligibility. A total of 296 out of 313 willing subjects were excluded due to not meeting the inclusion criteria, pregnant or lactating women, had diabetes, hypertension or diarrhoea, and laxative use. Finally, 27 subjects were assigned randomly in a non-blinded manner to consume either one serving size (100 ml) of test beverage product once a day, containing 6g PDX (Group A, *n*=14, considered as active control group), or two servings of the same product, containing 12g PDX (Group B, *n*=13, considered as intervention group). Group A consumed the test beverage product at 10 AM, whereas Group B consumed at two different times: 10 AM and 3 PM. Two levels of PDX concentration were chosen for intervention as these amounts were considered to be tolerated safely for a one-time consumption in humans and can be practically consumed in a real-life setting (per unit bottle). Moreover, the duration of PDX consumption was seven days with consideration of the feasibility and laxative effect of the test beverage product. Furthermore, subjects were instructed to maintain their usual diet during the study, while consuming the test beverage product according to their respected group. During the course of the study, two subjects in Group A and one subject in Group B withdrew from the study due to personal reasons. In total, 24 final subjects completed the study and were included in the statistical analyses. Figure 1 summarises the study flowchart.

Phase 3 (endline, day 7)

At Phase 3, changes in outcome parameters, like bowel habits (constipation score, stool frequency and stool consistency), gastrointestinal symptoms (abdominal pain, bloating and flatulence), and compliance were assessed.

Outcome parameters

Bowel habits

The selected six-item questionnaire used for constipation diagnosis was adapted from the CCQ (Chan *et al.*, 2005). The

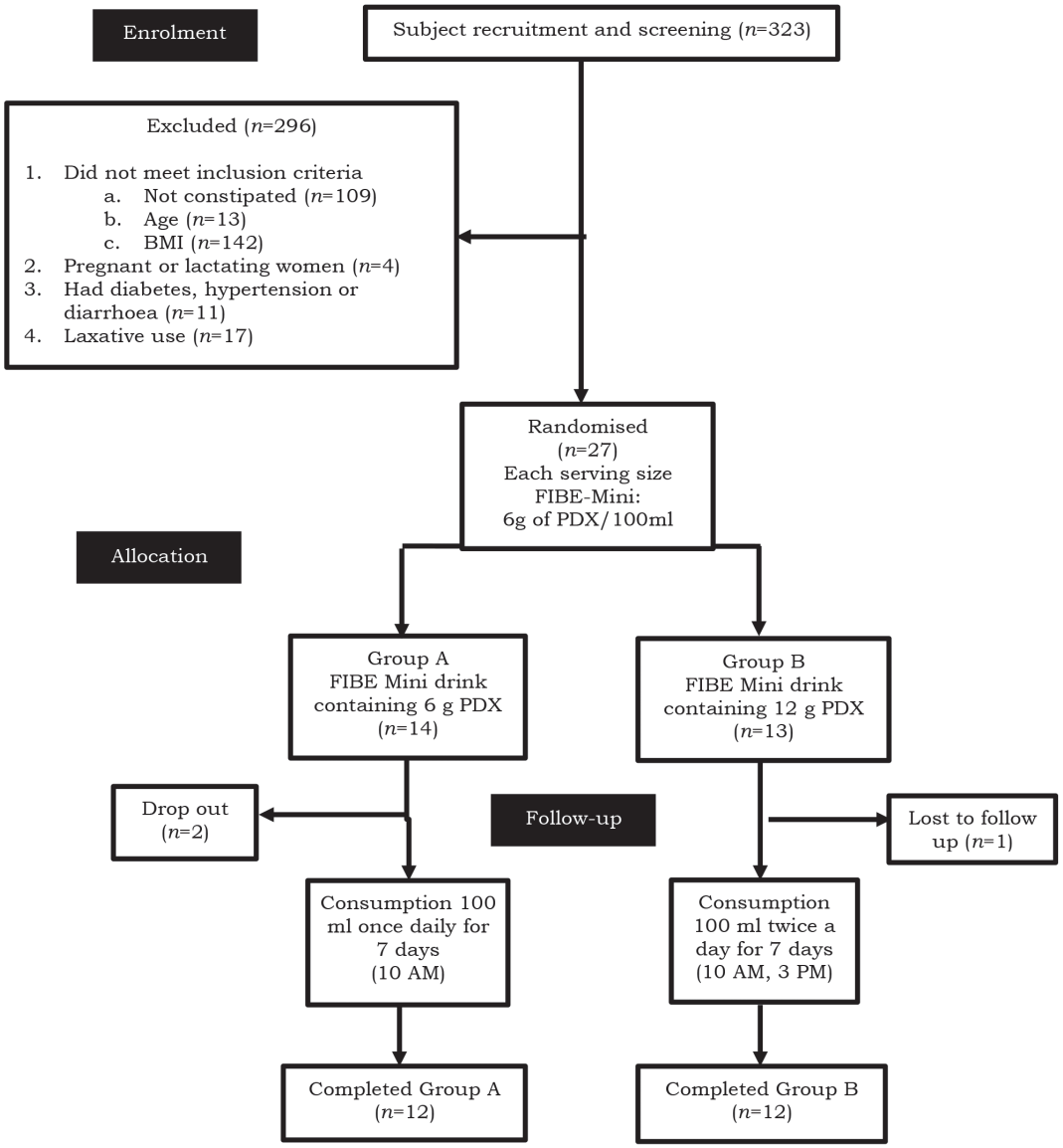

Figure 1. CONSORT flowchart of the study.

following constipation criteria were used: (i) an unsatisfactory condition due to infrequent defecation (<3 times a week), (ii) difficulty passing stool (severity of false alarm), (iii) feeling of incomplete evacuation, (iv) having severe lumpy or hard stools, (v) use of laxative, and (vi) abdominal bloating (Chan *et al.*, 2005). Constipation scoring was done on a five-point Likert scale, i.e. never (0), rarely (1), sometimes (2), often (3), and always (4) (Vagias, 2006). The total score of these six items was added up to determine the final constipation score. Constipation was confirmed when the sum of score was >5.

CCQ is a combination of the Rome II criteria (frequency), the Patient Assessment of Constipation-Symptoms (PAC-SYM: severity), and the use of laxative. The Cronbach's α coefficient for the six-item CCQ in Indonesian language was 0.739; thus, the questionnaire was considered to be reliable and valid.

Stool consistency was examined by using The Bristol Stool Scale (Blake, Raker & Whelan, 2016). It was categorised into seven types of scale, i.e. type 1 (separate hard lumps, like nuts), type 2 (lumpy sausage-shaped), type 3 (sausage-shaped with cracks on the surface), type 4 (sausage or snake-shaped with a smooth and soft surface), type 5 (soft blobs with clear cut edges), type 6 (fluffy pieces with ragged edges, mushy stool) and type 7 (watery or no solid pieces). According to these categories, types 1-2 were classified as constipated stool type, types 3-4 were the ideal stool type, and types 5-7 happen when diarrhoea is present.

Gastrointestinal symptoms

The severity of gastrointestinal symptoms, like abdominal pain, bloating and flatulence were monitored before and after the intervention period by using a one-dimensional visual analogue scale (VAS). All subjects were required to rank each symptom based on a 0-10 scale, where 0 indicated no symptom, 1-3 were mild symptoms, 4-6 were moderate symptoms, and 7-10 indicated severe symptoms (Breivik *et al.*, 2008).

Dietary intake

*S*ubjects were provided with a food diary in the form of a 7-day "food catalogue' to record the amount of foods eaten during the day. A trained health practitioner and nutritionist taught the subjects on how to record their daily food consumption.

Table 1. Nutritional composition of Group A (6g, active control group) and Group B (12g, intervention group) PDX beverages[†]

	Group A[‡] *(6g, active control group)*	*Group B* [§] *(12g, intervention group)*
Trade name	Fibe Mini	Fibe Mini
Form	Ready-to-drink	Ready-to-drink
Composition		
Serving size 100 ml containing		
Energy, kcal	50	100
Protein, g	0	0
Total fat, g	0	0
Carbohydrate, g[¶]	10.9	21.8
PDX, g[††]	6.0	12.0
Sugar, g	9.0	18.0
Sodium, mg	16.5	33.0

[†]Ingredients: saccharides (sugar, high fructose corn syrup, oligosaccharide), polydextrose, carbon dioxide, acidulant, fragnance, tomato pigment and flavour enhancer (amino acids)
[‡]One serving consumed per day (10 AM)
[§]Two servings consumed per day (10 AM, 3PM)
[¶]1g available carbohydrate provides energy: 4.1 kcal (Kim & Choi, 2015)
[††]Equivalent to 1kcal/g, provided by the SCFA produced from its partial fermentation by the microbiota (Do Carmo *et al.*, 2016)

Detailed example on how to record the intake was given on the front page of the diary, including the time of consumption (breakfast, lunch, dinner and snack time), food type, and the amount of eaten item per unit.

Test beverage product and compliance

The test beverage product was a PDX (prebiotic) beverage (Fibe-Mini®) manufactured by Otsuka Pharmaceutical Co., Ltd, Tokyo, Japan. The nutritional composition of the test beverage product per 100 ml is described in Table 1. The test beverage product was analysed at an accredited laboratory by the Japanese Government, Japan Food Research Laboratories, Tokyo, Japan No. 19065330001-0101.

Subjects were followed-up via group messenger, which provided daily instruction and coordination, as well as a reminder for them to complete their food diary throughout the study. Subjects' compliance was measured with two mechanisms, i.e. a picture of the finished bottle was sent to the group messenger and empty bottles returned to the receptionist. The outcome investigator (LH) further cross-checked that the number of pictures sent and returned bottles were equal in quantity to the ones distributed per person.

Statistical analysis

The sample size calculation followed the rule of thumb for a pilot study by Julious (2005) with a minimum sample size of 12 subjects per group. Data were analysed by IBM SPSS Statistics V21.0.0 (IBM Corporation, Armonk, NY, USA). The Kolmogorov-Smirnov test assessed the normality of data distribution. Results of the analysis were mainly reported using descriptive statistics with 95% CI. Group A (6g PDX, active control group) was compared with Group B (12g PDX, intervention group) with respect to the primary outcome variables, like bowel habits and gastrointestinal symptoms. At baseline, Independent *t*-test and Chi-Square Test were performed to evaluate between-group analysis for continuous and categorical variables, respectively. Data about age, body mass index, dietary intake, constipation score, gastrointestinal symptoms score (e.g. abdominal pain, bloating and flatulence) were presented as mean±standard error of mean (SEM). Categorical variables about gender and work place were presented as proportions (n, %). Furthermore, other categorical variables like compliance, stool frequency, stool consistency and gastrointestinal symptoms were analysed and compared between groups using Chi-Square Test. Changes in constipation score and gastrointestinal symptoms from baseline point within and between groups were compared using the General Linear Model repeated measure ANOVA analysis. Sub-analysis, by adjusting for baseline values and energy intake, was performed due to different starting points and between-group intake. Considered as a confounder, the values of these variables at baseline point and energy intake were therefore analysed as a covariate.

RESULTS

Table 2 describes the baseline characteristics of the subjects. Of the 24 subjects, 11 (45.8%) were male and 13 (54.2%) were female workers, respectively. The majority of subjects came from the Head Office (41.7%), followed by Pasar Rebo branch (33.3%) and Tangerang branch (25%). Both Groups A and B were comparable in age, BMI, gender, work place, dietary intake and bowel habits. The subjects were sufficiently constipated, indicated by having a constipation score of >5, with 9.8±2.3 and 8.1±1.7 for Group A and Group B, respectively.

Table 2. Baseline characteristics of the subjects (*n*=24)

Characteristics	*Overall (n=24)*	*Polydextrose (PDX)*		*p-value*[†]
		Group A (n=12)	*Group B (n=12)*	
Age (year), Mean±SEM	27.2±0.9	27.1±1.4	27.3±1.3	0.89
Body mass index (kg/m^2), Mean±SEM	22.0±0.3	22.1±0.6	21.9±0.3	0.65
Gender, *n* (%)				0.22[‡]
Male	11 (45.8)	7 (58.3)	4 (33.3)	
Female	13 (54.2)	5 (41.7)	8 (66.7)	
Work place, *n* (%)				0.59[‡]
Pasar Rebo	8 (33.3)	4 (33.3)	4 (33.3)	
Tangerang	6 (25.0)	4 (33.3)	2 (16.7)	
Head Office (Jakarta)	10 (41.7)	4 (33.3)	6 (50.0)	
Dietary intake				
Energy (kcal), Mean±SEM	1355±110	1516±195	1194±90	0.15
Protein (g), Mean±SEM	72.0±8.3	81.1±13.1	62.9±9.9	0.28
% of daily intake [§]	21.8	21.9	21.3	
Carbohydrate (g), Mean±SEM	152.6±13.7	162.6±25.1	142.7±11.6	0.48
% of daily intake [§]	46.2	44.0	49.0	
Total fat (g), Mean±SEM	47.5±4.2	55.1±6.4	40.0±4.7	0.07
% of daily intake [§]	32.6	33.8	31.2	
Fibre (g), Mean±SEM	7.5±0.8	8.3±1.4	6.6±0.9	0.32
Bowel function				
Constipation mean score, Mean±SEM	8.9±0.4	9.8±0.6	8.1±0.5	0.06

Group A (6g, active control group); Group B (12g, intervention group)
[†]between group comparison by independent *t*-test ($p<0.05$)
[‡]between group comparison by chi-square test ($p<0.05$)
[§]Rubner energy conversion factors: 4.1 kcal/g (protein), 4.1 kcal/g (carbohydrate), 9.3 kcal/g (fat) (Kim & Choi, 2015)

Table 3 shows the changes in constipation score and gastrointestinal symptoms: abdominal pain, bloating and flatulence from baseline to endline. Based on the mixed linear model repeated measure analysis, it was observed that the overall consumption of PDX beverage was effective in reducing constipation mean score [(ΔM = -4.50±0.66; 95% CI (-5.87–-3.13)]. Results from further analysis with adjustment for baseline values and energy intake demonstrated that subjects who consumed 12g PDX had a 4.9% lower constipation mean score (ΔM = -4.96±0.96) compared to those who consumed 6g PDX (ΔM = -4.04±0.96).

At endline, both groups consuming either 6g or 12 PDX did not show significant differences in the observed gastrointestinal symptoms, like abdominal pain (ΔM = -0.08±0.49), bloating (ΔM = -0.29±0.37) and flatulence (ΔM = -0.17±0.47). There was a higher tendency for subjects who consumed 12 PDX to have less abdominal pain (M = 0.25±0.64) compared to those who consumed 6g PDX, but it did not reach statistical significance. Based on

Table 3. Result from pilot study comparing 7-day bowel habits and gastrointestinal symptoms scores (*n*=24)

Outcome measure	*Baseline point (n=24)*	*Endline (n=24)*	*Mean differences (95% CI)*	*Group x Trial*†
Bowel habits				
Constipation score				
Overall	8.92±0.42	4.42±0.65*	-4.50±0.66 (-5.87 – -3.13)	0.52
6g PDX	8.92±0.00‡	4.88±0.96*‡	-4.04±0.96 (-6.03 – -2.04)	
12g PDX	8.92±0.00‡	3.95±0.96*‡	-4.96±0.96 (-6.96 – -2.97)	
Gastrointestinal symptoms				
Abdominal Pain				
Overall	0.83±0.30	0.75±0.43	-0.08±0.43 (-1.09 – 0.923)	0.29
6g PDX	0.83±0.00‡	1.25±0.64‡	0.42±0.64 (-0.90 –1.75)	
12g PDX	0.83±0.00‡	0.25±0.64‡	-0.58±0.64 (-1.91 – 0.75)	
Abdominal Bloating				
Overall	2.00±0.45	1.71±0.39	-0.29±0.37 (-1.25 – 0.66)	0.97
6g PDX	2.00±0.00‡	1.69±0.53‡	-0.31±0.53 (-1.41 – 0.83)	
12g PDX	2.00±0.00‡	1.72±0.53‡	-0.27±0.54 (-1.39 – 0.83)	
Flatulence				
Overall	2.71±0.51	2.54±0.52	-0.17±0.47 (-1.27 – 0.94)	0.55
6g PDX	2.71±0.00‡	2.82±0.66‡	0.17±0.66 (-1.26 – 1.49)	
12g PDX	2.71±0.00‡	2.26±0.66‡	-0.44±0.66 (-1.82 – 0.93)	

Data are displayed as mean±SEM; CI, Confidence Interval
*p<0.05, Bonferroni; the intervention effect as the difference in change-from baseline within the time points
†Group x Trial interaction represents the treatment effect as the difference in change-from baseline between the two groups
‡adjusted for baseline point and energy intake

the analogue scale, both groups had mild abdominal bloating (6g PDX: *M* = 1.69±0.53; 12g PDX: *M* = 1.72±0.53) and mild flatulence (6g PDX: *M* = 2.82±0.66; 12g PDX: *M* = 2.26±0.66); but again, these did not reach statistical differences.

Table 4 shows that the proportion of subjects consuming either 6g or 12g PDX did not differ significantly in terms of defecation frequency, stool consistency score, abdominal pain, bloating and flatulence. After a seven-day consumption of PDX beverage, 87.5% of the subjects had desirable defecation frequency. Of them, there was a trend whereby more subjects with a seven-day consumption of 12g PDX (91.7%) to experience "never <3 times defecation frequency per week". A similar trend was shown in stool consistency, where majority of the subjects had no difficulty passing stool or had normal stool consistency. In total, more than half of the constipated subjects (58.3%) had type 4 stool consistency at the end of the study. In addition, in terms of compliance, Group A subjects consumed on average 100% (700 ml) and Group B consumed 100% (1400 ml) of the test beverage product. Therefore, subjects in both Group A and Group B were fully compliant (100%).

Furthermore, all subjects (*n*=24) reported several constipation-related symptoms, such as abdominal pain, bloating and flatulence at the beginning

Table 4. The proportion of stool frequency, stool consistency, and gastrointestinal symptoms at baseline (Day 0) and end of study (Day 7) (*n*=24)

Characteristics	*Baseline point*			*Endline*		
	Overall (n=24)	*Polydextrose (PDX)*		*Overall (n=24)*	*Polydextrose (PDX)*	
		6 g (n=12)	*12 g (n=12)*		*6 g (n=12)*	*12 g (n=12)*
Assessment of constipation, (in the past 2 weeks), *n* (%)						
<3 defecation/week						
Never	0 (0.0)	0 (0.0)	0 (0.0)	21 (87.5)	10 (83.3)	11 (91.7)
Rarely	5 (20.8)	1 (8.3)	4 (33.3)	2 (8.3)	1 (8.3)	1 (8.3)
Sometimes	12 (50.0)	7 (58.3)	5 (41.7)	1 (4.2)	1 (8.3)	0 (0.0)
Often	5 (20.8)	2 (16.7)	3 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)
Always	2 (8.3)	2 (16.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Stool consistency						
Type 1	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.2)	1 (8.3)	0 (0.0)
Type 2	4 (16.7)	2 (16.7)	2 (16.7)	1 (4.2)	1 (8.3)	0 (0.0)
Type 3	9 (35.7)	6 (50.0)	3 (25.0)	4 (16.7)	2 (16.7)	2 (16.7)
Type 4	7 (29.2)	3 (25.0)	4 (33.3)	14 (58.3)	6 (50.0)	8 (66.7)
Type 5	3 (12.5)	1 (8.3)	2 (16.7)	2 (8.3)	1 (8.3)	1 (8.3)
Type 6	1 (4.2)	0 (0.0)	1 (8.3)	2 (8.3)	1 (8.3)	1 (8.3)
Type 7	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Gastrointestinal symptoms, *n* (%)						
Abdominal pain						
None	16 (66.7)	6 (50.0)	10 (83.3)	19 (79.2)	8 (66.7)	11 (91.7)
Mild	5 (20.8)	4 (33.3)	1 (8.3)	4 (16.7)	3 (25.0)	1 (8.3)
Moderate	3 (12.5)	2 (16.7)	1 (8.3)	1 (4.2)	1 (8.3)	0 (0.0)
Severe	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Abdominal bloating						
None	8 (33.3)	3 (25.0)	5 (41.7)	11 (45.8)	5 (41.7)	6 (50.0)
Mild	11 (45.8)	5 (41.7)	6 (50.0)	7 (29.2)	4 (33.3)	3 (25.0)
Moderate	3 (12.5)	2 (16.7)	1 (8.3)	6 (25.0)	3 (25.0)	3 (25.0)
Severe	2 (8.3)	2 (16.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Flatulence						
None	8 (33.3)	4 (33.3)	4 (33.3)	10 (41.7)	4 (33.3)	6 (50.0)
Mild	9 (37.5)	3 (25.0)	6 (50.0)	5 (20.8)	3 (25.0)	2 (16.7)
Moderate	4 (16.7)	3 (25.0)	1 (8.3)	7 (29.2)	4 (33.3)	3 (25.0)
Severe	3 (12.5)	2 (16.7)	1 (8.3)	2 (8.3)	1 (8.3)	1 (8.3)

Defecation frequency was measured using CCQ; Stool consistency was assessed using Bristol Stool Scale

of the study. Of these symptoms, 23 were in Group A (6g PDX) and 17 were in Group B (12g PDX). Of the 40 reported symptoms, eight subjects reported abdominal pain [Group A: mild: 4 (33.3%), moderate: 2(16.7%); Group B: mild: 1 (8.3%), moderate: 1 (8.3%)]; 16 subjects were bloated (Group A: mild: 5 (41.7%), moderate: 2 (16.7%), severe: 2 (16.7%); Group B: mild: 6 (50.0%), moderate: 1 (8.3%)]; and 16 subjects had flatulence [Group A: mild: 3 (25%), moderate: 3 (25%), severe: 2 (16.7%); Group B: mild: 6 (50%), moderate: 1 (8.3%), severe: 1 (8.3%)].

Based on the data reported in Table 4, out of the total 40 reported symptoms, 32 remained unresolved after the consumption of PDX beverage over seven days. However, it was clear that improvement in abdominal pain, bloating and flatulence was seen by the end of the study for those who consumed PDX beverage.

DISCUSSION

Nowadays, the mainstream Indonesian young adults are consuming more protein than their body requires, carbohydrate-rich foods, and less dietary fibre (Table 2). With respect to dietary fibre, it has been well-documented that higher fibre intake reduces the risk of all-cause cardiovascular mortality, the incidence of non-communicable diseases, and constipation (Mayor, 2019; Yang *et al.,* 2012). Considering the low intake of dietary fibre, it is then reasonable to suggest whether supplementation of dietary fibre through products will improve bowel habits. Therefore, this study was designed to investigate whether PDX in the form of ready-to-drink beverage demonstrates a beneficial effect on bowel habits.

Identifying the fact that the constipation-alleviating effect of PDX in humans has been widely documented in different dose-responses in clinical trials (Do Carmo *et al.*, 2016), the present study had at least three distinctive characteristics. Firstly, the present study was performed in Indonesian young adults with a constipation problem. This strongly suggested that the studied population was sufficiently constipated, which is likely to build on the strength of evidence regarding the constipation-alleviating effect of PDX beverage consumption. Secondly, the average fibre intake of subjects was 7.5±4.1g/day, which implied that only one-third of the daily fibre intake recommendation by WHO (2003) – 25g/day was fulfilled by the subjects. This finding was in line with the previous data observed by the Ministry of Health (MOH) Indonesia (2008), where Indonesians have a low level of dietary fibre intake of around 10.5g/day. Thirdly, a ready-to-drink beverage containing PDX was used, while in most clinical trials, PDX was incorporated in powder or yoghurt (Ibarra *et al.*, 2019; Magro *et al.,* 2014).

PDX is one of the non-digestible food ingredients studied for its prebiotic potential. Its prebiotic potential has been demonstrated in altering the gut microbiota, which results in relieving or preventing constipation (Ibarra *et al.*, 2019). Besides being an outstanding functional fibre, it has been accepted as a dietary fibre in more than 20 countries and approved in over 60 countries to be incorporated into foods to boost fibre content, as well as to replace sugar and fat (Flood, Auerbach & Craig 2004). It is reported that a daily PDX consumption of up to 90g or 50g in a single dose is well tolerated by humans. Besides, it has been established that a regular intake of 4-12g PDX improves physiologic functions without adverse effects (Jie *et al.*, 2000). While the majority of available data on the constipation-alleviating effect of PDX has been investigated in healthy subjects (Ibarra *et al.*, 2019), data on

subjects experiencing constipation are lacking. The current study is the first to demonstrate the effects of consuming PDX (prebiotic) beverage, containing 6g and 12g PDX once a day for seven days in constipated subjects. The observed efficacy was shown to be comparable to what has been found with PDX dose-responses in other clinical trials (Ibarra *et al.*, 2019; Duncan *et al.*, 2018).

In the current study, the constipation-alleviating effect of PDX beverage consumption was observed at the end of the study (Day 7), that was, for consuming either one serving of PDX beverage containing 6g/day PDX or two servings of the same product, containing 12g/day PDX. Subjects who consumed 12g PDX once a day experienced a greater reduction in overall constipation mean score compared to those who consumed 6g PDX once a day. Additionally, there was a higher number of subjects who reported constipation relief, with 91.7% of subjects having desirable defecation frequency (>3 defecation per week), and 66.7% who had ideal stool consistency (type 4) after seven days of PDX beverage consumption.

Recent trials demonstrated a clear dose-response effect for PDX (Ibarra *et al.,* 2019; Shimada *et al.*, 2015), although the reported constipation-alleviating effects in these studies were shown after a period of 14 days. Also, data on 6g dosage are rarely investigated. Based on this present study findings, consuming one serving size of PDX beverage (100ml) containing 6g PDX for seven days was able to relieve and prevent constipation. This suggests that incorporating PDX into ready-to-drink beverage has shed new light on the intervention for constipated subjects. This accounts for its practical and safe one-time consumption with a better laxative effect in real-life setting (per unit bottle). PDX was also shown to be efficient in this form of product, indicating that PDX consumption in liquid form appears to have a larger constipation-alleviating effect over a shorter period of time compared to interventions designed using solid form (e.g. yoghurt or powder) with a longer period of time. However, further trials need to be conducted to confirm the efficacy of PDX in different product formats. Also, subjects who consumed one serving size of PDX beverage could achieve an additional 20% in fibre intake (BPOM, 2016), thus, this may help to increase the overall daily fibre intake of the Indonesian society.

Do Carmo *et al.* (2016) described that the possible mechanism of action of PDX in improving the ease of bowel movement is its ability in stimulating the human colon by reducing bowel transit time, increasing total weekly bowel frequency without inducing adverse gastrointestinal symptoms and by producing soft stools. Shimada *et al.* (2015) found out that PDX consumption for seven days effectively changed bowel function (stool frequency increased from 3 times to 7 times per week) and reported desirable stool consistency like a sausage or snake-shaped with a smooth and soft surface over an eight-week consumption period. Similarly, Ibarra *et al.* (2019) investigated the bowel habits of an adult population (n=192, mean age 42.7±18.8) in a double-blind, randomised, placebo-controlled trial, where subjects were assigned into four groups of intervention: i.e. 12g PDX or 8g PDX and 4g maltodextrin or 4g PDX and 8g maltodextrin or placebo (12g maltodextrin), for a period of 14 days. The efficacy of PDX consumption was observed on constipation score, with 12g PDX daily consumption decreasing more constipation mean score than 8g PDX or 4g PDX. Thus, the regular consumption of 12g PDX effectively increased the proportion of adults who were relieved from constipation from 54.0% to 79.0%, with an increase in stool frequency

by >2 defecations per week. But, the dose-response effect of PDX on stool consistency did not reach statistical significance due to the low incidence of constipation in the study population.

On the other hand, the mechanism of action of PDX (prebiotics) in exacerbating gastrointestinal symptoms remains debatable. Staudacher *et al.* (2014) described that the nature of PDX has various mechanisms, i.e. colonic-gas production by microbiota fermentation and altered intestinal motility. According to Do Carmo *et al.* (2016), PDX (prebiotics) remains undigested throughout the large intestine due to the long fermentation cycle, which stays usable as a carbon supply for the microbiota; therefore, it may stimulate either the growth or the activity of the microbiota. Then, the continuous fermentation of the colonic microbes results in a steady output of short-chain fatty acids (SCFA) and a little volume of gas (Röytiö & Ouwehand, 2014; Hernot *et al.*, 2009). Clinically, disrupted gas transport and inadequate gas evacuation may contribute to the development of abdominal distention, resulting in pain or flatulence out of proportion to the volume of gas trapped in a particular segment of the intestine. One suggested explanation is that PDX also stimulates the growth of methanogens, which then decreases the production of methane, increases the ileal and colon transit time, and reduces the amplitude of contraction, thus accelerating peristalsis and resulting in better intestinal motility (Waqar & Rehan 2019). Consequently, this physiological mechanism may facilitate the positive results correlated with PDX intake in the improvement of bowel function, e.g. alleviating constipation and producing smoother stools in humans (Röytiö & Ouwehand, 2014).

These current study findings are partly consistent with previous studies (Ibarra *et al.*, 2019; Duncan *et al.*, 2018; Shimada *et al.*, 2015), indicating that PDX consumption helps to solve gastrointestinal symptoms. However, Duncan *et al.* (2018) observed that both regular 8g and 12g of PDX consumption over two weeks in chronically constipated adults did not improve subjective-reported symptoms, as compared to baseline. Adverse effects, such as abdominal pain (8g/day PDX: 27.5%, 12g/day PDX: 20.0%) and flatulence (8g/day PDX: 2.5%, 12g/day PDX: 0.0%) were not fully treated by the end of the study. In contrast to the earlier mentioned study, no abdominal cramps or other discomforts were reported by those who consumed PDX for four weeks (Shimada *et al.*, 2015). In a recent study using different daily dose-response of PDX, Ibarra *et al.* (2019) discovered that consuming 12g/day of PDX for 14 days resolved all reported adverse effects (e.g. abdominal discomfort, flatulence, abdominal pain upper, nausea) by the end of the study.

This study was feasibly successful due to the use of the CCQ diagnostic criteria developed by Chan *et al.* (2005) for determining constipation as an inclusion criteria. Considering the time frame of the current pilot study, CCQ was an ideal screening method for quick classification of constipation based on frequency, symptom severity and laxative use. Also, the questionnaire was chosen because it was considered easy to understand and has been proven to have a consistent and reproducible result. However, the use of the Likert Scale in the questionnaire administration may have led to bias, due to the unclear definition of each scale category, e.g. “sometimes”, “often”. This may have allowed subjects to give vague answers based on a general view of their current condition (high subjectivity). Furthermore, the compliance in consuming the PDX

beverage was good; 100% of the provided test beverage products were consumed in both groups.

On the other hand, a drawback is worth mentioning. Although the present study hypotheses were supported statistically, this study was an early phase of a clinical trial with a focus on investigating whether PDX beverage affects bowel habits and relieve constipation. These findings are important as the basis evidence for larger research trials in future. Therefore, further research studies, including the use of placebo (control) group, longer intervention period (i.e. 28 days or longer), with a focus on more constipation-related symptoms or adverse effects, might be able to strengthen the positive effect of PDX (prebiotic) beverage consumption.

CONCLUSION

The subjects' bowel habits indicated by the overall constipation mean score was significantly lower in those who consumed two serving sizes of PDX beverage once a day (200 ml), containing 12g PDX (Group B, intervention group) than those who consumed one serving of the same product, containing 6g PDX (Group A, active control group). Group B also had a higher percentage of desirable stool frequency and ideal stool consistency with fewer subject-reported gastrointestinal symptoms, compared to Group A.

In conclusion, this preliminary investigation has confirmed the potential of PDX (prebiotic) beverage consumption in constipation management. PDX has an important role in alleviating constipation, thus, consumption of PDX beverages can be recommended to constipated young adults with their existing dietary habits.

Acknowledgment

Sincere appreciation to all study partners of PT. Amerta Indah Otsuka, PT. Otsuka Distribution Indonesia and other parties involved for the support. Subjects and outcome investigator are gratefully acknowledged. Special thanks to Fithraturrahmah and Prof. Widjaja Lukito for help in reviewing the manuscript.

Authors' contributions

MYK, analysed and interpreted the data, reviewed and finalised the manuscript; NI, principal investigator, designed the study, wrote the manuscript; LH, outcome investigator (data collection), reviewed manuscript; CR, assisted in statistical analysis, compiled the data; FS, contributed in study design and reviewed the manuscript.

Conflict of interest

All authors have no conflict of interest regarding the publication of this manuscript. NI, LH, CR, and FS were the former scientific team of PT. Amerta Indah Otsuka at the time of study execution. MYK is the new scientific supervisor employed by PT. Amerta Indah Otsuka. This pilot study was supported by Otsuka Pharmaceuticals, Co., Ltd., the parent company of PT. Amerta Indah Otsuka, which provided the study product (Fibe-Mini). All authors disclose that the sponsor company had no influence in the execution of the study, including no input into the study design, data collection, analyses, or interpretation of the data, in the writing of the manuscript, and in the decision to publish the results.

References

Blake M, Raker J & Whelan K (2016). Validity and reliability of the Bristol Stool Form Scale in healthy adults and patients with diarrhoea-predominant irritable bowel syndrome. *Aliment Pharmacol Ther* 44(7):693-703.

BPOM RI (2016). Peraturan Kepala Badan Pengawas Obat dan Makanan Republik Indonesia Nomor 9 Tahun 2016 tentang Acuan Label Gizi. Jakarta.

Breivik H, Borchgrevink P, Allen S, Rosseland L, Romundstad L, Breivik Hals E, Kvarstein G & Stubhaug A (2008). Assessment of pain. *Br J Anaesth* 101(1):17-24.

Chan AO, Lam KF, Hui WM, Hu WH, Li J, Lai KC, Chan CK, Yuen MF & Wong BC (2005). Validated questionnaire on diagnosis and symptom severity for functional constipation in the Chinese population. *Aliment Pharmacol Ther* 22(5):483-8.

Chey WD (2017). Symposium report: an evidence-based approach to Ibs and Cic: applying new advances to daily practice: a review of an adjunct clinical symposium of the American College of Gastroenterology Meeting October 16, 2016• Las Vegas, Nevada. *Gastroenterol Hepatol* 13(2 Suppl 1):1.

Costabile A, Fava F, Röytiö H, Forssten SD, Olli K, Klievink J, Rowland IR, Ouwehand AC, Rastall RA & Gibson GR (2012). Impact of polydextrose on the faecal microbiota: a double-blind, crossover, placebo-controlled feeding study in healthy human subjects. *Brit J Nutr* 108(3):471-81.

Do Carmo MMR, Walker JCL, Novello D, Caselato VM, Sgarbieri VC, Ouwehand AC, Andreollo NA, Hiane PA & Dos Santos EF (2016). Polydextrose: physiological function, and effects on health. *Nutrients* 8(9):553.

Duncan PI, Enters-Weijnen CF, Emami N, McLean P, Nunes T, Beaumont M, Crabbe R, Whelan K, Mark Scott S & DeWit NJ (2018). Short-term daily intake of polydextrose fiber does not shorten intestinal transit time in constipated adults: a randomized controlled trial. *Nutrients* 10(7):920.

Flood M, Auerbach M & Craig S (2004). A review of the clinical toleration studies of polydextrose in food. *Food Chem Toxicol* 42(9):1531-42.

Forootan M, Bagheri N & Darvishi M (2018). Chronic constipation: A review of literature. *Medicine* 97(20).

Hernot DC, Boileau TW, Bauer LL, Middelbos IS, Murphy MR, Swanson KS & Fahey Jr GC (2009). In vitro fermentation profiles, gas production rates, and microbiota modulation as affected by certain fructans, galactooligosaccharides, and polydextrose. *J Agric Food Chem* 57(4):1354-61.

Ibarra A, Pelipyagina T, Rueffer M, Evans M & Ouwehand AC (2019). Efficacy of polydextrose supplementation on colonic transit time, bowel movements, and gastrointestinal symptoms in adults: a double-blind, randomized, placebo-controlled trial. *Nutrients* 11(2):439.

Jie Z, Bang-yao L, Ming-Jie X, Hai-wei L, Zu-kang Z, Ting-song W & Craig SA (2000). Studies on the effects of polydextrose intake on physiologic functions in Chinese people. *Am J Clin Nutr* 72(6):1503-1509.

Julious SA (2005). Sample size of 12 per group rule of thumb for a pilot study. *Pharmaceut Statist* 4(4):287-91.

Kim E, & Choi J (2015). The evaluation of metabolizable energy in traditional Korean food for protein sources. *J Ethnic Foods* 2(4):179-185.

Lee HJ, Choi JK, Ryu HS, Choi CH, Kang EH, Park KS, Min YW & Hong, KS (2017). Therapeutic modulation of gut microbiota in functional bowel disorders. *J Neurogastroenterol Motil* 23(1):9.

Magro DO, de Oliveira LMR, Bernasconi I, de Souza Ruela M, Credidio L, Barcelos IK, Leal RF, de Lourdes Stesuko Ayrizono M, Fagundes JJ, de B Teixeira L, Ouwehand AC & Coy CSR (2014). Effect of yogurt containing polydextrose, Lactobacillus acidophilus NCFM and Bifidobacterium lactis HN019: a randomized, double-blind, controlled study in chronic constipation. *Nutr J* 13(1):1-5.

Mayor S (2019). Eating more fibre linked to reduced risk of non-communicable diseases and death, review finds. *BMJ* 364:l159.

MOH Indonesia (2008). *Overweight due to lack of fibre*. Ministry of Health, Indonesia.

Mounsey A, Raleigh MF & Wilson A (2015). Management of constipation in older adults. *Am Fam Physician* 92(6):500-4.

Mugie SM, Benninga MA & Di Lorenzo C (2011). Epidemiology of constipation in children and adults: a systematic review. *Best Pract Res Clin Gastroenterol* 25(1):3-18.

Philichi L (2018). Management of childhood functional constipation. *J Pediatr Health Care* 32(1):103-11.

Röytiö H & Ouwehand A (2014). The fermentation of polydextrose in the large intestine and its beneficial effects. *Benef Microbes* 5(3):305-13.

Shimada M, Nagano N, Goto S, Ito K, Tsutsui T, Ando T, KAMIOkA H & Ogawa T (2015). Effect of polydextrose intake on constipation in japanese dialysis patients: A triple-blind, randomized, controlled trial. *J Nutr Sci Vitaminol* 61(4):345-53.

Staudacher HM, Irving PM, Lomer MC & Whelan K. (2014). Mechanisms and efficacy of dietary FODMAP restriction in IBS. *Nature Reviews Gastroenterology & Hepatology 11*(4): 256.

Vagias WM (2006). Likert-type scale response anchors. *Clemson International Institute for Tourism & Research Development, Department of Parks, Recreation and Tourism Management Clemson University.*

Wahab PA, Kadir AA, Lee YY, Ali SH & Yusoff DM (2019). Chronic constipation among community-dwelling older people in the East Coast region of Peninsular Malaysia. *Makara Journal of Health Research* 23(3):8.

Waqar SHB & Rehan A (2019). Methane and constipation-predominant irritable bowel syndrome: entwining pillars of emerging neurogastroenterology. *Cureus* 11(5).

WHO (2003). Diet, Nutrition and the Prevention of Chronic Diseases. World Health Organization, Geneva. From https://www.who.int/dietphysicalactivity/publications/trs916/en/ [Retrieved July 30 2020].

WHO (2020). Mean body mass index (BMI): situation and trends. World Health Organization, Geneva. From https://www.who.int/gho/ncd/risk_factors/bmi_text/en/ [Retrieved July 30 2020].

Yang J, Wang HP, Zhou L & Xu CF (2012). Effect of dietary fiber on constipation: a meta-analysis. *World J Gastroenterol* 18(48):7378.

Yudiyanto AR (2018). Obesity and functional constipation in children. *Paediatr Indones* 58(1):1.

Mal J Nutr 26(3): 369-377, 2020

Validation of the Turkish version Power of the Food Scale (PFS) for determining hedonic hunger status and correlate between PFS and body mass index

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ABSTRACT

Introduction: This study was carried out to determine the validity and reliability of the Turkish culture-adapted version of "Power of the Food Scale" (PFS), which was originally developed by Lowe *et al.* (2009). In addition, associations between body mass index (BMI) and PFS scores were assessed. **Methods:** The study sample consisted of a total of 363 volunteering students aged >18 years, who were studying at the Başkent University in Turkey. Validity and reliability analyses were conducted for the Turkish version of the PFS. **Results:** The correlations of each item in the PFS with the total score were found to be positive and >0.30. The Cronbach's alpha value was determined as 0.85. The construct validity of the scale was analysed with confirmatory factor analysis. The Adjusted Goodness of Fit Index was 0.97 and the Root Mean Square Error of Approximation was 0.07. These fit indices of the model confirmed the construct validity of the PFS. A positive and statistically significant correlation was found between BMI values of the students and the total score of the scale (r=0.157; p=0.003). **Conclusion:** The findings obtained in this study have laid out that the Turkish Power of Food Scale (T-PFS), which was adapted to Turkish culture from PFS, is a valid and reliable measurement tool that can be applied in Turkey. Thus, T-PFS is thought to be likely to contribute to studies aiming to determine the status of hedonic hunger.

Keywords: Hedonic hunger, power of food scale, Turkey university students

INTRODUCTION

Obesity is a global health problem that directly impacts 20% of the world's population. It is also a leading risk factor for mortality among non-communicable diseases such as metabolic syndrome, cancer and cardiovascular disease (WHO, 2017). Early adulthood represents a critical period in the development of obesity. Recent cross-sectional data have shown that the prevalence of overweight and obesity in adults aged between 20 and 39 years is almost twice that of adolescents aged between 12 and 19 years (Ogden *et al.*, 2014). The prevalence of overweight and obesity in Turkey has increased considerably in adult males and females in the last 20 years. The results obtained from different periods showed that obesity is a significant and serious public health problem in Turkey (Erem, 2015).

Today, eating behaviour in humans is known to be mostly driven by the response to environmental triggers regarding foods, regardless of physiological needs

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doi: https://doi.org/10.31246/mjn-2019-0129

(Cleobury & Tappert, 2014; Schüz, Schüz & Ferguson, 2015). People eat not only when they feel hungry but also for pleasure due to the high availability of and easy access to food (Berthoud, 2011; Monteleone, Scognamiglio & Monteleone, 2013). This is manifested in many phrases in the scientific literature, such as "hedonic eating", "emotional eating", "stress-induced eating", "food addiction", "eating to feel good", and "eating as a treatment". "Hedonic eating" is defined as a desire to consume food for motivation regardless of energy content (Lowe & Butryn, 2007; Boggiano *et al.*, 2015; Cappelleri *et al.*, 2009; Berthoud, 2011). Hedonic eating motives individuals to consume even though the body does not need food. The types of foods generally consumed under these conditions are high energy products, which are processed and flavoured with a high content of fat, sugar, or salt (Boggiano *et al.*, 2015; Burgess *et al.*, 2014). A person's consumption of his/her favourite dessert despite being full after dinner is an example of this situation. With the consumption of food that gives pleasure, hedonic mechanisms increase food consumption by heading off our homeostatic mechanisms. Therefore, it is important to establish a balanced relationship between modern obesogenic lifestyle and food consumption (Lowe & Levine, 2005; Dalton & Finlayson, 2013).

This study aimed to carry out a validity and reliability assessment on the Turkish culture adapted PFS, which was originally developed by Lowe *et al.* (2009), to evaluate the feelings and thoughts of individuals about the consumption of food and nutrition without a metabolic necessity in the environments where delicious foods are widely available.

MATERIAL AND METHODS

Ethics

For the study, 'Research Board Approval' was obtained from the Başkent University Medical and Health Sciences Research Board with the decision number 94603339-604.01.02 / 12617 and dated 04.04.2017.

Permission

Permission to use and translate the scale was obtained from the creator of the scale Lowe MR et al. via email. At the same time, a mutual agreement was signed. The Turkish version of the scale was also shared with the authors.

Participants

The sample of this study consisted of a total of 363 volunteering students aged over 18 years, including 293 females and 70 males, who were studying at the Başkent University in Turkey. There are a total of 11 faculties at the Başkent University and a total of 41 departments under these faculties. The sample of the study included classes and departments from these faculties to ensure that each faculty was represented in the sample. In adapting a scale to a different language and culture, the recommended sample size to determine its validity and reliability should be at least 5-10 times the number of the items in the scale (Osborne & Costello, 2004). Sample selection was conducted according to the Simple Random Sampling technique by assigning numbers to faculties and departments and generating random numbers in the Excel computer software. Permissions were obtained from the faculties and departments, which were selected in the sampling procedure, and then the questionnaire was administered to the students in their classrooms.

Questionnaire form

The first section of the questionnaire collected information about the demographic characteristics of the students such as age, gender, and body mass index (BMI). The rest of the questionnaire was the 21-item Turkish adapted version of PFS, which composed of three factors (food availability, food

presence and food taste, respectively). The questionnaire was self-administered by the students in their classes under the supervision of the researchers.

BMI measure

Height (cm) and body weight (kg) values of the students were taken. BMI was calculated by dividing weight (kg) by the square of height (m).

Translation of the original form of the PFS into Turkish

To adapt the PFS into Turkish, first of all, the original form of this 21-item scale was translated into Turkish. The standard translation-back-translation method was used in the translation process of this questionnaire (Beaton *et al.*, 2000). For this purpose, a total of three experts, including two experts who had a good command of English in the field of nutrition and a faculty member with an advanced level of English from the Başkent University Faculty of Health Sciences first translated the scale into Turkish. Then the translated form was translated back into English from Turkish. The Turkish adaptation process of the scale was finalised after the most recent translated forms had been evaluated in terms of consistency and semantic integrity, and that necessary amendments had been made.

To determine the intelligibility of the scale in terms of language and meaning, it was submitted to the instructors from the Department of Nutrition and Dietetics for review and evaluation. Besides, the scale was piloted to approximately 20 students from different departments to determine the intelligibility of the items, the appropriateness of item sequencing, and the time needed for completing the scale. Accordingly, the opinions and suggestions of the students were collected. After making necessary amendments in the scale based on the feedbacks, it was then finalized and administered to the target sample group. No problem was encountered during this stage.

Statistical analysis

After the adaptation of the scale into the Turkish language, for the Explanatory Factor Analysis, the Principal Component Factor Analysis was employed to determine the number of underlying factors (items) in the PFS. The fit between the Turkish version of the scale with the original form was analysed using Confirmatory Factor Analysis (CFA). Fit indicators such as Chi-square (χ^2) Goodness of Fit Index, Adjusted Goodness of Fit Index, Root Mean Square Residual, and Root Mean Square Error of Approximation indices were calculated. To determine the reliability between the items of the scale (internal consistency), item analysis and Cronbach's alpha coefficient were calculated. Correlations between the total score of the PFS scale and BMI values were analysed with Pearson's correlation analysis.

RESULTS

According to the findings, 80.7% of the students were females. The mean age of the students was 21.3±1.8 years, and the average BMI was 21.80±4.07kg/m^2. While 70.6% of the students were under normal BMI classification (18.50-24.99kg/m^2), 12.5% and 3.0% were classified as slightly obese (25.00-29.99kg/m^2) and obese (>30.00kg/m^2), respectively. A positive and statistically significant correlation was found between the BMI values of the students and their PFS scale scores (r=0.157; p = 0.003).

Explanatory factor analysis of the PFS

In the study, Kaiser-Meier-Olkin (KMO) test was employed to test whether the sample size was adequate, and Bartlett's Sphericity Test was used to determine whether there was a correlation between the items, which is a prerequisite for

factor analysis. Accordingly, the results of the KMO test statistics showed that the sample size was adequate (KMO = 0.87). A KMO value of >0.50 indicates that the sample size of the related scale data is sufficient. According to the Bartlett Sphericity Test result, the level of correlation between the items was found to be sufficient to do a factor analysis (χ^2 = 1493; p<0.0001).

As a result of the Explanatory Factor Analysis (EFA), 6 out of the 21 items were excluded from the scale as their factor loadings were <0.30 and they impaired construct validity. The same items had also been omitted from the original scale. The scale was then divided into 3 factors under the constraint of an eigenvalue >1. The factor loading for the items in each factor was >0.30, and the scale was found to explain 33.08% of the total variance. As shown in Table 1, the items grouped under factor 1 were items 1, 2, 5, 10, 11 and 13; those under factor 2 were items 3, 4, 6 and 7; and those gathered under factor 3 were items 8, 9, 12, 14 and 15.

Confirmatory factor analysis of the PFS

In this study, the three-factor structure was tested based on the original form to determine the confirmatory factor validity of PFS. IBM SPSS AMOS 21.0 version (2012)'s Structural Equation Modelling was employed to analyse whether the collected data were appropriate for the model. The fit statistics of the model are shown in Table 2, and the fit scheme is presented in Figure 1.

Table 1. Items, factor loadings, eigenvalues, and variance explanation for the Turkish Power of Food Scale (T-PFS)

Items	*Factor 1 (Food Available)*	*Factor 2 (Food Present)*	*Factor 3 (Food Tasted)*
PFS 1	0.68		
PFS 2	0.70		
PFS 5	0.69		
PFS 10	0.64		
PFS 11	0.66		
PFS 13	0.65		
PFS 3		0.68	
PFS 4		0.64	
PFS 6		0.61	
PFS 7		0.64	
PFS 8			0.48
PFS 9			0.73
PFS 12			0.38
PFS 14			0.66
PFS 15			0.63
Eigenvalue	4.96	1.55	1.09
Variance explanation percentage	33.08	10.33	7.26

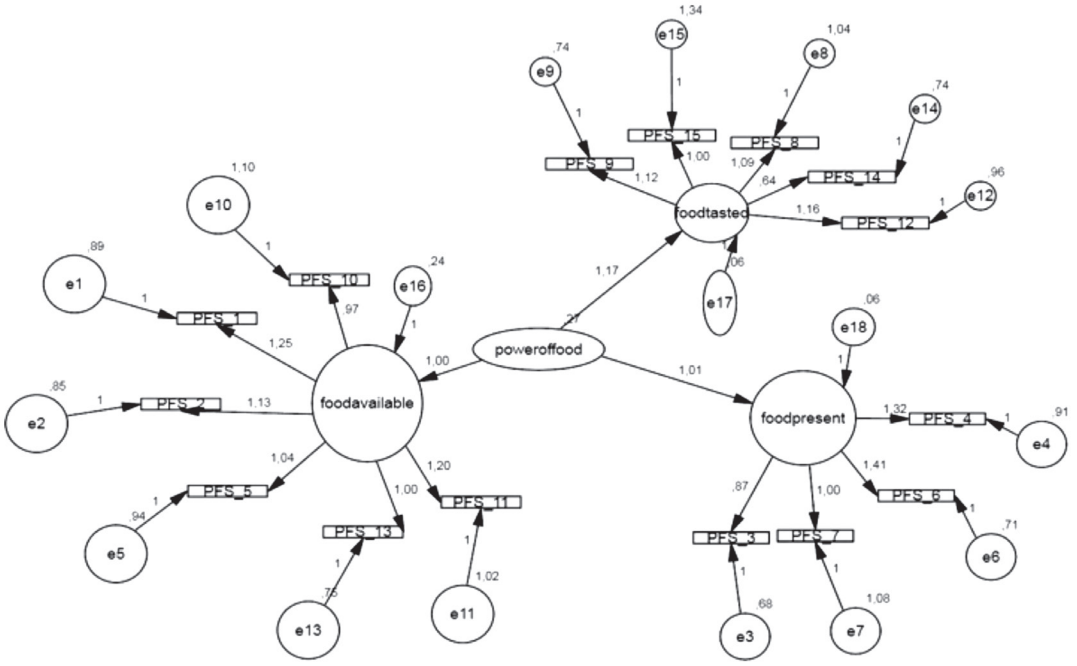

Figure 1. The fit scheme of PFS scale with confirmatory factor analysis and the three-factor model

Different indices can be used to evaluate the fit of a model. According to the Chi-square (χ^2) Goodness of Fit Index used in this study, the scale was observed to have a perfect fit. Besides, the Adjusted Goodness of Fit Index (AGFI) was found as 0.97. An AGFI value that is >0.90 shows that the model has goodness of fit. Similarly, a Root Mean Square Residual (RMR) value that is <0.05 and a value of Root Mean Square Error of Approximation (RMSEA) that is <0.08 too show the model has goodness of fit. In this study, the RMR was 0.048, and the RMSEA was 0.07. With that, the values obtained from this scale indicated the acceptability and applicability of the Turkish version of the PFS (Table 2).

As shown in Figure 1, the results of the "two-level confirmatory factor analysis" were obtained by adding 'power of food', which is an upper-level factor (latent variable), explained by three factors (latent variables) in the model. The items linked to each factor, the number of errors, and the regression coefficients explaining them are given in Figure 1. The Turkish version of the PFS was confirmed by obtaining the same results as the original scale.

Table 2. The fit statistics of the PFS scale according to confirmatory factor analysis

Fit indexes	*Cutoff Criteria in the Literature*	*Turkish PFS scale results*
χ^2/df	3-5	4.80
AGFI	≥0.90	0.97
RMR	≤0.05	0.048
RMSEA	0.06-0.08	0.07

Reliability analysis for internal consistency

The level of internal consistency (reliability) between the items in the PFS was calculated by item-total correlations and Cronbach's alpha internal consistency coefficients. Cronbach's alpha internal consistency coefficient was found to be 0.85 for the PFS. Cronbach's alpha internal consistency coefficient yields a value of between 0 and 1. The closer this coefficient is to 1, the more reliable the tool is.

As is seen in Table 3, the correlations of all items with the total score were positive and >0.30. This indicated that the scale as a whole could measure the power of food on individuals. Besides, the reliability coefficients (Cronbach's alpha) for the three subscales of PFS approved by CFA were 0.80 for factor 1 (food availability), 0.67 for factor 2 (food presence), and 0.69 for factor 3 (food taste). These results showed that each factor had adequate reliability. Two-month test-retest reliability in the Başkent University sample (n=90) was found to be adequate (r=0.82; p<0.001).

Score based evaluation of the PFS

As stated by Lowe *et al.* (2009), the PFS consisting of three factors and 15 items is evaluated over a five-point Likert type scale. Each item is responded with one of the "strongly agree", "agree", "no idea", "disagree", and "strongly disagree" options. The scores of the options are 5, 4, 3, 2 and 1, respectively. An increased scale score of an individual meant an increase in the impact of power of food on the individual (hedonic hunger). The total score was divided by the number of items, and then the resulting mean score was interpreted. If the mean score was over 2.50, it indicated the presence of hedonic hunger and showed that the individual is affected by food.

The students who participated in this study scored a minimum of 1.33 points, a maximum of 5 points, and an average of 3.18±0.68 points from

Table 3. Reliability analysis results for the items of PFS

Item	*Item-total scale correlation*	*Cronbach's alpha coefficient if item deleted*
PFS 1	0.549	0.840
PFS 2	0.498	0.843
PFS 3	0.385	0.849
PFS 4	0.542	0.841
PFS 5	0.506	0.843
PFS 6	0.562	0.840
PFS 7	0.387	0.849
PFS 8	0.501	0.843
PFS 9	0.532	0.842
PFS 10	0.442	0.846
PFS 11	0.561	0.840
PFS 12	0.527	0.842
PFS 13	0.555	0.840
PFS 14	0.333	0.851
PFS 15	0.397	0.849

the scale. Besides, the students were found to have an average of 2.78±0.88 points from the first subscale "food availability", 3.43±0.81 points from the second subscale "food presence", and 3.33±0.79 points from the third subscale "food taste".

DISCUSSION

This study aimed to adapt the three-subscale, 15-item PFS, which was developed by Lowe *et al.* (2009), to the Turkish culture. The adaptation process started with the translation of the scale from the source language to the target language and went on with the determination of linguistic and idiomatic equivalences, and then pilot administration. Finally, the Turkish version of the PFS was administered to 363 university students, and the data obtained were analysed.

The results found in this study were similar to the results of the PFS developed by Lowe *et al.* (2009). Cappelleri *et al.* (2009) examined the validity and reliability of the PFS in two separate sample groups – one including obese individuals and the other on a sample of the general population. They concluded that the PFS, which consisted of 15 items and three factors had a reliability coefficient that ranged between 0.81 and 0.91. Mitchell *et al.* (2016) studied the psychometric properties of PFS in a sample of preadolescents and adolescents (n=148). The result of CFA in their study also indicated that the items in the scale were loaded under three factors as in the original. They found that Cronbach's alpha coefficient for the total score and the three factors ranged from 0.86 to 0.95. The results obtained using a sampling of pre-adolescents and adolescents were similar to the results of our study conducted on university students.

In our study, positive and statistically significant correlations were found between the BMI of the students and their PFS scale scores (r=0.157; p=0.003). All three sub-factors were also found to be positively correlated with BMI, although statistical significance was only determined in the food availability subscale (r=0.251; p<0.001). In their narrative review on hedonic hunger measured by PFS, Espel Huynh *et al.* (2018) found a positive correlation between BMI and PFS in 8 out of 10 studies. These results also supported the finding that increased PFS score clearly showed hedonic hunger. Determination of individuals' hedonic hunger levels will provide important information about their tendency to become obese. Thus, clinicians/dietitians and similar healthcare professionals may evaluate their patients using PFS to determine their hedonic hunger level, and perhaps recommend a treatment/diet programme accordingly.

The first limitation of this study was the inclusion of students from a single university in the sample. Perhaps it would be more appropriate to work with a larger sample group covering the whole country. The second limitation of the study was the absence of another scale in the study that measures eating behavior. Compensation for these constraints in future studies and comparison with our results will further increase the scientific value of the PFS.

CONCLUSION

PFS is a scale used to determine the status of hedonic hunger. The findings obtained indicated that the Turkish version of the PFS, which was adapted from the original PFS, is a valid and reliable instrument that can be applied in Turkey. It is thought that PFS will contribute to studies aiming to determine the status of hedonic hunger.

Acknowledgement

The authors are grateful to the Başkent University Administration and the students who participated in the research.

Authors' contributions

AOM, principal investigator, conceptualised and designed the study, analysed and interpreted the data, prepared the draft of the manuscript and reviewed the manuscript; HM, led the data collection and design of the research, conducted the study and wrote the manuscript.

Conflict of interest

Authors declare no conflict of interest.

References

Aliasghari F, Jafarabadi MA, Yaghin NL & Mahdavi R (2018). Psychometric properties of Power of Food Scale in Iranian adult population: gender-related differences in hedonic hunger. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*. https://doi.org/10.1007/s40519-018-0549-3

Beaton DE, Bombardier C, Guillemin F & Ferraz MB (2000). Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures. *SPINE* 25(24):3186–3191.

Berthoud HR (2011). Metabolic and hedonic drives in the neural control of appetite: who is the boss? *Curr Opin Neurobiol* 21:888-896.

Boggiano MM, Wenger LE, Turan B Tatum MM, Sylvester MD, Morgan PR, Morse KE & Burgess EE (2015). Real-time sampling of reasons for hedonic food consumption: further validation of the palatable eating motives scale. *Front Psychol* 6:744.

Burgess EE, Turan B, Lokken KL, Morse A & Boggiano MM (2014). Profiling motives behind hedonic eating. Preliminary validation of the palatable eating motives scale. *Appetite* 72:66-72.

Cappelleri JC, Bushmakin AG, Gerber RA, Leidy NK, Sexton CC, Karlsson J & Lowe MR (2009). Evaluating the power of food scale in obese subjects and a general sample of individuals: development and measurement properties. *IJO* 33:913-922.

Cleobury L & Tappert K (2014). Reasons for eating 'unhealthy' snacks in overweight and obese males and females. *J Hum Nutr Diet* 27:333-341.

Dalton M & Finlayson G (2013). Hedonics, satiation and satiety. University of Leeds, UK. doi: 10.1533/9780857098719.4.221.

Erem C (2015). Prevalence of overweight and obesity in Turkey. *IJC Metab Endocr* 8:38-41.

Espel-Huynh HM, Muratore AF & Lowe MR (2018). A narrative review of the construct of hedonic hunger and its measurement by the Power of Food Scale. *Obes Sci Pract* 161:238-249.

IBM SPSS AMOS 21.0 version (2012). Amos Development Corporation. Meadville, PA 16335 USA.

Lowe MR & Butryn ML (2007). Hedonic hunger: A new dimension of appetite? *Physiol Behav* 91:432-439.

Lowe MR, Butryn ML, Didie ER Annunziato RA, Thomas JG, Crerand CE, Ochner CN, Coletta MC, Bellace D, Wallaert M & Halford J (2009). The power of food scale. a new measure of the psychological influence of the food environment. *Appetite* 53:114-118.

Lowe MR & Levine AS (2005). Eating motives and the contoversy over dieting: eating less than needed versus less than wanted. *Obes Res* 13:797-805.

Mitchell TB, Cushing CC & Amaro CM (2016). Psychometric properties of the power of food scale in a community sample of preadolescents and adolescents. *J Child Fam Stud* 25:2733-2739.

Monteleone P, Scognamiglio P, Monteleone AM Perillo D, Canestrelli B & Maj M (2013). Gastroenteric hormone responses to hedonic eating in healthy humans. *Psychoneuroendocrinology* 38:1435-1441.

Ogden CL, Caroll MD, Kit BK & Flegal KM (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *JAMA* 311(8):806-814.

Osborne JW & Costello AB (2004). Sample size and subject to item ratio in principal components analysis. Pract Assess *Res & Eval* 9:1-9.

Schüz B, Schüz N & Ferguson SG (2015). It's the power of food: individual differences in food cue responsiveness and snacking in everyday life. *Int J Behav Nutr Phy* 12:149.

WHO (2015). World Heath Statistics. World Health Organization. From http://www.who.int/gho/publications/world_health_statistics/2015/en/ [Retrieved November 20 2017].

Appendix 1. Original and Turkish language items for the Power of Food Scale (PFS)

Item numbers	*Original English language items*	*Turkish language items*
PFS 1	I find myself thinking about food even when I am not physically hungry.	*Fiziksel olarak aç olmadığım zamanlarda bile kendimi yiyecek düşünürken buluyorum.*
PFS 2	I get more pleasure from eating than I do from almost anything else.	*Yemek yemek, başka bir şey yapmaktan daha çok zevk veriyor.*
PFS 3	If I see or smell a food I like, I get a powerful urge to have some.	*Sevdiğim bir yemeği gördüğüm ya da kokusunu aldığım zaman, biraz yemek için güçlü bir dürtü hissederim.*
PFS 4	When I'm around fattening food I love, it's hard to stop myself from at least tasting it.	*Bulunduğum ortamda sevdiğim yağlı/ şişmanlatıcı yiyecekler varsa, kendimi tadlarına bakmak için durdurmakta zorlanıyorum.*
PFS 5	It's scary to think of the power that food has over me.	*Besinlerin üzerimdeki gücünü düşünmek oldukça korkutucu*
PFS 6	When I know a delicious food is available, I can't help myself from thinking about having some.	*Lezzetli bir yemeğin hazırda var olduğunu bildiğimde, onu yeme konusunda kendime engel olamıyorum.*
PFS 7	I love the taste of certain foods so much that I can't avoid eating them even if they're bad for me.	*Bazı besinlerin tadını o kadar çok seviyorum ki, benim için zararlı olduklarını bilsem bile onları yemeyi bırakamıyorum*
PFS 8	Just before I taste a favorite food, I feel intense anticipation.	*Çok sevdiğim bir besini tatmadan önce, o besinle ilgili yoğun bir beklenti içerisine giriyorum*
PFS 9	When I eat delicious food I focus a lot on how good it tastes.	*Lezzetli bir yemek yediğimde, tadının ne kadar iyi olduğuna çok odaklanıyorum*
PFS 10	Sometimes, when I'm doing everyday activities, I get an urge to eat 'out of the blue' (for no apparent reason).	*Bazı zamanlarda, günlük aktiviteler yaparken, 'aniden' yemek yeme isteği duyuyorum (belirgin bir sebep yok iken).*
PFS 11	I think I enjoy eating, a lot more than most other people.	*Diğer insanlara göre yemek yemekten daha fazla zevk aldığımı düşünüyorum*
PFS 12	Hearing someone describe a great meal makes me really want to have something to eat.	*Biri bana çok güzel bir yemeği tarif ettiğinde, bir şeyler yeme isteği duyuyorum.*
PFS 13	It seems like I have food on my mind a lot.	*Aklımın sürekli yemekle meşgul olduğunu düşünüyorum.*
PFS 14	It's very important to me that the foods I eat are as delicious as possible.	*Yediğim besinlerin mümkün olduğunca lezzetli olması benim için çok önemlidir.*
PFS 15	Before I eat a favorite food my mouth tends to flood with saliva.	*Çok sevdiğim bir besini yemeden önce, ağzımın sulandığını hissediyorum*

Mal J Nutr 26(3): 379-388, 2020

Perspectives of Malaysian parents on eating out: A qualitative analysis

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ABSTRACT

Introduction: The culture of eating out among Malaysians has substantially increased in recent years due to the urbanisation of the society. Frequent eating out has been linked with reduced quality of diet, reduced intake of micronutrients, and increased weight gain. This study aims to explore specific factors on the perceptions and behaviours related to eating out from the perspective of parents. **Methods:** A qualitative study was carried out among 27 informants from various ethnicities and locations in Peninsular Malaysia. All sessions were audio-recorded, fully transcribed and analysed using thematic content analysis. **Results:** The main overarching theme that surfaced from this study was the role of parents in shaping the practice of eating out. Time constraints due to parents' work commitments, the availability of various food outlets, increase in family bonding time and food preferences were recurring themes revealed by informants as facilitating factors to eating out. Other emerging themes, such as hygiene of food premises and cost of food, posed as barriers to eating out. **Conclusion:** These findings offered a better understanding on the eating out practices of a family from the parents' perspective. Information as such could be incorporated in strategies to enhance the promotion of healthy eating and nutrition interventions that aim to inculcate healthy food choices while eating out.

Keywords: Eating out, parents, qualitative study, Malaysia

INTRODUCTION

The culture of eating out is emerging in Malaysia and has undergone a new dimension due to the urbanisation of the society in recent years. Economic growth and urbanisation have caused lifestyle changes among Malaysians where both parents have to work (Ali & Abdullah 2012). These lifestyle changes include a notable shift in eating culture and are linked to environmental changes such as the increasing number of food outlets in residential areas (Bodicoat *et al.*, 2015). Another noticeable change is the growth of fast food outlets that makes eating out affordable and convenient. This scenario results in numerous families spending more on eating out (Smith *et al.*, 2013).

Eating out is defined as any food or beverages prepared outside the family home. However, eating out does not include ready-to-eat meals purchased in a supermarket (Lake *et al.*, 2010).

Frequent eating out has been linked with a low-quality diet and weight gain problems (Adams *et al.*, 2015). Foods

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doi: https://doi.org/10.31246/mjn-2019-0137

consumed away from home are usually high in energy content, a factor that may significantly contribute to excessive energy intake, thereby potentially contributing to obesity (Zeng & Zeng, 2018). Moreover, eating out is also linked with low consumption of fruits and vegetables (Lachat *et al.*, 2012). Additionally, a study among children aged 2–18 years old in the United States found that fast food outlets contribute more to energy intakes than meals and snacks consumed in schools or day care centres (Powell & Nguyen, 2013). Therefore, eating out is associated with weight gain among the young generation (Adams *et al.*, 2015). Furthermore, individuals tend to consume more energy and larger portions with lesser vegetables and fruits while eating out (Vandevijvere *et al.*, 2019). Consequently, foods away from home also provide large adverse effects on diet quality and energy intake (Todd *et al.*, 2012). Therefore, individuals who frequently consume meals away from home are also susceptible to non-communicable diseases (Jilcott *et al.*, 2011).

To understand the eating out practices in a family, the Social Ecological Model (Kilanowski, 2017) illustrates the multilevel influence of individual, social and environmental factors. This study qualitatively explores specific factors on the perceptions and behaviours of parents related to eating out.

MATERIAL AND METHODS

This study was part of a larger research that focuses on four different target groups with different socio-economic backgrounds. In this study, we focused on parents with adolescents aged 13–17 years old. In-depth interviews guided by semi-structured questions were conducted with 27 parents from multiple locations. Such interviews allowed for in-depth data collection given that the interviewer could probe for explanations from respondents (Fusch & Ness, 2015). In addition, insights into the beliefs, attitudes and knowledge pertaining to the informants and their family's eating out experiences and its impact on their health were obtained.

The study was conducted to represent a broad range of population in Peninsular Malaysia, whereby the Northern and Eastern regions were conducted in Pokok Sena, Kedah and Dungun, Terengganu. States in the Central and Southern regions were conducted in Petaling Jaya, Selangor and Muar, Johor. The study population were selected through a purposive sampling method, with pre-set criteria identified. Access to parents was facilitated by the school teachers, then potential parents were identified by prospective informants via snowball sampling through their acquaintances.

Face-to-face in-depth interviews were conducted with each informant. The inclusion criteria were Malaysian citizens, having either one or more adolescent child(ren) and able to communicate either in English or Malay language (*Bahasa Melayu*). The interview process was carried out until the information reached a saturation point, whereby no new themes could be generated from the interview session.

Instrument

Prior to data collection, a research guide was developed to answer the objective of the study. It was based on the grounded theory approach (Charmaz, 2000) and explored the topic of investigation from the informants' perspectives while connecting surfacing findings to the Social Ecological Model. In addition, relevant literature search, the first writer's own experience with guidance from the other two writers and semi-structured interview methodology (Bernard, 2016) were used to construct the guide. The guide consisted of a list of questions with useful prompts to encourage informants to respond and provide an in-depth perspective during the interview session. The format

was a semi-structured research guide with primary and related questions to provide a consistent structure to the questions posed during the interview. The research guide is a mechanism for steering the discussion and enhancing the consistency of data collection. All questions were sequenced from general and comprehensive to specific. The research guide was used during all the interview sessions to ensure consistency in questions asked. However, the in-depth interview sessions were designed to be exploratory and relatively unstructured, allowing new ideas and interesting insights to be pursued (Bernard, 2016). Table 1 displays the primary questions from the research guide.

Study procedure

A pre-test on the research guide was conducted on three parents to assess the clarity of language, vocabulary and flow of questions. Afterwards, an improved research guide was developed. A pilot test was then conducted on five parents, both in Malay and English languages, to assess the content, estimation of time for each session and identify any practical problems with the responses. The research guide was revised on the basis of feedbacks given by the informants during the pilot study. All study methods and protocols were approved by the Universiti Kebangsaan Malaysia (UKM) Research Ethics Committee prior to study implementation. All informants were provided with a written informed consent form and a subject information sheet for participation and permission to be audio-taped prior to the commencement of the data collection session.

Data collection

In-depth interviews were conducted individually with informants. A short introduction was provided to explain the confidentiality of the study. Informants were notified that they were free to provide any ideas and feedbacks. Informants were also guaranteed that their information would be treated in a confidential manner, although an audio of each in-depth interview session was recorded for the purpose of analysis. The interview session took an average time of approximately 45 minutes to 1 hour to

Table 1. Research Guide with Primary Topics and Questions

Primary Topics	*Main Questions*
Introduction	Could you tell me your personal and family background? Do you mind sharing your family's eating pattern? Do you eat outside with your family? Where do you normally go when eating out?; Which type of eateries or restaurants?
Frequency	How frequent do you eat outside with your family members?
Cost	How much do you normally spend when eating out?
Food Choice	What do you think of the food choices available when eating out? How do you find food premises at your neighborhood areas? What do you think about the price and quality of food?
Reason for eating out	May I know the reasons of eating out?
Parents' Influences	How far does your role as a parent influences decision-making when eating out?
Barriers/Facilitators	What type of challenges do you face in practising healthy eating when eating out? Do you have any specific facilitators in eating out? What is your preference when eating out?

complete. The data collection was carried out from August to November 2016.

Data analysis

As part of the data analysis, the first writer transcribed all audio recordings to ensure that all sessions were translated into texts to enable systematic analysis (Creswell *et al.*, 2003). Then, the transcribed texts were analysed qualitatively using the inductive thematic analysis approach, Atlas.Ti, and coded via an open coding process. Similar and related themes, sub-themes and main domains were identified (summaries and emergent themes were generated on the basis of transcripts). Two independent reviewers performed content analysis to identify major themes using a combined deductive and inductive approach. To assure content validity within specific themes, inter-rater reliability tests were assessed and found to be acceptable with a Kappa score of 0.80.

RESULTS

Informants' characteristics

This study included a total of 27 informants, aged 43–52 years, and was entirely made up of women (100%). The majority of participants were Malay (81%), followed by Chinese (15%) and Indian (4%). In terms of locality, the informants came from both urban and rural areas. Most participants achieved at least secondary education. Table 2 presents the demographic characteristics of the informants.

Based on the analysed data, predominant perceptions that were derived were summarised under nine themes related to eating out. Each theme was described and representative quotes that illustrated these prevailing perceptions are reported in italics. Responses in local language were translated into English. Table 3 provides the primary answers representative of each theme.

Table 2. Characteristics of the informants

Characteristics	*n*	*%*
Age (years)		
40-49 years old	18	67
50 years old and above	9	33
Sex		
Female	27	100
Ethnicity		
Malay	22	81
Chinese	4	15
Indian	1	4
Locality		
Urban	14	52
Rural	13	48
Education level		
Secondary	6	22
Tertiary	21	78

Table 3. Themes and sub-themes of eating out

Theme	*Sub-themes*
Characteristic of eating out	Frequency of eating out Types of food outlets
Individual	Time scarcity‡ Food preferences‡ Cost of foods†
Social	Role of parents Family bonding time‡ Celebration/Rewards‡
Environmental	Availability of food premises‡ Accessibility to food sources‡ Hygiene of food premises†

†Barriers factors

‡Facilitating factors

Eating out characteristics

Frequency

Frequency refers to the number of visits to any food outlet. As noted by the informants, the frequency of eating out was based on family decision. Several

families frequently ate at food outlets whereas others frequently ate at home.

Hmmm… No, not frequently. If we can (eat out) once a month, that's considered a lot. (Informant 24, Mother)

Roughly four to five times in a month. (Informant 8, Mother)

I don't normally buy food outside. Will cook. (Informant 20, Mother)

Types of food outlets

In general, informants revealed that they have access to various types of food outlets in their neighbourhood, which included fast food outlets, food stalls and restaurants.

Sometimes Chinese restaurant, (sometimes) Thai restaurant… because we can choose what we want to order. (Informant 24, Mother)

I can say that we often go to fast food outlets and the restaurants by the roadside. (Informant 21, Mother)

We seldom go to hawker stalls. But sometimes, (we'll go because) we want to introduce variety of foods (to the children) with different environment so that they will experience eating at places without air-conditioning. (Informant 27, Mother)

Factors influencing the practice of eating out

Multifaceted themes regarding eating out behaviour from the perspective of parents were identified based on the Social Ecological Model. The themes could be categorised under different factors, such as individual, social and environmental. Based on the findings of the study, the themes were then classified as facilitators and barriers for eating out practice.

Parents' role

Parents play a vital role in the eating out behaviour of family members. The majority of informants said that they were aware of their role in determining the food intake and physical development of their children.

Normally, when they want to eat pizza, instead of taking them out, I'll try to make it myself. (Informant 26, Mother)

Yes, that's quite often. Sometimes pizza, sometimes KFC. The children will request for it. But it's up to us whether or not to take them there. (Informant 21, Mother)

So…the food that I decide to buy, the food I bring back home, that's my decision. You are what you eat... (Informant 27, Mother)

Time scarcity

Most of the informants highlighted time scarcity due to work commitments as a facilitating factor to eating out. Most parents reported that they did not have the time to prepare food at home for their family.

When both of us are working… coincidentally I go back late…and my husband as well. So there's not enough time to prepare food at home. (Informant 18, Mother)

Usually when busy working… not enough time to prepare. (Informant 9, Mother)

Yes, time and commitment. When I reach home, it's already 4pm... sometimes it's 5pm. So we are too tired then. (Informant 21, Mother)

Food preferences

Food preferences vary between individuals. One facilitating factor influencing the practice of eating out is the accessibility to different types of foods. In addition, some families might want to try new food choices away from home.

> *Yes, we normally go to western food due to their (children) preference. (Informant 8, Mother)*

> *Sometimes we will give the kids fast food, even though we know it's not really healthy…but since the kids requested…and we also feel like having it as well… (Informant 18, Mother)*

> *And my children always want to try new food. (Informant, 20, Mother)*

Family/Bonding time

Another facilitating factor to eating out is the parents' desire to spend quality time with their children. Many informants highlighted the fact that eating outside was also considered as family time. Parents reported that they preferred eating away from home because everyone could order what they wanted to eat.

> *Normally on weekend, we can all go together and I can rest… because on weekdays, everybody is busy. Rushing for tuition and to do this and that, and it's very jam-packed to go out. (Informant 8, Mother)*

> *My husband always says that we often gather together on Sundays…so we'll eat outside. When the children comes back from the boarding school, if we can't have breakfast together, probably we can do lunch instead. (Informant 11, Mother)*

Celebration/Rewards

Family events, such as personal achievements, birthdays and other special occasions were identified as a facilitator to eating out as family members can celebrate together at the food outlet.

> *Sometimes we celebrate (the children's) birthdays outside… or if there's any occasions. (Informant 4, Mother)*

> *I want to show my appreciation to them. So I will let them choose whatever (food) they want. (Informant 28, Mother)*

> *Sometimes when there are visitors coming over, like relatives. Then we'll go out for meals. (Informant 24, Mother)*

Availability

Informants also reported that environmental factors, such as the availability of various types of food premises around the neighbourhood as a facilitating factor to eating out.

> *…the environment made it easy for the kids to notice the shops, the fast food outlets and the newly opened restaurants. So there are many types of foods nowadays. (Informant 20, Mother)*

Accessibility

Several informants reported that accessibility to various food sources helped them to have more options or alternative food types. In fact, a cluster of services provided by food outlets such as drive-through, extended operation hours and delivery services encouraged them to eat out.

… just close to my house… and there are even a few more (outlets) in this district (Informant 5, Mother)

Yes…because it's more convenient due to its operation hours. (Informant 24, Mother)

But now they have delivery services. So, if we don't (want to) go out, sometimes we'll just order delivery…whenever we don't feel like having rice. (Informant 20, Mother)

Cost

Informants reported that cost was a significant barrier to eating out. Majority admitted that the cost of eating out was higher as compared to eating at home. For informants with many members in their household, eating out incurred higher costs and thus demotivated them from such practice.

Actually, it's not worth it. Normally when eating out, I'll say, 'with RM100…I can buy raw ingredients such as fresh meat, seafood…and cook (for the family) for a week'. (Informant 4, Mother)

I don't normally…we don't really (eat out). We don't spend a lot… because if we feel like eating seafood such as lobsters or crabs… because we are quite a big family… we are aware that eating out will be expensive. So, we will end up ordering just fish and omelette. (Informant 12, Mother)

Too expensive. (Informant 19, Mother)

Hygiene

A few informants were concerned with the hygiene of the premises while eating out. Outlets with poor hygiene practices became one of the barriers to eating out. Although most of the parents preferred to patron food outlets with good hygiene practices, sometimes these were hard to find.

…we normally prefer the restaurants that are clean, but there are not many options. (Informant 24, Mother)

Eating at home will be healthier, right? But when we eat outside, I can't dictate the cleanliness of the food. (Informant 14, Mother)

DISCUSSION

This study investigated the factors that influenced family members to eat out, based on the parents' perspective. The results revealed that eating out is an alternative to preparing food at home. Majority of the informants practised this eating behaviour frequently, at least once a month. Parallel to family practices, eating out was considered part of a family's activity regardless of locality (urban or rural) and socio-economic background of informants. However, those residing in urban areas were found to eat out more frequently than those in rural areas. The findings were generally aligned with studies carried out by Cynthia *et al.* (2013) and Ali & Abdullah (2012), who reported that Malaysians, especially those in urban areas, opt for fast and easy meals to suit their hectic lifestyle. In contradiction, a study in the United States showed that eating out practices were more common among the lower socio-economic group and minority populations located in the sub-urban areas (Nguyen & Powell, 2003).

An overarching theme that surfaced was about the fundamental role parents play in the choices and purchases of foods when eating out. Parental behaviours are crucial in stimulating healthy eating

practices in their children. This was in line with earlier findings by Kasparian *et al.* (2017) where parents play a significant role in their family's eating out practices and also decide whether to facilitate or discourage eating out. Another study carried out in Melbourne and Geelong, Australia, revealed that parents are likely to be essential mediators of fast food consumption (Timperio *et al.*, 2009). As a result, parents can influence their children's eating behaviour through specific feeding practices and parenting style.

Besides, this study highlighted various factors that facilitated and hindered the habit of eating out in a family. The facilitating factors were time constraints, food preferences, bonding time among family members, and the availability and accessibility of food outlets. One factor that was largely responsible for eating out practices was time constraint due to parents' work commitments and having no time to prepare food for other family members. This was similar to other study carried by Mancino *et al.* (2009), which showed a positive relationship between a woman's opportunity and cost of time, whereby working mothers have limited time to prepare food for the family.

From the findings, informants also reported that the food preferences of their children played a role in facilitating eating out. A revolution on consumer tastes, especially in children, has been observed. Cooking programmes, overseas travel, and growing cultural and ethnic diversity (Habib *et al.*, 2011) have broadened the experience of eating out by wanting to explore new cuisines, which can often be found outside of home.

The perception of eating out as a treat was one of the most frequently mentioned factors by parents, which aligned with the study of Eck *et al.* (2019). Several informants mentioned that important family events, such as birthday celebrations, served as treats or rewards for their children. All these celebrations were identified as another factor encouraging eating out practices in families (Anderson, 2002).

As noted by the informants, the availability of food premises led to more food options on offer, which encouraged the behaviour of eating out. Food premises can range from street stalls to fast food outlets and other restaurants. This might be due to the improved socio-economic status of Malaysians, which has encouraged the mushrooming of food outlets in the neighbourhood. In addition, the increased number of food premises and fast food outlets near residential areas provided accessibility and convenience to the informants (Belon *et al.*, 2016). Day & Pearce (2011) reported that easy access to food outlets within the neighbourhood increasingly facilitate eating out. The findings also revealed that delivery services from nearby restaurants and fast food outlets provided motivation for informants to eat out. This is parallel with Xin (2016), who reported that the commercial foodservice industry now provide extra services and facilities to its customer. Therefore, the close distance between home and food outlets, coupled with delivery services, increased the accessibility of eating out practices.

Meanwhile, this study has also identified barriers to eating out. These barriers included the cost of foods and hygiene of food premises. Informants mentioned that foods prepared outside of home were more costly compared with home-cooked foods. They perceived that eating out was costly, particularly for those with many family members. Therefore, the cost of foods was one of the crucial factors to consider when eating out. This finding supported the studies by Scozzafava (2017), which revealed that the price of foods, coupled with the quality of service, was the most important element in eating out. Furthermore, other informants claimed that eating at home was associated with

cost effectiveness and also inculcated healthy eating practices because they can choose the ingredients for their foods. Nearly all informants identified hygiene standard of food outlets as a deterrent. Prentice (2003) revealed that foods outside of homes might be associated with poor hygiene during preparation, storage and handling that may lead to diseases.

The present study has several limitations which should be noted. Firstly, this qualitative study was solely dependent on self-reporting, which might not reflect the actual scenario of eating out practices among Malaysian parents. In addition, as the current study only involved female parents, the results are not generalisable to male parents.

Despite these limitations, this study represented parents of adolescents from multi-socioeconomic backgrounds and from various locations. Therefore, the results have established the eating out practices among parents from different backgrounds. Also, the in-depth interview approach provided factors related to eating out as perceived by parents, thus would be useful to the uptake of targeted interventions or evidence-based guidelines. These insights and contributions might help to employ a quantitative method in measuring the constructs revealed by the respondents of this study.

CONCLUSION

In conclusion, numerous factors influenced the family practice of eating out. The facilitating factors included time constraint, availability and accessibility of food outlets, family bonding time and food choices or preferences. The two barriers to eating out were hygiene and cost. The results of our study showed that the facilitating factors of eating out appeared to be stronger than the barriers, as mentioned by the informants. Therefore, informants' feedbacks provided essential input for further studies to understand the eating practices of family members and inculcate healthy practices when eating out.

Acknowledgement

We would like to express our sincerest gratitude to all respondents who have voluntarily participated in this study.

Authors' contributions

SAG, substantial contributions to conception and design, data acquisition, analysis and/or interpretation; and drafting the article or revising it critically for important intellectual content; RAT, final approval of the version to be published**;** NAK, final approval of the version to be published**.**

Conflict of interest

The authors declare that there was no conflict of interest in the publication of this paper.

References

Adams J, Goffe L, Brown T, Lake AA, Summerbell C, White M, Wrieden W & Adamson AJ (2015). Frequency and socio-demographic correlates of eating meals out and take-away meals at home: cross-sectional analysis of the UK national diet and nutrition survey, waves 1-4 (2008-12). *Int J Behav Nutr 12:51.* doi:10.1186/s12966-015-0210-8.

Ali N & Abdullah M (2012). The food consumption and eating behaviour of Malaysian urbanites. issues and concerns. *Malays J Soc Space* 3(1):44–53.

Anderson A (2002). Alan Warde & Lydia Martens: Eating out: social differentiation, consumption and pleasure. *J Consum Policy* 25(3–4):457–460. doi:10.1023/A:1020373609615.

Belon AP, Nieuwendyk LM, Vallianatos H & Nykiforuk CIJ (2016). Perceived community environmental influences on eating behaviors: A Photovoice analysis. *Soc Sci Med* 171:18–29. doi:10.1016/j.socscimed.2016.11.004.

Bernard HR, Wutich A & Ryan GW (2016). *Analyzing qualitative data: Systematic approaches.* SAGE publications.

Bodicoat DH, Carter P, Comber A, Edwardson C, Gray LJ, Hill S, Webb D, Yates T, Davies MJ & Khunti K (2015). Is the number of fast-food outlets in the neighbourhood related to screen-detected type 2 diabetes mellitus and associated risk factors? *Public Health Nutr.* 18(9):1698-705. doi:10.1017/S1368980014002316.

Charmaz K (2000). Grounded theory: Objectivist and constructivist methods. *Handbook of qualitative research*. Sage Publications, Inc.

Creswell JW, Plano Clark VL, Gutman ML & Hanson EW (2003). Advanced Mixed Methods Research Designs. In VL Plano Clark & JW Creswell (eds.). *The Mixed Methods Reader* (pp.159–196). SAGE Publications, California.

Cynthia J, Zalilah MS & Lim MY (2013). Relationship between family meals away from home and nutritional status of adolescents. *Mal J Nutr* 19(1):25-35.

Day PL & Pearce J (2011). Obesity-promoting food environments and the spatial clustering of food outlets around schools. *Am J Prev Med* 40(2):113–121.

Eck KM, Delaney C, Olfert MD, Hagedorn RL, Leary MP, Santella ME, Clark RL, Famodu OA, Shelnutt KP & Byrd-Bredbenner C (2019). Parents' and kids' eating away from home cognitions. *Brit Food J* 121(5):1168–1182. doi:10.1108/BFJ-07-2018-0431.

Fusch PI & Ness LR (2015). Are we there yet? Data saturation in qualitative research. *The Qualitative Report* 20(9):1408–1416.

Habib FQ, Abu Dardak R & Zakaria S (2011). Consumers' preference and consumption towards fast food: Evidences from Malaysia. *Business Management Quarterly Review* 2(1): 14–27.

Jilcott SB, Wade S, McGuirt JT, Wu Q, Lazorick S & Moore JB (2011). The association between the food environment and weight status among eastern North Carolina youth. *Public Health Nutr* 14(09):1610–1617. doi:10.1017/S1368980011000668.

Kasparian M, Mann G, Serrano EL & Farris AR (2017). Parenting practices toward food and children's behavior: Eating away from home versus at home. *Appetite* 114:194–199. doi:10.1016/j.appet.2017.03.045.

Kilanowski JF (2017). Breadth of the Socio-Ecological Model. *J Agromedicine* 22(4):295–297. doi:10.1080/1059924X.2017.1358971.

Lachat C, Nago E, Verstraeten R, Roberfroid D, Van Camp J & Kolsteren P (2012). Eating out of home and its association with dietary intake: a systematic review of the evidence. *Obes Rev* 13(4):329–46. doi:10.1111/j.1467-789X.2011.00953.x.

Lake AA, Burgoine T, Greenhalgh F, Stamp E & Tyrrell R (2010). The foodscape: Classification and field validation of secondary data sources. *Health Place* 16(4):666–673.

Mancino L, Todd J & Lin B (2009). Separating what we eat from where : Measuring the effect of food away from home on diet quality. *Food Policy* 34(6):557–562. doi:10.1016/j.foodpol.2009.09.003.

Nguyen BT & Powell LM (2003). The impact of restaurant consumption among US adults: effects on energy and nutrient intakes. *Public Health Nutr* (11):2445–2452. doi:10.1017/S1368980014001153.

Powell LM & Nguyen BT (2013). Fast-food and full-service restaurant consumption among children and adolescents: effect on energy, beverage, and nutrient intake. *JAMA Pediatrics* 167(1):14-20. doi:10.1001/jamapediatrics.2013.417.

Prentice AM & Jebb SA (2003). Fast foods, energy density and obesity: a possible mechanistic link. *Obesity reviews* 4(4):187-194.

Scozzafava G, Contini C, Romano C & Casini L (2017). Eating out: which restaurant to choose? *British Food Journal*.

Smith D, Cummins S, Clark C & Stansfeld S (2013). Does the local food environment around schools affect diet? Longitudinal associations in adolescents attending secondary schools in East London. *BMC Public Health* 13(1):70. doi:10.1186/1471-2458-13-70.

Timperio AF, Ball K, Roberts R, Andrianopoulos N & Crawford DA (2009). Childrens takeaway and fast-food intakes: Associations with the neighbourhood food environment. *Public Health Nutr* 12(10):1960–1964. doi:10.1017/S1368980009004959.

Todd JE, Mancino L & Lin B-H (2012). The Impact of Food Away from Home on Adult Diet Quality. USDA-ERS Economic Research Report Paper No. 90. doi:10.2139/ssrn.1557129.

Vandevijvere S, Lachat C, Kolsteren P & Van Oyen H (2019). Eating out of home in Belgium: current situation and policy implications. *Br J Nutr* 102:921–928. doi:10.1017/S0007114509311745.

Worsfold D & Worsfold PM (2007). How clean is that cafe? Online hygiene inspection reports for consumers. *J Foodservice* 18(3):93–100. doi:10.1111/j.1745-4506.2007.00051.x.

Xin W (2016). *Strategic Marketing Management of Food Delivery*. Bachelor's Thesis. HAMK University of Applied Sciences, Finland.

Zeng Q & Zeng Y (2018). Eating out and getting fat? A comparative study between urban and rural China. *Appetite* 120:409-415. doi:10.1016/j.appet.2017.09.027.

Mal J Nutr 26(3): 389-399, 2020

Effects of repeated deep-frying on fatty acid profiles of potato fries and frying oils: soybean oil, canola oil and their 1:1 blend

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ABSTRACT

Introduction: This study looked at the fatty acid composition changes in potato fries fried in three different types of oils, namely soybean oil (SO), canola oil (CO), and a 1:1 blend of soybean oil and canola oil (SCO), throughout an intermittent frying process of 80 batches in five consecutive days. The study also examined the fatty acid composition changes in SO, CO and SCO during the frying process. **Methods:** Fat from potato fries (extracted by Soxtec system) and oil samples from the corresponding frying oil were analysed by gas chromatography-mass spectrometer (GC-MS) to examine the fatty acid profile changes during the deep-frying process. **Results:** Linoleic acid (LA) and α-linolenic acid (ALA) in all three oils decreased, while oleic acid (C18:1), stearic acid (C18:0), palmitic acid (C16:0) and octanoic acid (C8:0) increased. Formation of C18:1 *trans* fatty acid was observed as the frying time increased. The fatty acid composition of the potato fries was consistent with the fatty acid composition of the corresponding frying oils. **Conclusion:** Our results showed that blending soybean oil and canola oil did not significantly improve the frying stability of the resulting oil in terms of fatty acid profile. Due to the formation of *trans* fatty acids and the decrease in polyunsaturated fatty acids, our study also recommends not to use the same frying oil repeatedly and not to consume food products cooked in reused oil.

Keywords: Deep frying, reused oil, fatty acid, potatoes

INTRODUCTION

It has been reported that long chain omega-3 polyunsaturated fatty acids (PUFAs), including α-linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) are important to help protect against cardiovascular disease (CVD), neurodegeneration, and inflammation (Calder, 2006; Rajaram, 2014). Consumption of dietary omega-3 PUFAs is necessary, as the human body requires them for good health. While EPA and DHA are obtained largely from marine-based food, ALA is found mainly in plant oils such as flaxseed, soybean oil (SO), and canola oil (CO).

Since oil is an excellent medium for heat transfer, food is swiftly cooked

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doi: https://doi.org/10.31246/mjn-2020-0011

when it is plunged into oil (Alvis *et al.*, 2009). However, during the deep-frying process, multiple complex reactions, including oxidation, polymerisation, and hydrolysis occur in the frying oil and its fried product (Choe & Min, 2007). As a result, components such as free fatty acids and *trans* isomers are formed. *Trans* fatty acids are known to have detrimental effects on health such as increased levels of low density lipoprotein cholesterol (LDL-C) and increased risk of atherosclerosis (Han *et al.*, 2002). Additionally, in the fast-food industry, a batch of frying oil is repeatedly reused for up to 1 to 4 days, depending on the hours of operation (Phiri, Mumba & Mangwera, 2006). Monitoring of the frying performance of frying oils is therefore very important for human health and nutrition.

Soybean oil contains a high percentage of PUFAs (e.g. LA and ALA), which are of significant dietary importance. Gerde *et al.* (2007) observed that both LA and ALA in SO decreased after using the same oil to deep fry potato fries for 23 days. To minimise the undesired degradation compounds and/or to maintain the quality of the fried products, oils that consist mostly of SFAs and MUFAs are normally chosen for deep frying (Choe & Min, 2007). Canola is one of the five major oilseeds produced in the world (Gunstone, 2002) and the fatty acid composition of CO makes it one of the most ideal vegetable oil in terms of imparting health benefits. CO has a high percentage of monounsaturated fatty acids (MUFAs), which has higher thermal oxidative stability than PUFAs. However, a study has shown that repeated usage of CO for deep-frying purposes reduced the amount of MUFAs (Santos *et al.*, 2018).

To improve frying stability, new techniques such as oil blending, hermetic frying, and addition of antioxidants into oil (Aladedunye & Przybylski, 2009b; Aydeniz & Yilmaz, 2016; Choe & Min, 2007) have been developed in recent years. Studies have shown that blending PUFA oils with SFA or MUFA oils improved the oil stability of PUFA oils (Bhatnagar *et al.*, 2009; Hashempour-Baltork *et al.*, 2016; Serjouie *et al.*, 2010). Hence, blending two oils together might produce an end-product that has high nutritional value and oxidative stability. Farhoosh, Kenari & Poorazrang (2009) showed that blending CO with other oils such as palm oil, corn oil and olive oil improved the frying stability of CO.

During deep frying of potato fries, a mass transfer between the potato fries and the oil would occur (Dobarganes, Márquez-Ruiz & Velasco, 2000). There would be oil absorption and water loss from the potato fries. Since the potato fries would be consumed, it would be of interest to look at its fatty acid composition. Therefore, the aim of the present study was to examine: (1) the fatty acid composition changes of SO, CO, and a 1:1 blend of soybean oil and canola oil (SCO) throughout an intermittent frying process of 80 batches in five days, (2) the fatty acid composition changes in the potato fries fried in these three different types of oil.

MATERIALS AND METHODS

Preparation of standard solutions for gas chromatography-mass spectrometer (GC-MS) analysis

The internal standard solution was prepared by dissolving 200 mg of methyl undecanoate (C11:0 FAME, Sigma Aldrich, Singapore) in 1 mL of n-hexane. The Fatty Acid Methyl Esters (FAMEs) calibration standard solution was prepared by dissolving 40 mg of calibration standard (GLC 603B, Nu-Chek-Prep, USA) in 1 mL of n-hexane.

Frying protocol

The frying protocol involved intermittent

Table 1. Fatty acid composition (%) of Soybean Oil (SO), Canola Oil (CO) and Soybean-Canola Oil (SCO)

Type of oil	*Fatty acids*	*Time (h)*					
		0.0	*0.8*	*1.6*	*2.4*	*3.2*	*4.0*
SO	C8:0	0.00	0.04	0.10	0.14	0.19	0.21
	C14:0	0.10	0.10	0.12	0.11	0.11	0.12
	C16:0	13.2	13.4	13.7	16.2	15.1	14.4
	C16:1	0.09	0.10	0.10	0.12	0.10	0.11
	C17:0	0.12	0.12	0.12	0.13	0.12	0.13
	C18:0	5.65	5.81	5.97	6.00	6.05	6.29
	C18:1t	0.00	0.00	0.00	0.07	0.08	0.10
	C18:1	25.2	25.5	25.9	25.7	26.2	26.4
	C18:2	46.3	45.8	45.1	43.1	43.7	43.9
	C20:0	0.47	0.49	0.51	0.52	0.52	0.57
	C18:3	7.87	7.63	7.28	6.86	6.55	6.55
	C20:1	0.24	0.28	0.29	0.29	0.28	0.31
	C22:0	0.48	0.49	0.51	0.52	0.52	0.60
	C24:0	0.14	0.13	0.16	0.17	0.25	0.18
CO	C8:0	0.00	0.02	0.06	0.08	0.11	0.14
	C16:0	6.15	6.21	6.32	6.27	6.38	6.41
	C16:1	0.26	0.26	0.27	0.26	0.26	0.27
	C18:0	2.52	2.55	2.61	2.59	2.66	2.65
	C18:1t	0.00	0.00	0.09	0.12	0.17	0.18
	C18:1	58.2	58.8	59.4	60.4	60.6	61.2
	C18:2	21.3	21.0	20.5	20.1	19.8	19.5
	C20:0	0.86	0.87	0.90	0.89	0.92	0.91
	C18:3	8.13	7.67	7.19	6.68	6.40	6.05
	C20:1	1.75	1.77	1.80	1.76	1.80	1.77
	C22:0	0.34	0.35	0.37	0.37	0.39	0.39
	C22:1	0.16	0.16	0.16	0.16	0.17	0.17
	C24:0	0.11	0.12	0.14	0.14	0.15	0.15
SCO	C8:0	0.00	0.05	0.08	0.11	0.15	0.17
	C16:0	9.81	10.0	10.2	10.7	10.9	10.6
	C16:1	0.16	0.18	0.18	0.18	0.19	0.17
	C18:0	4.12	4.26	4.37	4.30	4.48	4.56
	C18:1t	0.00	0.00	0.09	0.11	0.12	0.15
	C18:1	40.7	41.7	42.2	42.6	42.7	43.1
	C18:2	35.0	34.2	33.6	33.2	32.7	32.6
	C20:0	0.63	0.68	0.71	0.69	0.75	0.76
	C18:3	8.06	7.30	6.90	6.44	6.30	6.14
	C20:1	0.85	0.90	0.91	0.90	0.94	0.98
	C22:0	0.39	0.41	0.42	0.42	0.44	0.47
	C24:0	0.13	0.13	0.13	0.14	0.15	0.16

frying of 80 batches of fries over five days. Fresh U.S. Russet potatoes (FairPrice NTUC, Singapore) were peeled and cut into equal lengths of 60 to 70 mm, with an equal width and height of 12 mm. 5 L of each type of oil, namely SO, CO and SCO, was used for frying. For SCO, 2.5 L of SO and 2.5 L of CO were mixed together before frying. Potato fries were fried in 100 g batches at 180°C for 3 min. Batches of fries were fried at 10-min intervals and 16 batches were processed per day for five consecutive days. Oil samples were taken on the first day before frying and after every four batches of frying. At the end of each day, the fryer was turned off and the oil was cooled to room temperature.

Lipid extraction

Lipid in the potato fries was extracted with petroleum spirit (40°C - 60°C) using the Soxtec 2055 system (FOSS, Denmark). The extraction method used in this study was adapted and modified from Matsler & Siebenmorgen (2005). 5 g of each sample was weighed into the cellulose thimbles and a thin layer of defatted cotton was placed on top of the sample. The thimbles containing the samples were then placed in the oven at 103 ± 2°C for 2 h. Next, the thimbles were placed into the Soxtec system and the extraction cups were placed beneath the thimbles. The Soxtec extraction programme consisted of four steps, which were boiling, rinsing, recovery and pre-drying. Firstly, the samples were immersed in boiling petroleum spirit for 30 min and then rinsed for 40 min. Next, there was a recovery stage of 10 min, followed by pre-drying for 5 min. The hotplate temperature was held at 135°C throughout the four stages. After extraction, the cups were dried at 103 ± 2°C for 30 min and then placed in the dessicator. The fat obtained from each sample was stored at -20°C until further analysis.

Determination of fatty acid composition

Determination of fatty acid composition was based on an application note by Agilent (Juskelis *et al.*, 2014). Oil samples were diluted in a 1:1 ratio with hexane. 10 μL of the 1:1 mixture and 3.3 μL of internal standard (200 mg/mL) were added into a gas chromatography (GC) vial. Next, the GC vial was placed on the sample tray of the GC autosampler. Derivatisation of fatty acids was performed on the Agilent Sample Prep WorkBench and the steps for the derivatisation were as follows: Firstly, 120 μL of 2N sodium hydroxide (NaOH) in methanol was added to the vial and mixed for 20 s at 1500 rpm. Then, the vial was transferred to the heater at 70°C for 5 min. Samples were allowed to cool for 5 min before 240 μL of 12.5% boron trifluoride (BF_3) in methanol was added. The vial was mixed for 20 s at 1500 rpm and transferred to the heater at 70°C for 5 min. Samples were allowed to cool for 5 min before 300 μL of water and 300 μL of hexane were added. The vial was mixed for 20 s at 1500 rpm and the top layer (1 μL) was injected into the GC-MS.

GC-MS analysis

The analysis was performed using a 7890B GC system (Agilent Technologies, USA) coupled with the MS detector with MSD ChemStation software. The GC-MS parameters were adapted from Agilent (Juskelis *et al.*, 2014). The separation of the different fatty acid methyl esters was performed on a HP-88 column (60 m × 0.25 mm, 0.20 μm, Agilent Technologies, USA). A split injector at 250°C and a spilt ratio of 50:1 was used. The oven temperature programme was isothermal at 140°C for 5 min. The temperature was increased to 240°C at a rate of 4°C/min and maintained for 0 min. Helium was used as the carrier gas under a constant flow mode at 1 mL/min. The MS detector was at 280°C and a scan acquisition

mode of 40 to 500 AMU was used. The FAMEs were identified by comparing their retention times and mass spectrum with the calibration standards. In this study, peaks that cannot be identified were not considered in the calculation of the percentage of fatty acids.

RESULTS

The fatty acid profile of SO before frying is shown in Table 1. The major fatty acids in SO included C16:0 (palmitic acid or PA, 13.21%), C18:0 (stearic acid or SA, 5.65%), C18:1 (oleic acid or OA, 25.23%), C18:2 (LA, 46.28%) and C18:3 (ALA, 7.87%). No *trans* fatty acid (C18:1t) was observed in pure SO. As seen from Table 1, changes in the fatty acid composition profile of SO were observed during continuous frying process. It was noticed that the levels of C18:2 (LA) and C18:3 (ALA) in frying oil decreased, while the levels of other fatty acids increased with frying time. At the end of 4-h frying, the levels of LA and ALA decreased by 2.39% and 1.32%, respectively. Similarly, as shown in Table 1, the most abundant fatty acid in CO was C18:1 (OA, 58.23%). Other major fatty acids included C16 (PA, 6.15%), C18 (SA, 2.52%), C18:2 (LA, 21.29%) and C18:3 (ALA, 8.13%). Similar to SO, deep-frying potatoes in CO led to the decrease of LA and ALA, but to an increase of other fatty acids. At the end of 4h frying, the levels of LA and ALA decreased by 1.84% and 2.08%, respectively. When SO and CO was blended (SCO, v/v = 1:1), Table 1 shows that the main fatty acids in SCO were OA (40.69%) and LA (34.95%). At the end of 4h frying, the levels of LA and ALA decreased by 2.39% and 1.92%, respectively. On the other hand, the contents of *trans* fatty acid (C18:1t) increased by 0.10%, 0.18%, and 0.15% during frying time in SO, CO, and SCO, respectively.

To evaluate the kinetic rate for LA and ALA degradation, the levels of LA and ALA at different frying time in SO are shown in Figures 1a and 1b, respectively. In this system, the decrease of LA can be described by:

$$r = -\frac{d[LA]}{dt} = k[LA]^n$$

where k is the rate constant or rate coefficient and n is the reaction order.

Figure 1a shows that $[LA] = 45.805 - 0.5694 \times t$.

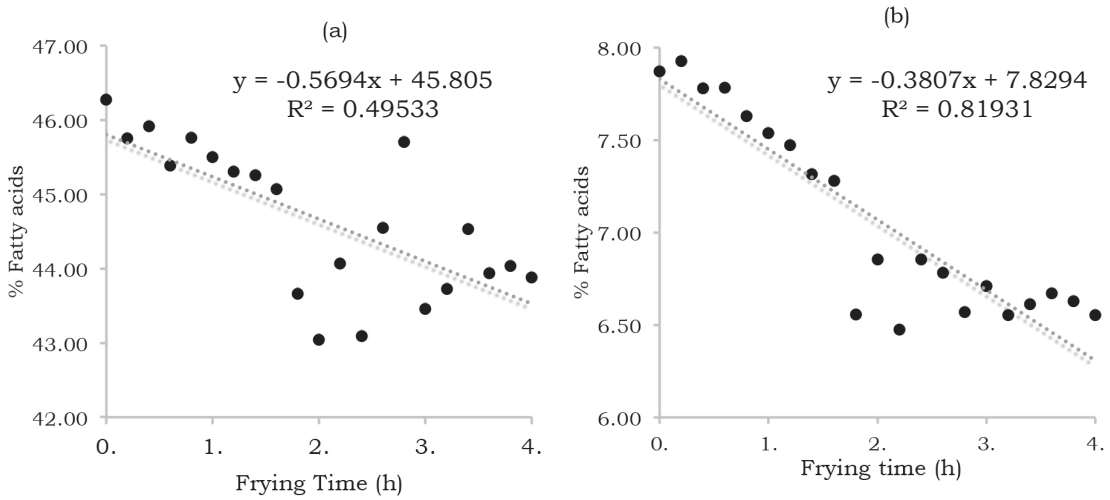

Figure 1(a) Changes in LA with frying time for SO;(b) Changes in ALA with frying time for SO

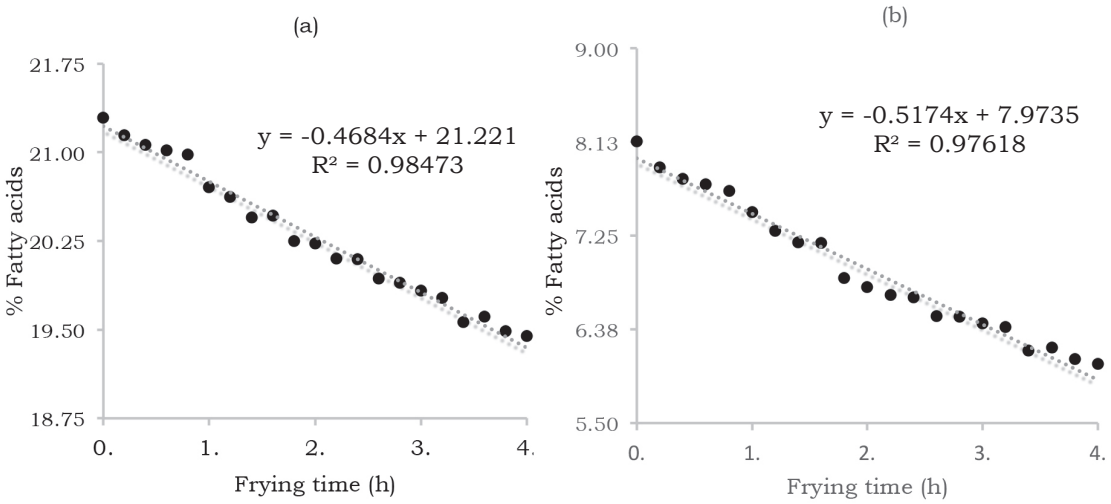

Figure 2(a) Changes in LA with frying time for CO; (b) Changes in ALA with frying time for CO

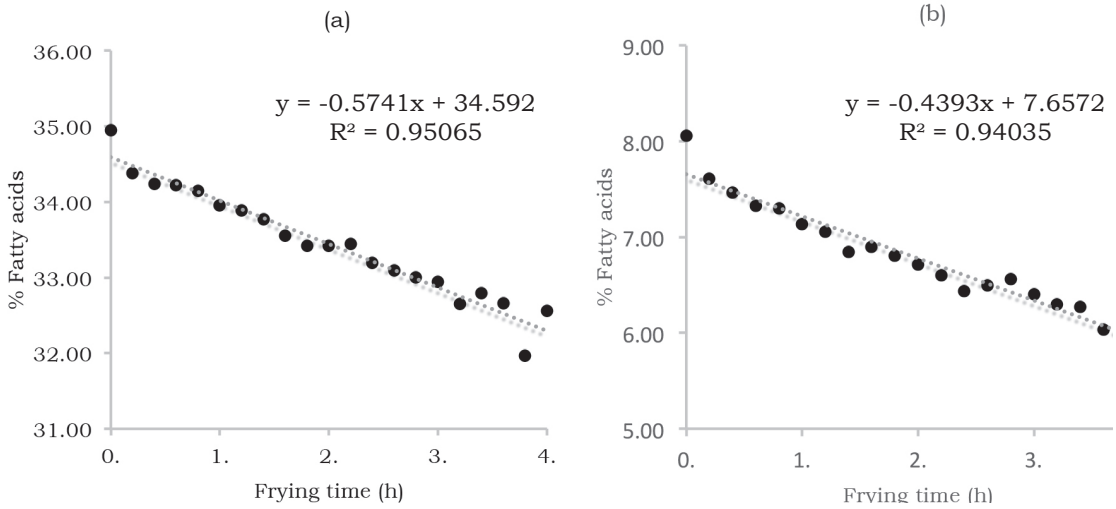

Figure 3(a) Changes in LA with frying time for SCO; (b) Changes in ALA with frying time for SCO

Therefore, the degradation of LA during deep-frying is a pseudo-zero-order reaction with a reaction constant of 0.569 h^{-1}. Similar reaction orders were observed for LA in the other two oils (Figures 2a and 3a), as well as ALA in all three oils (Figures 1b, 2b, and 3b). Based on the reaction orders, the half-life of LA and ALA, which is the time needed for the percentage of LA and ALA in the oil to decrease to half of its original value, was calculated. For SO, it would take 40.2 h for LA and 10.3 h for ALA, respectively to decrease to half of their original values. While for CO, it would take 22.7 h and 7.7 h for LA and ALA, respectively to decrease to half of their original values. In SCO, the half-life of LA and ALA were 30.1 h and 8.7 h, respectively.

Fatty acid compositions and *trans* fatty acid contents of potato fries fried in

Table 2. Fatty acid composition (%) of potato fries fried in Soybean Oil (SO), Canola Oil (CO) and Soybean-Canola Oil (SCO)

Type of oil	*Fatty acids*	*Time (h)*				
		0.8	*1.6*	*2.4*	*3.2*	*4.0*
SO	C8:0	0.06	0.09	0.17	0.21	0.25
	C14:0	0.10	0.11	0.12	0.13	0.13
	C16:0	13.7	14.0	15.3	15.7	15.8
	C16:1	0.10	0.09	0.12	0.12	0.12
	C17:0	0.11	0.12	0.13	0.14	0.14
	C18:0	5.57	6.00	6.86	6.72	6.89
	C18:1t	0.00	0.00	0.07	0.09	0.10
	C18:1	25.8	26.0	28.1	27.8	28.1
	C18:2	46.7	45.0	41.9	41.5	41.2
	C20:0	0.45	0.51	0.58	0.61	0.61
	C18:3	6.62	7.15	5.48	5.71	5.37
	C20:1	0.23	0.27	0.31	0.31	0.33
	C22:0	0.43	0.55	0.63	0.57	0.66
	C24:0	0.13	0.14	0.18	0.20	0.19
CO	C8:0	0.04	0.06	0.09	0.11	0.15
	C16:0	7.14	6.20	6.72	6.68	6.73
	C16:1	0.27	0.25	0.29	0.28	0.26
	C18:0	2.74	2.58	2.84	2.81	2.77
	C18:1t	0.00	0.08	0.12	0.15	0.16
	C18:1	59.4	59.4	60.4	60.9	62.0
	C18:2	20.2	20.8	19.6	19.5	19.0
	C20:0	0.87	0.87	0.94	0.92	0.89
	C18:3	6.71	7.14	6.12	5.92	5.37
	C20:1	1.75	1.73	1.84	1.82	1.77
	C22:0	0.37	0.37	0.43	0.42	0.39
	C22:1	0.18	0.18	0.20	0.18	0.17
	C24:0	0.14	0.14	0.15	0.15	0.15
SCO	C8:0	0.07	0.09	0.12	0.16	0.20
	C16:0	10.8	10.7	10.7	10.8	11.1
	C16:1	0.20	0.19	0.19	0.19	0.20
	C17:0	0.10	0.10	0.10	0.10	0.10
	C18:0	4.55	4.72	4.73	4.77	4.97
	C18:1t	0.08	0.09	0.11	0.14	0.17
	C18:1	43.2	42.8	42.9	43.0	43.3
	C18:2	32.5	32.4	32.4	32.2	31.5
	C20:0	0.77	0.77	0.77	0.78	0.82
	C18:3	5.96	6.35	6.20	6.14	5.80
	C20:1	0.95	0.97	0.98	0.99	1.03
	C22:0	0.47	0.47	0.44	0.49	0.54
	C24:0	0.18	0.18	0.17	0.18	0.19

SO are shown in Table 2. By comparison of Table 1 and 2, the fatty acid profiles of SO and potato fries fried in SO were similar, but the decrease of LA in potato fries after 4-h frying was greater than that in SO (5.54% vs 2.39%). The fatty acid profiles of potato fries fried in CO and SCO shown in Table 2 were also similar to those in oils (Table 1). Unlike the results obtained in SO, the fries fried in CO had a smaller ALA decrease after 4-h frying than ALA decrease in the pure oil (1.34% vs 2.08%), as shown in Table 1 and 2. Table 1 and 2 also showed that the decrease of ALA was even smaller in fries fried in SCO than that in SCO (0.16% vs 1.92%).

DISCUSSION

In this paper, we examined the frying performance of potato fries in two traditional oils, i.e. SO (the most abundant fatty acid is LA) and CO (the most abundant fatty acid is OA). The fatty acid profiles of SO and CO before frying were in agreement with other studies (Abdulkarim *et al.*, 2007; Dubois *et al.*, 2007). Throughout 4 h of frying, LA in SO decreased by 2.39% whereas LA in CO decreased by 1.84%. In contrast, ALA in SO decreased by 1.32%, whereas ALA in CO decreased by 2.08%. The small degradation of LA and ALA in the present study was probably due to the lower frying temperature (i.e. 180°C). The percentage decrease of LA and ALA in both SO and CO were similar. Based on the percentage decrease of LA and ALA, our results suggest that oils containing PUFAs were as good as those containing MUFAs in deep-frying process.

Previous studies have shown that blending PUFA oils with SFA or MUFA oils improved the oil stability of PUFA oils (Bhatnagar *et al.*, 2009; Hashempour-Baltork *et al.*, 2016; Serjouie *et al.*, 2010). In this study, we examined the frying performance of SCO because there is little literature that investigates the fatty acid profile changes in SCO (Hashempour-Baltork *et al.*, 2016). Based on Table 1, it was observed that the levels of LA and ALA in SCO decreased by 2.39% and 1.92%, respectively. However, the levels of LA and ALA in SO decreased by 2.39% and 1.32%, respectively. The blending of CO and SO did not significantly improve the degradation levels of LA and ALA in SCO during the deep-frying process. During the deep-frying process, there was also formation of C18:1t in SCO. The levels of C18:1t in SCO increased by 0.15%, which was lower compared to the 0.18% increase of C18:1t in CO. However, the increase of C18:1t in SCO was still larger than the increase of C18:1t in SO (0.10%). Hence, our results suggest that blending soybean oil and canola oil does not improve the frying stability of the resulting oil in terms of fatty acid profile.

Interestingly, it was observed that the contents of octanoic acid (C8:0) increased with frying time. This result was in agreement with another study conducted by Aladedunye & Przybylski (2009a), where the levels of octanoic acid increased with frying time. Marquez-Ruiz & Dobarganes (1996) mentioned that the quantification of octanoic acid and heptanoic acid has been used as an assay for oxidative deterioration in fats and oils that did not contain naturally occurring octanoic acid and heptanoic acid. This is because the oxidation of unsaturated fatty acyl radicals produces a radical attached to the glyceridic backbone. After the addition of H., a bound octanoic acid or heptanoic acid attached to the glyceridic backbone will be formed. After the transesterification process, octanoic acid and heptanoic acid will be released. The oils used in this study contained OA, LA, and ALA, which were able to form octanoic acid from the process described above. As the

frying time increases, the oils undergo oxidation and hydrolysis, which lead to the elevation of octanoic acid. Heptanoic acid formation was not observed in this study due to the absence of heptanoic acid methyl ester in the calibration standards.

We also observed that the levels of OA, PA, and SA increased with frying time. Our results are consistent with a previous study showing that SFAs increased in both rapeseed oil and SO as the number of frying cycles increased (Bhardwaj *et al.*, 2016). Similarly, Gerde *et al.* (2007) observed that OA, PA, and SA in SO increased as the number of frying cycles increased. The increase in SFAs (PA and SA) and OA might be due to the breakdown of LA and ALA, which could transform into fatty acids with the same number of carbons or with lesser number of carbons.

During the deep-frying process, there was the formation of C18:1 *trans* fatty acid as the number of frying cycles increased. Fatty acids in oils heated at high temperatures are known to undergo chemical conversion from *cis* to *trans* isomer. *Trans* fatty acids in frying oils can be produced from free radical reaction, heat-induced isomerisation or concerted reaction (Zhang *et al.*, 2012). Tsuzuki *et al.* (2008) concluded that heating of highly purified triolein, trilinolein and trilinolenin induced *cis* to *trans* isomerisation. As the heating period increases, the amount of *trans* fatty acid increases. Bhardwaj *et al.* (2016) also reported that the amount of *trans* fatty acids in rapeseed oil and soybean oil increased as the number of frying cycles increased. Tsuzuki *et al.* (2008) mentioned that lipid oxidation of unsaturated fatty acids occurs together with the geometric isomerisation of unsaturated fatty acids. This is because *trans*-isomerism and polar compounds were not detected when triolein with added α-tocopherol was heated under a nitrogen stream. Hence, the formation of C18:1 *trans* fatty acid might have contributed to the decrease in linoleic and linolenic acids.

In this study, the fatty acid composition of the potato fries was similar to the fatty acid composition of the oils. This is due to the mass transfer that occurred during deep-frying of the potato fries. Mousa (2018) observed that oil absorption of potato fries occurred during deep-frying. Hence, the potato fries would have a similar fatty acid composition as the oil it was fried in.

CONCLUSION

Repeated usage of frying oils resulted in a decrease in the amount of PUFAs, i.e. LA and ALA and an increase in the amount of MUFAs and SFAs in the oils. After 4h of frying, the levels of LA and ALA in SO decreased by 2.39% and 1.32% respectively, while for CO, the levels of LA and ALA decreased by 1.84% and 2.08% respectively. For SCO, LA and ALA decreased by 2.39% and 1.92% respectively after 4 h of frying. As for *trans* fatty acids, the levels of C18:1t increased by 0.10% for SO, while the levels of C18:1T increased by 0.18% for CO. For SCO, the levels of C18:1T increased by 0.15%. In SCO, the half-life of LA and ALA were found to be 30.1 h and 8.7 h, respectively. Hence, blending soybean oil and canola oil did not significantly improve the fatty acid profile of the resulting oil. As for the potato fries, the fatty acid composition was consistent with the fatty acid composition of the vegetable oils. Due to the formation of *trans* fatty acids and the decrease in PUFAs, it is advised not to use the same frying oil repeatedly and not to consume food products cooked in reused oil.

Acknowledgement

The authors greatly acknowledge the financial support from A*STAR BMRC (Biomedical Research Council) and this research was funded by IAF-PP (HBMS Domain): H17/01/a0/A11 Food Structure Engineering for Nutrition and Health-CNRC Core Funds.

Authors' contributions

MTYY, conducted the study, data analysis and interpretation, prepared the draft of the manuscript; XB, conducted data analysis and interpretation, reviewed the manuscript; CJH, principal investigator, conceptualised and designed the study, reviewed the manuscript.

Conflicts of interest

We declare no conflict of interests.

References

Abdulkarim SM, Long K, Lai OM, Muhammad SKS & Ghazali HM (2007). Frying quality and stability of high-oleic Moringa oleifera seed oil in comparison with other vegetable oils. *Food Chem* 105(4):1382-1389.

Aladedunye FA & Przybylski R (2009a). Degradation and nutritional quality changes of oil during frying. *J Am Oil Chem Soc* 86(2):149-156.

Aladedunye FA & Przybylski R (2009b). Protecting oil during frying: A comparative study. *Eur J Lipid Sci Technol* 111(9):893-901.

Alvis A, Vélez C, Rada-Mendoza M, Villamiel M & Villada HS (2009). Heat transfer coefficient during deep-fat frying. *Food Control* 20(4):321-325.

Aydeniz B & Yilmaz E (2016). Performance of different natural antioxidant compounds in frying oil. *Food Technol Biotechnol* 54(1):21-30.

Bhatnagar AS, Prasanth Kumar PK, Hemavathy J & Gopala Krishna AG (2009). Fatty acid composition, oxidative stability, and radical scavenging activity of vegetable oil blends with coconut oil. *J Am Oil Chem Soc* 86(10):991-999.

Bhardwaj S, Passi SJ, Misra A, Pant KK, Anwar K, Pandey RM & Kardam V (2016). Effect of heating/reheating of fats/oils, as used by Asian Indians, on trans fatty acid formation. *Food Chem* 212:663-670.

Calder PC (2006). n–3 Polyunsaturated fatty acids, inflammation, and inflammatory diseases. *Am J Clin Nutr* 83(6):1505S–1519S.

Choe E & Min DB (2007). Chemistry of deep-fat frying oils. *J Food Sci* 72(5):77-86.

Dobarganes C, Márquez-Ruiz G & Velasco J (2000). Interactions between fat and food during deep-frying. *Eur J Lipid Sci Technol* 102(8-9):521-528.

Dubois V, Breton S, Linder M, Fanni J & Parmentier M (2007). Fatty acid profiles of 80 vegetable oils with regard to their nutritional potential. *Eur J Lipid Sci Technol* 109(7):710-732.

Farhoosh R, Kenari RE & Poorazrang H (2009). Frying stability of canola oil blended with palm olein, olive, and corn oils. *J Am Oil Chem Soc* 86(1):71-76.

Gerde J, Hardy C, Fehr W & White PJ (2007). Frying performance of no-trans, low-linolenic acid soybean oils. *J Am Oil Chem Soc* 84(6):557-563.

Gunstone FD (2002). *Vegetable oils in food technology: composition, properties and Uses.* Blackwell Publishing Ltd., New Jersey.

Han SN, Leka LS, Lichtenstein AH, Ausman LM, Schaefer EJ & Meydani SN (2002). Effect of hydrogenated and saturated, relative to polyunsaturated, fat on immune and inflammatory responses of adults with moderate hypercholesterolemia. *J Lipid Res* 43:445-452.

Hashempour-Baltork F, Torbati M, Azadmard-Damirchi S & Savage GP (2016). Vegetable oil blending: A review of physicochemical, nutritional and health effects. *Trends Food Sci Technol* 57:52-58.

Juskelis R, Cappozzo J, Jablonski J, Wylie PL & Mrozinski P (2014). *Automated Sample Preparation for FAME Analysis in Edible Oils Using an Agilent 7696A Sample Prep WorkBench.* From https://www.agilent.com/cs/library/applications/5991-5172EN-D2.pdf [Retrieved January 14 2019].

Marquez-Ruiz G & Dobarganes C (1996). Short-chain fatty acid formation during thermoxidation and frying. *J Sci Food Agric* 70(1): 120-126.

Matsler AL & Siebenmorgen TJ (2005). Evaluation of operating conditions for surface lipid extraction from rice using a Soxtec System. *Cereal Chem* 82(3):282-286.

Mousa RMA (2018). Simultaneous inhibition of acrylamide and oil uptake in deep fat fried potato strips using gum Arabic-based coating incorporated with antioxidants extracted from spices. *Food Hydrocoll* 83:265-274.

Phiri G, Mumba P & Mangwera A (2006). The quality of cooking oil used in informal food processing in Malawi: a preliminary study. *Int J Consum Stud* 30(6):527-532.

Rajaram S (2014). Health benefits of plant-derived α-linolenic acid. *Am J Clin Nutr* 100(1):443S–448S.

Santos CSP, Molina-Garciaa L, Cunhaa SC & Casal S (2018). Fried potatoes: Impact of prolonged frying in monounsaturated oils. *Food Chem* 243:192-201.

Serjouie A, Tan CP, Mirhosseini H & Che Man BY (2010). Effect of vegetable-based oil blends on physicochemical properties of oils during deep-fat frying. *Am J Food Technol* 5(5):310-323.

Tsuzuki W, Nagata R, Yunoki R, Nakajima M & Nagata T (2008). cis/trans-Isomerisation of triolein, trilinolein and trilinolenin induced by heat treatment. *Food Chem* 108(1):75-80.

Zhang Q, Saleh ASM, Chen J & Shen Q (2012). Chemical alterations taken place during deep-fat frying based on certain reaction products: A review. *Chem Phys Lipids* 165(6):662-681.

Mal J Nutr 26(3): 401-410, 2020

A cross-sectional study on nutritional status and dietary patterns of children with autism

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ABSTRACT

Introduction: Literature revealed that individuals with Autism Spectrum Disorders (ASD) experience significantly more feeding problems and obesity compared to their peers. This study was designed to investigate the nutritional status and dietary patterns of children with autism in different age groups in Dhaka city, Bangladesh. **Methods:** This cross-sectional study was conducted among 193 individuals with ASD. A questionnaire was used as a tool to collect information from the mother of the respondents and anthropometric assessments were conducted by measuring height and weight. The dietary patterns of the respondents were taken using a food frequency questionnaire. **Results:** The age range of the participants were between 3-18 years. It was found that 11.9%, 19.7% and 23.3% of the participants were underweight, overweight and obese, respectively according to Body Mass Index (BMI)-for-age. About 70% of the respondents had medium Individual Dietary Diversity Score (IDDS). In addition, the association between IDDS and obesity was significantly correlated (p=0.00). Individuals with ASD exhibited similar food preferences across most age groups with little changes. **Conclusion:** Our study figured out that the prevalence of overweight increased in accordance with age among children with ASD. They have a tendency to prefer likeness and routine in their diet, which expands the tendency to have an imbalanced diet. A dietary guideline including seven food groups should be followed to improve their nutritional status and dietary practices.

Keywords: Autism, nutritional status, dietary practice, socioeconomic

INTRODUCTION

Autism spectrum disorder (ASD) and autism are both general terms for a group of complex disorders in brain development, which may be considered as a life-long disorder that results in varying degrees of difficult social interactions, leading to a wide range of challenging behaviours (Abubakar, Ssewanyana & Newton, 2016). The symptoms of autism become obvious over the first year (Ozonoff *et al.*, 2008). What is clear, however, is that ASD is largely hereditary, with a higher incidence among boys than among girls (Health Council of the Netherlands, 2009). The prevalence of ASD range between 0.15% and 0.80% in Bangladesh. An alarmingly high prevalence of 3% was reported in Dhaka city and 0.07% in the rural area (NCDC *et al.*, 2013; Hossain *et al.*, 2017). A Swedish study found that people with

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doi: https://doi.org/10.31246/mjn-2019-0126

autism die over 16 years earlier than non-autistic people (Hirvikoski *et al.*, 2016). The average age of death is 36 years, which is around the middle of adulthood (Guan & Li, 2017). Studies in the United States have found lower rates of autism diagnosis associated with lower socioeconomic status (Kelly *et al.*, 2019).

In children and youth with disability, the risk of obesity is higher and is associated with lower levels of physical activity, inappropriate eating behaviours, and chronic health conditions (Hinckson *et al.* 2013). Both children and adults with ASD are more likely to be overweight or obese compared with normally developing societies (Safiza *et al.*, 2015; Fortuna *et al.*, 2016).

An individual with ASD experiences significantly more feeding problems when compared to his/her peers (Sharp *et al.*, 2013). Food refusal and introduction of new foods are cited as the most difficult problems in autism (Cornish, 1998). Persons with ASD are significantly more likely to refuse foods based on texture/consistency, taste/smell, mixtures, brand, and shape (Hubbard *et al.*, 2014). Children with a more limited food repertoire have an inadequate intake of a greater number of nutrients (Bandini *et al.*, 2010). It is generally accepted that autistic youngsters possess unusual eating habits (Williams, Dalrymple & Neal, 2000), which may be resulted from oral sensory sensitivity (Chistol *et al.*, 2018). In addition, their dietary patterns, food preferences and food stigma aggravate their poor nutritional condition, both in terms of under- and over-nutrition. In accordance, our study has been designed to assess the dietary patterns and nutritional status of individuals with autism in order to get an idea of the overall changes in nutritional status and food preferences according to their age.

MATERIALS AND METHODS

Study design, period and setting

A cross-sectional study was conducted in six conveniently accessible autism special institutions in Dhaka North City corporation area between the period of January to December 2018.

Participants

A sampling frame of 470 individuals from six autism special institutions was constructed. Among them, 193 student's information were collected randomly following inclusion criteria, which were individual with autism who was regular in visiting a particular institution for study or treatment purposes, and whose mother or caregiver had agreed to give an interview when selected as a study sample.

Procedures

A semi-structured questionnaire containing both closed- and open-ended questions were used to collect quantitative information. The questionnaire was used to gather information regarding socioeconomic status and dietary practices of individuals with autism. Height and weight were measured using standard procedures. A pilot study was carried out in a similar institution in Dhaka North City.

Measures

Nutritional status was assessed by measuring height and weight, which was associated with their age. The weight of the respondents was measured (to the nearest 0.1 kg) using a standardised digital weighing machine. They were barefooted, in minimum clothing, empty bladder and stomach when being weighed. Oedema was checked before taking weight. The height of the respondents was measured (to the nearest 0.1 cm) using a locally made

standardised height scale. Nutritional status was evaluated based on the World Health Organization (WHO) guidelines (WHO, 2009) for the calculation of z-score (3-5 years), while Emergency Nutritional Assessment (ENA) was used to calculate the z-score of participants below five years of age. The Center for Disease Control (CDC) and Prevention growth chart for 2-20 years in respective of sex and its online calculator were used to calculate the BMI-for-age percentiles, where overweight was defined as ≥ 85th percentile, obesity as ≥ 95th percentile, and underweight as < 5th percentile (Center for Disease Control & Prevention, 2014).

Dietary evaluation was measured by using a questionnaire of 16 food groups (Kennedy *et al.*, 2011), which was later converted into lesser food groups based on the anticipation of the study. The frequency of the Individual Dietary Diversity Score (IDDS) was calculated based on the Food and Agriculture Organization (FAO) 2011 guidelines using the frequency of consumption of nine different food groups in the last 24 hours. Value "one" was given for having the food and "zero" for not having the food. The sum of IDDS categorised respondents into three categories: low (score 0-3), medium (score 4-5) and high (score 6-9) (Kennedy *et al.*, 2011).

Socioeconomic status was measured by a quintile method, where the first quintile was categorised as low-income group, while the second to fourth quintiles and the fifth quintile were considered as middle- and higher-income groups, respectively.

Data analysis

All data collected from the respondents were compiled, tabulated and analysed according to the objectives of the study. Statistical Package for Social Sciences (SPSS version 22) was used to classify categorical variables and continuous variables in response to the research aims. Frequency distribution, percentage, and descriptive statistics including mean, standard deviation (SD) were calculated. Chi-square test was performed to test for significant associations and a p value of < 0.05 was considered as statistical significance. Microsoft Excel was used to analyse the IDDS scores and for graphical presentation.

Ethical consideration

This study was approved by Primeasia University, Dhaka, Bangladesh. Written consent was obtained from the participants. All the respondents were informed about the aim of the study. Confidentiality of personal information was strictly maintained.

RESULTS

Socio-demographic status

A total number of 193 individuals with ASD were studied and their socio-demographic status are shown in Table 1. The participation ratio for males and females was 2.5:1. A higher number of respondents came from medium sized families (4-7 members) and about 76.2% have been raised in a nuclear family. In addition, 83.4% of fathers and 67.9% of mothers were educated at the graduate and postgraduate levels. On the other hand, the rates of illiteracy were of the same order of magnitude among parents. Among the total sample, 67.4% of fathers were involved in business and non-government services. However, 90.2% of mothers were housewife. This study expressed that 70.9% of persons with autism were the first born of the family. It is remarkable that 87.0% of mothers were the caregiver of their child at home. The table also depicts that about 14.5% of the participants were from the low-income group, while 45.6% and 39.9% belonged to the middle- and high-income groups, respectively. Families had to spend 23.2% of their

Table 1. Socio-demographic characteristics of children with autism

Characteristics	*n*	*%*	*Mean*
Age group (years)			±8.5(years)
3-<5	31	15.4	
5-<10	109	54.2	
10-<18	53	26.4	
Sex			
Male	138	71.5	
Female	55	28.5	
Father's Occupation			
Govt. Service	12	6.2	
Non-Govt. Service and business	130	67.4	
Others	51	26.4	
Mother's Occupation			
Govt. Service	4	2.1	
Non-Govt. Service	15	7.7	
Housewife	174	90.2	
Education level of fathers			
Graduate and Post-Graduate	161	83.4	
Secondary and Higher Secondary level	22	11.3	
Primary level and illiterate	10	5.1	
Educational level of Mothers			
Graduate and Post-Graduate	131	67.9	
Secondary and Higher Secondary level	49	25.4	
Primary level and illiterate	13	6.7	
Caregiver at home			
Mother	168	87.0	
Grandmother/Father/Others	25	13.0	
Birth order			
First born	137	70.9	
Second born	48	24.9	
Third or fourth	8	4.2	
Types of family			
Nuclear family	147	76.2	
Joint family	46	23.8	
Income groups			
Low income group	28	14.5	
Middle income group	88	45.6	
Higher income group	77	39.9	
Mean income (BDT/Month)			
Low income group			29171
Middle income group			65600
Higher income group			144331
Mean expenditure (BDT/Month)			
Low income group			25723
Middle income group			54801
Higher income group			93219
Mean Expenditure on autistic child (education, treatment, others) (BDT/Month)			
Low income group			6793
Middle income group			15709
Higher income group			25466

total income as the cost for their child in the low-income group, 23.9% and 17.6% in the middle- and high-income groups, respectively.

Nutritional status

The overall nutritional status of the participants was assessed according to BMI-for-age percentile. A total of 31 children aged between 3 to <5 years were selected to be assessed according to three anthropometric indices - weight-for-age, height-for-age and weight-for-height z-scores, which were referred to for underweight, stunting and wasting, respectively.

Table 2 represents the weight-for-age z-scores, where 71.0% were normal according to their age. The prevalence of underweight was 3.1% and overweight was 25.9% among children with ASD. Height-for-age z-score indicated that the frequency of stunting among the participants was only 3.2%, while 80.6% were normal according to their age. This table showed the occurrence of wasting in only 6.9%, while 62.1% were normal and 31.0% were overweight according to their height and weight. Moreover, Table 2 also conveyed that underweight among children with autism was 11.9%. Likewise, overweight and obesity were 19.7% and 23.3%, respectively. A total of 45.1% of children with autism were healthy according to their age and sex. It has been observed that overweight increased gradually with age.

Dietary evaluation

A dietary assessment is a comprehensive evaluation of a person's food intake. Nutritional history and current dietary intake data provide information on a population, group or individual's nutritional status to identify potential nutritional problems.

In this study, the mothers reported that their children liked to ingest solid

Table 2. Nutritional status of individuals with autism

Anthropometric Indicators	*Underweight (<-2SD / BMI<18.5 / <5th Percentile)*		*Normal (±2SD / BMI 18.5-24.99/ 5th -<85th Percentile)*		*Overweight (>+2SD / BMI 25-29.99/ 85th -<95th Percentile)*		*Obese (BMI ≥30 / ≥95th Percentile)*	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Weight-for-age z- score (underweight), n=31	1	3.1	22	71.0	8	25.9	0	0
Height-for-age z-score (Stunting), n=31	1	3.2	25	80.6	5	16.2	0	0
Weight-for-height z-score (wasting), n=29	2	6.9	18	62.1	9	31.0	0	0
Overall nutritional status based on BMI-for-age, n=193	23	11.9	87	45.1	38	19.7	45	23.3
BMI-for-age, in different age groups								
3-<5 yrs. n=31	3	9.7	18	58.1	2	6.5	8	25.7
5-<10 yrs. n=109	14	12.8	46	42.2	21	19.3	28	25.7
10-<18 yrs. n=53	6	11.3	23	43.4	15	28.3	9	17.0

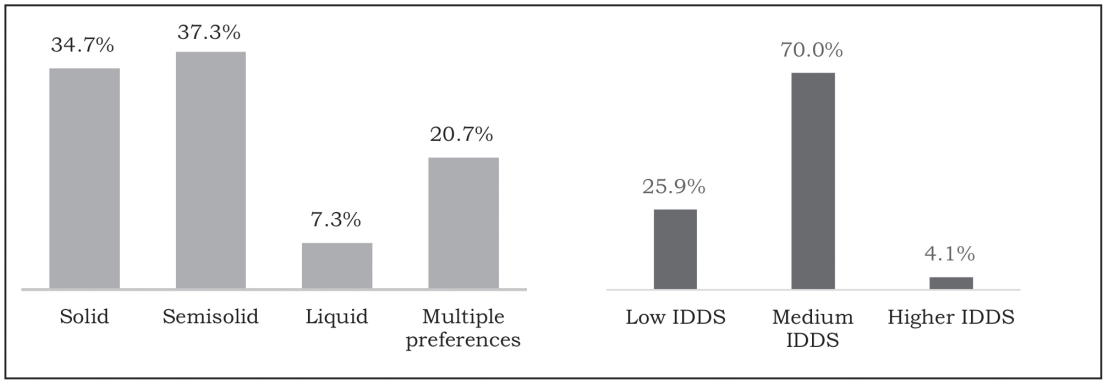

Figure 1. Preferences of food consistency and individual dietary diversity score (IDDS) among individuals with autism

and semi-solid foods. It was found that 34.7% and 37.4% of children preferred solid and semi-solid foods. Nevertheless, only 7.3% of children liked to consume liquid foods. Besides, 20.7% of individuals had multiple preferences on different consistency of foods. It was found that more than two-thirds (70%) of the study participants had medium IDDS, while 25.9% had low and only 4.1% had high IDDS, respectively. In addition, the association between IDDS and obesity (BMI) was significant (p<0.002) (Figure 1).

Interestingly, children with ASD have a strong liking and disliking of foods. This study revealed that cereal-based products and fats and oil were consumed by all age groups every day. In contrast, nuts and oil seeds were

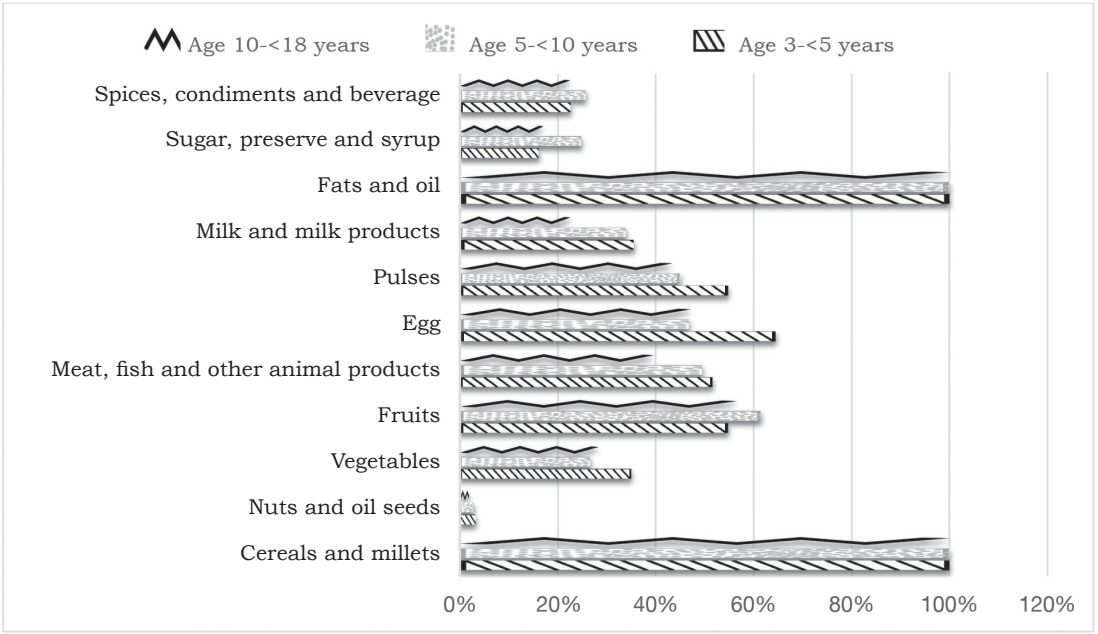

Figure 2. Food group preferences among individuals with autism according to different age groups

the least preferred foods. Milk and milk products, as well as egg consumption reduced comparatively with the increase in age. The consumption of other food groups did not change significantly with age.

Table 3 shows the association between nutritional status with different variables. The data represents that there were strong associations between parent's education level, income, and low birth weight with underweight. The table also revealed that income level and IDDS had a positive relationship with obesity.

DISCUSSION

The socio-demographic data of this study indicated that there were more male autistic participants compared to females. Almost two third of the individuals were first born, which was similar with that of another study conducted in the same region (Hasnain & Akter, 2014). The present study revealed that institutional education was high among the parents of individuals with autism and positively associated with undernutrition, although a previous study proved that there was no association between parent's education and the development of autism in children (Larsson *et al.*, 2005). The mean income of all three income groups (low, middle and high) was much higher than the per capita income of Bangladesh, which was also reflected in a 2017 study (Safa & Islam, 2017). The present study showed that around one-fourth of the total family income was spent on raising autistic children. Nevertheless, prior research has shown that the annual loss due to having a child with autism is about 14% of the total family income. This study also showed that almost 2/3 of children belonged to a nuclear and medium-size family. Likewise, a separate study reported that majority of their samples (87%) were from nuclear families (Hasnain & Akter, 2014).

Good nutrition is one of the leading factors for attaining a healthy life. Undernourishment was not predominant among our study population. On the other hand, this study found that overweight was gradually increased with age in autistic children. Conversely,

Table 3. Association of different variables with nutritional status (chi-squire test)

Factors	*Underweight p-value*	*Healthy p-value*	*Overweight p-value*	*Obesity p-value*
Age (Mean = 103 months, SD = 41 months)	0.11	0.30	0.80	0.43
Sex (Male 71.5%, Female 28.5%)	0.78	0.56	0.63	0.65
Income level (Mean = 91955 BDT, SD = 62280 BDT)	0.00**	0.55	0.73	0.02*
Fathers education	0.00**	0.10	0.01*	0.15
Mothers education	0.00**	0.00**	0.03*	0.32
Family types (Joint 23.8%, Nuclear 76.2%)	0.78	0.35	0.65	0.19
Premature baby (<37 weeks of pregnancy, Yes 20.2%)	0.04*	0.83	0.76	0.37
Low birth weight (<2.5 kg, Yes 24.9%)	0.02*	0.64	0.14	0.38
Exclusive breast feeding (Up to six months, Yes 56.5%)	0.79	0.68	0.25	0.42
IDDS (Mean 4.37, SD±1.34)	0.20	0.40	0.80	0.00**

*Correlation is significant at $p<0.05$; **Significant at $p<0.01$

a similar study revealed that obesity was higher among the younger age groups (Curtin *et al.*, 2005). The present study also found that family income and parent's education had a positive association with the nutritional status of participants, which had already been proven by a previous study (Skoufias, 1999).

In the current study, it was found that a greater number of children preferred semi-solid foods, which may have been resulted from oral sensory sensitivity (Chistol *et al.*, 2018). Cereals and fats and oils were the most preferred food groups. Unfortunately, intake of protein-enriched foods gradually decreased among them. Children aged between 5 and <10 years old consumed higher amounts of sugar and syrup compared to other age groups. This study also reported that almost two-third of the respondents had medium IDDS. An excellent statistical association was found between IDDS and obesity, which indicated that dietary diversity score had a great impact on nutritional status. Selective eating and food aversion were also found among children with ASD. Children with ASD tend to prefer the same food repeatedly, which can result in a severely imbalanced diet (Barnhill *et al.*, 2015). Research conducted by Evans *et al.* (2012) has found that children with ASD consume more sweetened beverages and snacks, and fewer fruits and vegetables than typically developing children, which resembled our study outcomes. The study findings indicated that both positive and negative malnutrition are quite significant with an imbalanced diet.

CONCLUSION

Our study showed that the prevalence of overweight and obesity over the years among the respondents with ASD was pretty alarming that it is reasonably worthy to be further investigated, preferably in longitudinal studies. Though our data did not contradict existing information dealing with the dietary habits of children with autism, long-term nutritional intervention including detailed dietary guidelines and awareness programmes play a fundamental role in the correction of inappropriate feeding habits and eventually improving the nutritional status of children with autism.

Acknowledgment

We would like to express our respect and sincere gratitude to our academic supervisor, co-supervisor and other teachers for their counsel and encouragement. We evolve respect to the Institute Authority and respondents for giving us permission to collect information from them. Finally, our special thanks to our parents and friends who supported us for conducting this study.

Author's contribution

MNI and FSB, contributed to the conception, design, acquisition, analysis and interpretation of data, also drafted and revised the manuscript; SMC, FY, SA and SBK, helped with conception and data acquisition. All authors approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

References

Abubakar A, Ssewanyana D & Newton CR (2016). A systematic review of research on autism spectrum disorders in sub-Saharan Africa. *Behav Neurol* 2016:1–14.

Bandini LG, Anderson SE, Curtin C, Cermak S, Evans EW, Scampini R & Must A (2010). Food selectivity in children with autism spectrum disorders and typically developing children. *J Pediatr* 157(2):259–264.

Barnhill K, Gutierrez A, Marti SN & Hewitson L (2015). Analysis of dietary intake in children with autism spectrum disorder. *Autism-Open Access* 5(3):154. doi: 10.4172/2165-7890.1000154.

Center for Disease Control and prevention (2014). Division of Nutrition, Physical Activity, and Obesity. From https://www.cdc.gov/nccdphp/dnpao/growthcharts/training/bmiage/page4.html. [Retrieved May 9 2014]

Chistol LT, Bandini LG, Must A, Phillips S, Cermak SA & Curtin C (2018). Sensory sensitivity and food selectivity in children with autism spectrum disorder. *J Autism Dev Disord* (2):583–91.

Cornish E (1998). A balanced approach towards healthy eating in autism. *J Hum Nutr Diet* 11(6): 501–509.

Curtin C, Bandini LG, Perrin EC, Tybor DJ & Must A (2005). Prevalence of overweight in children and adolescents with attention deficit hyperactivity disorder and autism spectrum disorders: a chart review. *BMC Pediatr* 5(1):48.

Evans EW, Must A, Anderson SE, Curtin C, Scampini R, Maslin M & Bandini L (2012). Dietary patternss and body mass index in children with autism and typically developing children. *Res Autism Spectr Disord* 6(1):399–405.

Fortuna RJ, Robinson L, Smith TH, Meccarello J, Bullen B, Nobis K & Davidson PW (2016). Health conditions and functional status in adults with autism: a cross-sectional evaluation. *J Gen Intern Med* 31(1):77–84.

Guan J & Li G (2017). Injury mortality in individuals with autism. *Am J Public Health* 107(5):791-793.

Hasnain MG & Akter M (2014). The relation of socio-economic factors with autism among children: a study in an urban area of Bangladesh. *J Pioneer Med Sci* 4(1):11-13

Health Council of the Netherlands, Gezondheidsraad (2009). Autism spectrum disorders: A lifetime of difference. The Hague: Health Council of the Netherlands/ Gezondheidsraad (GR). 2009/09E. 2009. From https://www.healthcouncil.nl/documents/advisory-reports/2009/07/16/autism-spectrum-disorders-a-lifetime-of-difference [Retrieved August 16 2020].

Hinckson EA, Dickinson A, Water T, Sands M & Penman L (2013). Physical activity, dietary habits and overall health in overweight and obese children and youth with intellectual disability or autism. *Res Dev Disabil* 34(4):1170-1178.

Hirvikoski T, Mittendorfer-Rutz E, Boman M, Larsson H, Lichtenstein P & Bölte S (2016). Premature mortality in autism spectrum disorder. *Br J Psychiatry* 208(3):232–238.

Hossain MD, Ahmed HU, Jalal Uddin MM, Chowdhury WA, Iqbal MS, Kabir RI & Sarker M (2017). Autism spectrum disorders (ASD) in South Asia: A systematic review. *BMC Psychiatry* 17(1):281.

Hubbard KL, Anderson SE, Curtin C, Must A & Bandini LG (2014). A comparison of food refusal related to characteristics of food in children with autism spectrum disorder and typically developing children. *J Acad Nutr Diet* 114(12):1981–1987.

Kelly B, Williams S, Collins S, Mushtaq F, Mon-Williams M, Wright B & Wright J (2019). The association between socioeconomic status and autism diagnosis in the United Kingdom for children aged 5–8 years of age: Findings from the Born in Bradford cohort. *Autism* 23(1):131–140.

Kennedy G, Ballard T, Dop MC & European Union (2011). *Guidelines for measuring household and individual dietary diversity*. Food and Agriculture Organization of the United Nations, Rome.

Larsson HJ, Eaton WW, Madsen KM, Vestergaard M, Olesen AV, Agerbo E, Schendel D, Thorsen P & Mortensen PB (2005). Risk factors for autism: perinatal factors, parental psychiatric history, and socioeconomic status. *Am J Epidemiol* 161(10):916–25.

NCDC, RCHCIB, BMRC & DSH (2013). Survey of Autism and Neurodevelopmental Disorders in Bangladesh. Non Communicable Diseases Control (NCDC) Programme, DGHS, MOHFW, Revitalization of Community Health Care Initiatives in Bangladesh (RCHCIB), Ministry of Health and Family Welfare (MOHFW); Bangladesh Medical Research Council (BMRC), MOHFW; Department of Pediatric Neuroscience, Dhaka Shishu Hospital, Dhaka, Bangladesh.

Ozonoff S, Heung K, Byrd R, Hansen R & Hertz-Picciotto I (2008). The onset of autism: patterns of symptom emergence in the first years of life. *Autism Res* 1(6):320–328.

Safa F & Islam MN (2017). Health related quality of life in children with autism spectrum disorder in Bangladesh. *IMC J Med Sci* 11(2): 40-44

Safiza MNN, Abdul Aziz NS, Siew Man C, Ambak R, Azahadi OM (2015). Nutritional Status of Children with Autism Spectrum Disorders, Cerebral Palsy and Down Syndrome: A Scoping Review. *Open Access J Sci Technol* 3(2015):101174. doi: https://doi.org/10.11131/2015/101174

Sharp WG, Berry RC, McCracken C, Nuhu NN, Marvel E, Saulnier CA & Jaquess DL (2013). Feeding problems and nutrient intake in children with autism spectrum disorders: A meta-analysis and comprehensive review of the literature. *J Autism Dev Disord* 43(9):2159–2173.

Skoufias E (1999). Parental education and child nutrition in Indonesia. *Bull Indones Econ Stud* 35(1):99–119.

WHO (2009). WHO Child Growth Standards and the Identification of Severe Acute Malnutrition in Infants and Children. A Joint Statement by the World Health Organization and the United Nations Children's Fund. Geneva: World Health Organization. From: http://www.ncbi.nlm.nih.gov/books/NBK200775/ [Retrieved August 16 2020].

Williams PG, Dalrymple N & Neal J (2000). Eating habits of children with autism. *Pediatr Nurs* 26(3):259-64.

Mal J Nutr 26(3): 411-423, 2020

Financial problems associated with food insecurity among public university students in Peninsular Malaysia

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ABSTRACT

Introduction: Food is a necessity for students. Yet, students' food expenditure is anticipated to be restrained by their financial status. This cross-sectional study aims to determine the prevalence of food insecurity and its determinants among university students attending public universities in Peninsular Malaysia. **Methods:** Multistage random sampling was used to select respondents from public universities in Peninsular Malaysia. A total of 427 undergraduate students completed a self-administered questionnaire at four randomly selected universities (Universiti Utara Malaysia, Universiti Kebangsaan Malaysia, Universiti Malaysia Pahang and Universiti Teknologi Malaysia). The questionnaire consisted of information concerning demographic and socioeconomic backgrounds, food security status, eating behaviour, financial literacy, and financial problem among university students. Frequency, chi-square, and logistic regression were used to analyse the variables. **Results:** Mean age of the respondents was 21.6 years, and 60.9% were found to be food insecure. Gender (χ^2=5.415), origin (χ^2=3.871), number of siblings (χ^2=4.521), financial problem (χ^2=42.364), and regular breakfast intake (χ^2=5.654) were associated with food security status (p<0.05). Male respondents had 1.5 times (AOR=1.547, 95% CI: 1.006-2.380) the risk of having low food security status. Those with higher financial problems (AOR=3.575, 95% CI: 2.332-5.481) were 3.5 times more likely to be food insecure. **Conclusion:** The prevalence of food insecurity among public university students in Peninsular Malaysia was significantly high. Thus, intervention studies should focus on students with financial problems. Moreover, establishing a better system for an on campus food pantry or food bank is needed to counter the high prevalence of food insecurity among university students.

Keywords: Food insecurity, financial literacy, financial problem, meal skipping, university students

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doi: https://doi.org/10.31246/mjn-2020-0032

INTRODUCTION

Obtaining sufficient food is a fundamental human right. As stated in the Universal Declaration of Human Rights, Article 25: food and shelter are for all (OHCHR, 1948). Everyone has the right to a standard of living adequate for health and well-being, including food. Food is a vital necessity of life. However, more than 800 million people in developing countries are not getting enough of it (WFP, 2020).

Food security is known as a significant concern at the individual, household, national, regional, and worldwide level. Food security exists when people can acquire safe, nutritionally adequate, and culturally acceptable foods at all times in a manner that maintains human dignity (FAO, 2008). On the other hand, food insecurity was initially defined in 1990 by Life Sciences Research Office (LSRO, 1990). It stated that food insecurity happens when the food systems are stressed, causing food to be not accessible, available, and enough quality, or the ability to acquire acceptable food in a socially acceptable way is limited or uncertain.

Published studies have addressed the high prevalence of food insecurity among university and college students. Based on a systematic review done by Bruening *et al.* (2017), the prevalence of food insecurity among the students ranged from 14.1% to 58.8% in the United States, 46.5% to 47.6% in Australia, 82.8% in Canada, and 12.5% to 84.0% in South Africa. Meanwhile, in Malaysia, the prevalence of food insecurity among university students ranges from 43.5% to 67.1% (Norhasmah, Zuroni & Marhana, 2013; Nur Atiqah *et al.*, 2015; Wan Azdie *et al.*, 2019), which is at an alarming rate. Combating food insecurity is real, getting enough and healthy food is a struggle.

A study was done by Norhasmah *et al.* (2013), focusing on the coping strategies and consequences of food insecurity among university students in four public universities namely, University Malaysia Perlis (UNIMAP), Universiti Malaya (UM), Universiti Teknikal Malaysia Melaka (UTeM), and University Sultan Zainal Abidin (UNiSZA). It also reported on the correlation between expenditure and food security status among students. Nur Atiqah *et al.* (2015) stated the consequences of food insecurity, focusing on its association with lipid profile among university students in Universiti Teknologi MARA (UiTM) Puncak Alam, while Wan Azdie *et al.* (2019) studied the determinants of food insecurity, focusing on the demographics, spending patterns, living arrangements, and time constraints among university students in International Islamic University Malaysia (IIUM), Kuantan. All these three studies were done in public universities within Peninsular Malaysia, focused on the prevalence of food insecurity among university students. Yet, none of these studies focused on financial literacy, financial problem, and eating behaviour as determinants of food insecurity among university students across Peninsular Malaysia. Among university students, food insecurity is consistently associated with financial independence, therefore they are required to start managing their money at this instance (Bruening *et al.*, 2017). According to Mohamad Fazli *et al.* (2008), university students are not prepared to manage their money on campus when they enroll into university. Students with food insecurity are significantly associated with those who are renting, boarding or sharing accommodation, having low incomes or are receiving government financial assistance (Hughes *et al.*, 2011; Norhasmah *et al.*, 2013).

According to Mohamad Fazli & MacDonald (2010), financial literacy among university students was defined based on their knowledge regarding financial goals, financial records, savings, investments, retirement, banking system, time value of money, wills, insurance, education loan, and general knowledge on personal finance. The study also stated that university students with better financial literacy were less likely to report having financial problems. Hogarth & Hilgert (2002) also reported that university students aged between 18 to 24 years were those with the least financial literacy compared to other age groups. Low financial literacy eventually leads to financial problems (Md Hafizi, 2013). To cope with financial problems, university students have reportedly reduced their meal sizes or skipped meals altogether throughout an entire day (Hanna, 2014). Food security status can be influenced by several factors, such as lack of food and money management skills, including budget planning and expenditure management skills, which arise from having low financial literacy. A more detailed and wide study is needed to provide an in-depth explanation on the patterns of prevalence and determinants of food insecurity among university students in Peninsular Malaysia. Thus, this study aims to identify the prevalence and determinants (demographics and socioeconomic characteristics, financial literacy, financial problem and the eating behaviour) of food insecurity among public university students in Peninsular Malaysia.

METHODOLOGY

Study design and samples

A cross-sectional study was conducted in public universities located in Peninsular Malaysia. Data collection was done throughout semester two (April-May 2015/2016). Prior to data collection, permission to carry out the study was obtained from the selected universities. Multistage random sampling was employed for recruitments. All 18 public universities were categorised into four zones, that were northern, east coast, central, and southern zones. One university was randomly selected to represent each of the four zones, which were Universiti Utara Malaysia (UUM) for northern, Universiti Malaysia Pahang (UMP) in the east coast, Universiti Kebangsaan Malaysia (UKM) for central and Universiti Teknologi Malaysia (UTM) in the southern zone, respectively. Then, one faculty was randomly chosen to represent each university, followed by a random selection of two programmes in each faculty. Finally, respondents aged between 19 to 25 years old from each faculty were selected using random systematic sampling based on odd number sequence of a name list provided by the university. All respondents were Malaysian undergraduate students. Undergraduate students were chosen as respondents because they are at the age of transitioning from parental supervision to independent living and developing their own food patterns.

Ethical clearance was obtained from the Ethics Committee for Research Involving Human Subject (JKEUPM) of Universiti Putra Malaysia [Reference No: FPSK(EXP16) P071]. The permission to carry out the study within the university campus was granted by each of these universities. Written informed consent was obtained from all respondents.

Measurements

The survey was conducted using a structured questionnaire to obtain information on the demographics and socioeconomic characteristics, food security status, eating behaviour, financial literacy, and financial problem among the respondents. Food security

status of university students was assessed during the past semester. The 10-item Adult Food Security Survey Module (USDA, 2012) was used to classify food security status among the respondents. Low food security and very low food security groups were merged into the food insecure category. All items were scored based on the Guide to Measuring Household Food Security and classified under the recommendations by USDA, Economic Research Service. Table 1 provides the definitions for each food security category and their corresponding scores.

Financial literacy was measured based on the total score of correct answers out of 25 questions concerning financial goals, financial records, savings, investments, retirement, banking system, time value of money, wills, insurance, education loan, and general knowledge of personal finance. This part consisted of 25 close-ended questions with true/false answers. One point was given to each correct response, thus, the total score was 25. This score was used to determine the level of financial literacy among students. This instrument has been developed and validated by Mohamad Fazli & MacDonald (2010) based on the Malaysian context.

Meanwhile, financial problem was measured by using an instrument validated by Mohamad Fazli *et al.* (2008). Ten questions on financial problem were asked on a 5-point Likert scale ranging from never (1) to every day (5). The financial problem questions were focused on problems such as: uncertain about where the money is spent; owe friend(s) money; spend more than can afford; borrow money to buy food; skip meals to save money; take money without permission from parents/others; upset when cannot buy things; shopping to relieve tension/ stress; impulsive shopping, and lending money to friends. The range in total scores for financial problems was from a low of zero to a high of 50. The mean score for overall financial problem was used to determine the status of financial problems among university students in Peninsular Malaysia.

The eating behaviour questionnaire (EBQ) was used to assess the frequency of meal intake among the respondents. This EBQ was adopted from a study done in Malaysia (Chin & Mohd Nasir, 2009). There were six items on how frequent the respondents consumed each meal daily (breakfast, morning snack, lunch, evening snack, dinner, and supper). It ranged from never (zero)

Table 1. Classification of food security status

Food security status	*Cumulative response score*	*USDA definition*
High food security	0	No food access problems or limitations
Marginal food security	1 to 2	Anxiety over food sufficiency or shortage of food in the house, with little or no indication of changes in food intake
Low food security	3 to 5	Reduced quality, variety or desirability of diet
Very low food security	>5	Disrupted eating patterns and reduced food intake

Source: USDA (2012)

to every day (seven times) a week. This study categorised the frequency of meal intakes into two categories: 'frequently skipped' with intakes less than five days per week for each meal, and 'regular intake' for intakes of five to seven days per week.

Statistical analysis

All data obtained were analysed using IBM SPSS version 23.0. All variables were presented as descriptive statistics that included frequency, percentage, mean, and standard deviation (SD). Chi-square was used to assess the association between all categorical variables with food security status. Binary logistic regression was used to determine the factors associated with food security status among respondents. Covariates were based on bivariate analysis, whereby only those with *p*-value of <0.05 were included in the adjusted model. The significance level of the analysis was based on a *p*-value of <0.05.

RESULTS

Distribution of the respondents' demographics and socioeconomic characteristics, financial literacy, financial problem, and eating behaviour are presented in Table 2. A total of 427 respondents from selected universities, namely UUM (Sintok), UMP (Gambang), UKM (Bangi), and UTM (Skudai) participated in this study with a 100% response rate. More than half of the respondents (60.2%) were female students, in line with the current situation at public universities in Malaysia, which are monopolised by female students (MOE Malaysia, 2013).

Majority of the respondents were of Malay ethnicity (83.6%), followed by Chinese (6.2%), Indian (4.7%), and others that included Bumiputera Sabah/ Sarawak and mixed (3.0%). The age of all respondents ranged from 19 to 25 years old. The mean age was 21.56±1.35 years old, with more than half of the respondents aged 19-21 years (males 51.2% and females 56.4%). One third of the respondents (39.8%) were in their first year of study (36.5% males and 42.0% females), followed by second year (25.8%) (21.8% males and 28.4% females), third year (24.4%) (26.5% males and 23.0% females), and a few in their final year (10.0%) (15.3% males and 6.6% females). Public universities in Malaysia offer comfortable accommodations to the students, thus, most of the respondents (96.5%) were staying on campus (93.5% males and 98.4% females). Furthermore, all the respondents (100%) were single. More than half of the respondents (59.7%) originated from a rural area (55.3% males and 62.7% females), while the rest were from an urban area (40.3%) (44.7% males and 37.4% females). The mean number of sibling(s) among respondents was 4.66±2.19. Only a few respondents (8.0%) were working as a part-timer (10.0% males and 6.6% females). Based on family background, majority of the respondents (83.4%) were from the household income category of Bottom 40% (B40) group (78.2% males and 86.8% females), 12.2% from the Middle 40% (M40) group (15.9% males and 9.7% females) and <5.0% from the Top 20% (T20) group (5.9% males and 3.5% females) (DOS Malaysia, 2017).

Female respondents (50.6%) had a higher financial literacy compared to male respondents (47.6%). At the same time, female respondents (56.0%) reported having lower financial problems compared to males (46.5%). Breakfast was the most skipped meal among the respondents (63.2%). However, female respondents tended to skip breakfast more (63.4%) compared to male respondents (53.5%). Contrarily, both genders frequently took lunch (80.3%) and dinner (72.4%). Male respondents consumed food regularly (81.8% for

Table 2. Background of the respondents (*N*=427)

Characteristics	*n (%)*			*Mean±SD*
	Male (n=170)	*Female (n=257)*	*Total*	
University				
UUM	32 (18.8)	75 (29.2)	107 (25.1)	
UMP	37 (21.8)	71 (27.6)	108 (25.3)	
UKM	37 (21.8)	69 (26.9)	106 (24.8)	
UTM	64 (37.7)	42 (16.3)	106 (24.8)	
Ethnicity				
Malay	136 (80.0)	221 (86.0)	357 (83.6)	
Chinese	16 (9.4)	16 (6.2)	32 (7.5)	
Indian	13 (7.7)	12 (4.7)	25 (5.9)	
Bumiputra Sabah/ Sarawak/Mixed	5 (2.9)	8 (3.1)	13 (3.0)	
Age (years)				
19-21	87 (51.2)	145 (56.4)	232 (54.3)	21.6±1.4
22-25	83 (48.8)	112 (43.6)	195 (45.7)	
Years of study				
1st	62 (36.5)	108 (42.0)	170 (39.8)	
2nd	37 (21.8)	73 (28.4)	110 (25.8)	
3rd	45 (26.5)	59 (23.0)	104 (24.4)	
4th	26 (15.3)	17 (6.6)	43 (10.1)	
Residence				
In campus	159 (93.5)	253 (98.4)	412 (96.5)	
Out campus	11 (6.5)	4 (1.6)	15 (3.5)	
Origin†				
Rural	94 (55.3)	161 (62.7)	255 (59.7)	
Urban	76 (44.7)	96 (37.4)	172 (40.3)	
Number of siblings				
1-3	61 (35.9)	77 (30.0)	138 (32.3)	4.7±2.2
4-6	71 (41.8)	157 (61.1)	228 (53.4)	
>6	38 (22.4)	23 (9.0)	61 (14.3)	
Working part-time				
Yes	17 (10.0)	17 (6.6)	34 (8.0)	
No	153 (90.0)	240 (93.4)	393 (92.0)	
Household income‡				
B40 (<RM 4360)	133 (78.2)	223 (86.8)	356 (83.4)	3444.3±3979.4
M40 (RM 4360- 9619)	27 (15.9)	25 (9.7)	52 (12.2)	
T20 (≥RM 9620)	10 (5.9)	9 (3.5)	19 (4.5)	
Financial literacy				
Lower than median	89 (52.4)	127 (49.4)	216 (50.6)	
Higher than median	81 (47.6)	130 (50.6)	211 (49.4)	
Financial problem				
Lower than mean	79 (46.5)	144 (56.0)	223 (52.2)	24.5±5.3
Higher than mean	91 (53.5)	113 (44.0)	204 (47.8)	

(to be continued)

Table 2. Background of the respondents (*N*=427) [Cont'd]

Characteristics	*n (%)*			*Mean±SD*
	Male (n=170)	*Female (n=257)*	*Total*	
Eating behaviour				
Breakfast				
Frequently skipped	107 (62.9)	163 (63.4)	270 (63.2)	
Regular intake	63 (37.1)	94 (36.6)	157 (36.8)	
Lunch				
Frequently skipped	31 (18.2)	53 (20.6)	84 (19.7)	
Regular intake	139 (81.8)	204 (79.4)	343 (80.3)	
Dinner				
Frequently skipped	29 (17.1)	89 (34.6)	118 (27.6)	
Regular intake	141 (82.9)	168 (65.4)	309 (72.4)	
Food security status				
High food security	15 (8.83)	27 (10.5)	42 (9.8)	
Marginal food security	40 (23.5)	85 (33.1)	125 (29.3)	
Low food security	77 (45.3)	91 (35.4)	168 (39.3)	
Very low food security	38 (22.4)	54 (21.0)	92 (21.6)	

†Origin refers to the hometown of the respondents
‡Household Income and Basic Amenities (HIS/BA) survey of 2016

lunch and 82.9% for dinner) compared to female respondents (79.4% for lunch and 65.4% for dinner). The prevalence of food insecurity was 60.9% among public university students in Malaysia, with 39.3% of them having low food security and 21.6% with very low food security (Table 2).

Table 3 shows that there were several significant associations (p<0.05) between gender, origin, and the number of siblings with food security status. Females (67.1%) were more food secured compared to males (32.9%). Meanwhile, the origin from rural vs. urban (63.5% vs. 36.5%), having >4 siblings vs. lesser (71.5% vs. 28.5%), skipped breakfast frequently vs. regular breakfast intake (58.5% vs. 41.5%) (p<0.05), and having high vs. low financial problem (60.4% vs. 39.6%) (p<0.001) were significantly more prevalent among the food insecure respondents compared to the food secured respondents.

After controlling for covariates (Table 4), there were only two factors that significantly contributed to food security status. The model showed that according to gender, male respondents were 1.5 times more likely to suffer from food insecurity than females (AOR=1.547, 95% CI: 1.006-2.380)(p<0.05), and respondents with higher financial problems had the highest odds of being 3.5 times more likely to experience food insecurity compared to those with low financial problems (AOR=3.575, 95% CI: 2.332-5.481) (p<0.001).

DISCUSSION

There is a high prevalence of food insecurity (60.9%) among university students in Peninsular Malaysia included in this study. Findings from this study are similar to previous studies done in Peninsular Malaysia (Norhasmah *et al.*, 2013; Nur Atiqah *et al.*, 2015; Wan Azdie *et al.*, 2019). The trend of food

Table 3. Association between factors and food security status among students (*N*=427)

Characteristics	*n (%)*		χ^2	*p-value**
	Food secure	*Food insecure*		
University				
UUM	36 (21.6)	71 (27.3)	5.42	0.12
UMP	36 (21.6)	72 (27.7)		
UKM	49 (29.3)	57 (21.9)		
UTM	46 (27.5)	60 (23.1)		
Ethnicity				
Malay	132 (79.0)	225 (86.8)	5.46	0.14
Chinese	18 (10.8)	14 (5.4)		
Indian	12 (7.2)	13 (5.0)		
Bumiputra Sabah/ Sarawak/Mixed	5 (3.0)	8 (3.1)		
Gender				
Male	55 (32.9)	115 (44.2)	5.42	0.02*
Female	112 (67.1)	145 (55.8)		
Age (years)				
19-21	100 (59.9)	132 (50.8)	3.40	0.07
22-25	67 (40.1)	128 (49.2)		
Years of study				
1st	69 (41.3)	101 (38.9)	0.84	0.84
2nd	43 (25.8)	67 (25.8)		
3rd	37 (22.2)	67 (25.8)		
4th	18 (10.8)	25 (9.6)		
Residence				
In campus	164 (98.2)	248 (95.4)	2.38	0.12
Out campus	3 (1.8)	12 (4.6)		
Origin†				
Rural	90 (53.9)	165 (63.5)	3.87	0.05
Urban	77 (46.1)	95 (36.5)		
Number of siblings				
1-3	64 (38.3)	74 (28.5)	4.52	0.03*
≥4	103 (61.7)	186 (71.5)		
Working part-time				
Yes	9 (5.4)	25 (9.6)	2.48	0.12
No	158 (94.6)	235 (90.4)		
Household income‡				
B40 (< RM4360)	131 (78.4)	225 (86.5)	4.93	0.09
M40 (RM 4360-9619)	27 (16.2)	25 (9.6)		
T20 (≥ RM9620)	9 (5.4)	10 (3.8)		
Financial literacy				
Lower than median	83 (49.7)	133 (51.2)	0.09	0.77
Higher than median	84 (50.3)	127 (48.9)		
Financial problem				
Lower than mean	120 (71.9)	103 (39.6)	42.36	<0.01*
Higher than mean	47 (28.1)	157 (60.4)		

(to be continued)

Table 3. Association between factors and food security status among students (*N*=427) [Cont'd]

Characteristics	*n (%)*		χ^2	*p-value**
	Food secure	*Food insecure*		
Eating behaviour				
Breakfast				
Frequently skipped	89 (53.3)	108 (41.5)	5.65	0.02*
Regular intake	78 (46.7)	152 (58.5)		
Lunch				
Frequently skipped	140 (83.8)	226 (86.9)	0.79	0.74
Regular intake	27 (16.2)	34 (13.1)		
Dinner				
Frequently skipped	130 (78.3)	208 (80.0)	0.18	0.68
Regular intake	36 (21.7)	52 (20.0)		

**p*-value <0.05
†Origin refers to the hometown of the respondents
‡Household Income and Basic Amenities (HIS/BA) survey of 2016

insecurity prevalence is seen to be more significant when multiple universities from different locations were involved, as shown by Norhasmah *et al.* (2013) at 67.1% compared to studies that only focused on one location, such as those done by Wan Azdie *et al.* (2019) at 54.4% and Nur Atiqah *et al.* (2015) at 43.5%, respectively. This is because of the mixture of urban and rural locations of the universities, which might influence food accessibility. For example, the high cost of food transportation from rural to urban areas. Food items in

Table 4. Factors associated with food security status among students (*N*=427)

Variable	*Adjusted OR† (95% CI)*	*p-value*
Gender		
Male	1.55 (1.01-2.38)	0.05
Female	1.00 (ref)	
Origin		
Rural	1.38 (0.90-2.12)	0.14
Urban	1.00 (ref)	
Number of siblings		
1-3	1.00 (ref)	
≥4	0.99 (0.61-1.60)	0.96
Financial Problem		
Lower than median	1.00 (ref)	
Higher than median	3.58 (2.33-5.48)	<0.01*
Eating Behaviour		
Breakfast		
Frequently skipped	1.30 (0.85-2.0)	0.23
Regular intake	1.00 (ref)	

**p*-value <0.05
†Adjusted for gender, origin, number of siblings, financial problem, and breakfast intake

the university located in an urban area costs more compared to a rural area. Fresh food items such as vegetables and fish can also be one of the most expensive items in urban areas, given the costs acquired in their marketing, in terms of transportation from production areas, with some that perished during transportation process (Armar-Klemesu, 2000; Rose *et al.*, 2008).

Even though there was a high percentage of food insecurity reported from the respondents that came from B40 families, there was no association between household income and food security status in this study (Table 3). On the contrary, as reported by Wan Azdie *et al.* (2019), respondents with parental income of more than RM 5000 were food secured (41.3%). Despite the difference in food costs between these university locations, students get the same amount of funds from family members, education loan or scholarships, depending on their family's financial status. Wan Azdie and collegues (2019) also reported high food insecurity among respondents with Perbadanan Tabung Pendidikan Tinggi Nasional (PTPTN) loan compared to those on Jabatan Perkhidmatan Awam Malaysia (JPA) scholarship. A study conducted by Meldrum & Willows (2006) reported that there was a relationship between higher food costs with the money received from financial aids. Healthy food costs more to the students with an economical diet, with lower financial aid. Thus, regardless of household income and types of scholarship, the lack of financial literacy and management will contribute to higher financial problems among students, which later leads to food insecurity.

Moreover, studies done by Thanthida (2010) stated that people, particularly those originating from rural areas with limited purchasing power, are more likely to be confronted by the problem of food insecurity. The basis of the problem most likely stems from poverty or a low-income family. Hence, it explains how the origin is somehow associated with food insecurity status among university students. Respondents originating from rural areas who are enrolled in universities located in the urban areas with higher food costs to bear may face food insecurity due to lack of financial sources, management and literacy.

A bigger family and low-income households have been associated with prevalent food insecurity. Those having more than four siblings have a higher tendency to be food insecure, as supported by Costa *et al.* (2017). A study done by Nur Hafizah *et al.* (2013) stated that socio-economic level affects eating behaviour, in which students who come from lower or middle-income families spend less on food compared to those from high-income families.

This study documented a significant association between male students and food insecurity, even though male respondents spent more on food (Meldrum & Willows, 2006). These findings are supported by studies done by Hughes *et al.*, (2011). This was due to the spending behaviour among the students, in which, female students were more likely to create monthly savings and budgeting (Danek, 2017). In contrast, male students spent more on food. A study conducted by Hayhoe *et al.* (2000) stated that females spend more on clothing and appearance items, compared to males who spend on leisure items such as electronics, entertainment and food when they are away from home. The findings also showed that female students tended to cut their daily necessities and save regularly compared to male students.

Danek (2017) reported an association between female students with food insecurity. However, Hughes *et al.*, (2011) reported that no association between gender and food insecurity

among university students. Thus, both genders are exposed to food insecurity. Based on the report by Amare (2010), students tended to have a late breakfast or might combine it with lunch, or have an early dinner as a coping strategy by means of skipping meals. A review done by Pendergast *et al.* (2016) detailed that students tended to take late breakfast or combine breakfast with lunch as brunch because of time constraints, cost, and weight control, which is most prominent among female students.

This study also recorded that male students had low financial literacy and were reported to engage in high financial problems. Furthermore, respondents who were dealing with financial problems were almost thrice as likely to report experiences with food insecurity, suggesting that financial assistance was short of meeting their financial demands of attending university (Meldrum & Willows, 2006; Norhasmah *et al.*, 2013). Conversely, according to Mohamad Fazli *et al.* (2008), most students used education funding for purposes other than for academic expenses. This showed that there is less awareness on financial literacy and management among the students (Dahlia, Rabitah & Zuraidah, 2009; Md Hafizi, 2013), indicating that students are somewhat unprepared in managing their money on campus. Prominent financial problem among students increases their risk of engaging with low food security status. Insufficient money was reported as the primary contributor to the prevalence of food insecurity among students (Hanna, 2014). Due to financial stress and as a strategy to cope with food insecurity, some tend to borrow money to buy food and might even buy on credit (Mohamad Fazli *et al.*, 2008; Norhasmah *et al.*, 2013).

Nevertheless, it is important to highlight that regardless of gender, students with financial problems were more likely to be food insecure. Since university students have more independence while living away from their family for the first time, they need to manage the demands of both financial and studies at the same time. Furthermore, Darmon & Drewnowski (2008) stated that the strategy of food insecure consumers in saving money is by selecting high energy-dense foods instead of nutrient-dense foods. These foods are low in nutritional quality and have a higher level of calories, which may contribute to overweight, obesity, and abdominal adiposity. With this alarming prevalence of food insecurity among university students, actions must be made before it becomes detrimental to their health and leads to negative impacts on their academic performances.

One of the limitations of this study was its cross-sectional study design. Thus, the causal relationship between the variables could not be traced. Other possible factors of food security status among university students in Peninsular Malaysia that focus on financial aspects should be covered in future studies.

CONCLUSION

A high prevalence of food insecurity (60.9%) denotes that it is a major problem among the university students studied. This study revealed that every three out of five university students in Malaysia are food insecure. Gender and financial problem were the main factors contributing to food insecurity among public university students in Peninsular Malaysia. Intervention studies are essential to scale down the prevalence of food insecurity, such as by increasing food availability and accessibility on campus. Every public university in Malaysia should provide and establish food banks or pantry around the campus for students. Despite the fact that some of the universities have already

implemented this, a proper system should be applied to make it work. Development studies focusing on food consumption and the cost of healthy foods should be conducted, providing the basis between the different needs of food for each gender, on whether to provide more food for males compared to female students, since males need more calories than females. At the same time, a better system to control food price on campus should be one of the efforts from the university authorities.

Other than that, an in-depth qualitative study can be done to unroot the issues of food insecurity among the students, focusing on financial issues. Intervention studies focusing on students with financial problems is a must. Moreover, there is a need to prepare students on how to properly manage their financial resources. University authorities, relevant policymakers, and professionals can also help by conducting talks to educate students on financial literacy in the early years of university enrolment. Increasing the education fund will also lessen the financial burden of the students.

Acknowledgement

The study was funded by the Malaysian Consumer and Family Economics Association (MACFEA) mini-grant 2016/2017. We wish to thank the universities' (UUM, UKM, UMP, and UTM) staffs and students who took part in the survey.

Authors' contribution

NMJ, collected and analysed the data, as well as wrote the manuscript; NS, supervised the flow of the research and reviewed the manuscript; SNA, reviewed the manuscript; SAZB, reviewed the manuscript.

Conflict of interest

All the authors declare no conflict of interests.

References

Amare Y (2010). *Urban Food Insecurity and Coping Mechanisms. A Case Study of Lideta Sub-city in Addis Ababa*. Forum for Social Studies (FSS) Research Report. Addis Ababa, Ethiopia. From http://publication.eiar.gov.et:8080/xmlui/bitstream/handle/123456789/3046/22.pdf1abbyy.pdf?sequence=1&isAllowed=y [Retrieved June 6 2019].

Armar-Klemesu M (2000). Growing Cities, Growing Food: Urban Agriculture on the Policy Agenda. A Reader on Urban Agriculture. In N Bakker, M Dubbeling, S Gündel, U Sabel-Koschella, & H de Zeeuw (eds). *Urban Agriculture and Food Security, Nutrition and Health* (pp. 99–117). Deutsche Stiftung fur Internationale Entwicklung (DSE), Zentralstelle fur Ernahrung und Landwirtschaft. Feldafing, Germany.

Bruening M, Argo K, Payne-Sturges D & Laska MN (2017). The struggle is real: a systematic review of food insecurity on postsecondary education campuses. *J Acad Nutr Diet* 117(11):1767–1791. https://doi.org/10.1016/j.jand.2017.05.022

Chin YS & Mohd Nasir MT (2009). Eating behaviour among female adolescents in Kuantan District, Pahang, Malaysia. *Pak J Nutr* 8(4):425–432. https://doi.org/10.3923/pjn.2009.425.432

Costa NS, Santos MO, Carvalho CPO, Assunção ML & Ferreira HS (2017). Prevalence and factors associated with food insecurity in the context of the economic crisis in Brazil. *Current Developments in Nutrition* 1(10). https://doi.org/10.3945/cdn.117.000869

Dahlia I, Rabitah H & Zuraidah MI (2009). A study on financial literacy of Malaysian degree students. *Cross-Cultural Communication* 5(4):51–59.

Danek A (2017). *Food Insecurity and Related Correlates among Students Attending Appalachian State University*. Appalachian State University. Boone, North Carolina.

Darmon N & Drewnowski A (2008). Does social class predict diet quality? 1 – 3. *Am J Clin Nutr* 87:1107–1117.

DOS Malaysia (2017). *Household Income and Basic Amenities Survey Report (HIS) 2016*. Department of Statistics Malaysia. From https://newss.statistics.gov.my/newss-portalx/ep/epFreeDownloadContentSearch.seam?cid=54306 [Retrieved November 23 2019].

FAO (2008). *EC-FAO Food Security Information for Action Programme*. Food and Agriculture Organization of the United Nations, Rome.

Hanna LA (2014). Evaluation of food insecurity among college students. *Am Int J Contemp Res* 4(4):46–49.

Hayhoe CR, Leach LJ, Turner PR, Bruin MJ & Lawrence FC. (2000). Differences in spending habits and credit use of college students. *J Consum Aff* 34(1):113-133.

Hogarth JM & Hilgert MA (2002). Financial knowledge, experience and learning preferences: preliminary results from a new survey on financial literacy. Proceedings of the American Council on Consumer Interests 2002 Annual Conference. *Consumer Interest Annual* 48:1-7.

Hughes R, Serebryanikova I, Donaldson K & Leveritt M (2011). Student food insecurity: The skeleton in the university closet. *Nutr Diet* 68(1):27–32. https://doi.org/10.1111/j.1747-0080.2010.01496.

LSRO (1990). *Core Indicators of Nutritional State for Difficult-to-sample Populations*. Bethesda, Maryland. From https://www.faseb.org/Portals/2/PDFs/LSRO_Legacy_Reports/1990_Core Indicators of Nutritional State for Difficult-to-sample Populations.pdf [Retrieved March 6 2017].

Md Hafizi A (2013). Financial literacy research on undergraduate students in Malaysia: current literature and research opportunities. *Int J Educ Res* 1(11):1–12.

Meldrum LA & Willows ND (2006). Food insecurity in university students receiving financial aid. *Can J Diet Pract Res* 67(6):43–46. https://doi.org/10.3148/67.1.2006.43

MOE Malaysia (2013). *Indikator Pengajian Tinggi Malaysia*. Ministry of Education Malaysia From https://mohe.gov.my/en/download/awam/statistik/2013/76-indikator-pengajian-tinggi-malaysia-2013/file [Retrieved March 6 2016]

Mohamad Fazli S & MacDonald M (2010). Savings behavior and financial problems among college students: the role of financial literacy in Malaysia. *Crosscultural Communication* 6(3):P103-110. https://doi.org/10.3968/j.ccc.1923670020100603.009

Mohamad Fazli S, Macdonald M, Jariah M & Laily P (2008). Financial behaviour and problems among college students in Malaysia: research and education implication. *Consumer Interests Annual* 54:166–170.

Norhasmah S, Zuroni MJ & Marhana AR (2013). Implication of food insecurity among students receiving financial assistance in public institution of higher education. *MAJCAFE* 16(December):78-90

Nur Atiqah A, Norazmir M, Khairil Anuar M, Mohd Fahmi M & Norazlanshah H (2015). Food security status: It's association with inflammatory marker and lipid profile among young adult. *International Food Research Journal* 22(5):1855–1863.

Nur Hafizah M, Muhammad Shahrim AK, Mohhidin O & Hazrina G (2013). Relationships of socioeconomic level with eating behavior of traditional food among adolescents. *Mediterr J Soc Sci* 4(11):13–20. https://doi.org/10.5901/mjss.2013.v4n11p13

OHCHR (1948). Universal Declaration of Human Rights. United Nations. https://www.ohchr.org/en/udhr/documents/udhr_translations/eng.pdf [Retrieved November 10 2019]

Pendergast FJ, Livingstone KM, Worsley A & McNaughton SA (2016). Correlates of meal skipping in young adults: a systematic review. *Int J Behav Nutr Phys Act* 13(1):125. https://doi.org/10.1186/s12966-016-0451-1

Rose D, Bodor J, Swalm C, Rice J, Farley T & Hutchinson P (2008). Deserts in New Orleans? illustrations of urban food acces and implications for policy. *Vasa* (February): 1–30. From http://medcontent.metapress.com/index/A65RM03P4874243N.pdf [Retrieved November 10 2019]

Thanthida W (2010). *Food Security in Thailand: Hunger in the Midst of Plenty*. Georgetown University. Washington, DC.

USDA (2012). U.S. Adult Food Security Survey Module: Three-stage design, with screeners 2012(September):7. U.S. Department of Agriculture, Washington DC. https://www.ers.usda.gov/media/8279/ad2012.pdf

Wan Azdie MAB, Shahidah I, Suriati S & Rozlin AR (2019). Prevalence and factors affecting food insecurity among university students in Pahang, Malaysia. *Mal J Nutr* 25(1):59–67.

WFP (2020). *Zero hunger*. World Food Programme. From https://www.wfp.org/zero-hunger [Retrieved January 25 2020].

Mal J Nutr 26(3): 425-439, 2020

Effects of occupational sunlight exposure and monsoon season on vitamin D concentration among outdoor and indoor workers in Malaysia

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ABSTRACT

Introduction: Despite abundant sunshine for cutaneous vitamin D synthesis, low levels of vitamin D have been documented among the Malaysian population. The aim of this study was to characterise the effects of occupational sunlight exposure and monsoon season on serum 25-hydroxyvitamin D [25(OH)D] concentration. **Methods**: A comparative cross-sectional study was performed among Malay outdoor (n=119) and indoor workers (n=119) in Kelantan. Two-point data were collected on the same participants, first during non-monsoon season and second during the northeast monsoon season. Data collection comprised of anthropometry measurements (body mass index and body fat), fasting blood test [serum 25(OH)D concentration], and questionnaire (physical activity level, sun exposure, sun protection use, and vitamin D intake). Vitamin D classification was based on the 2011 Endocrine Society Clinical Practice Guidelines. **Results:** This study found that serum 25(OH)D concentrations were significantly higher in outdoor compared to indoor workers irrespective of season (p<0.001) and sex (p<0.001). Monsoonal differences in serum 25(OH)D concentration was only observed in male outdoor workers (mean difference=10.39 nmol/l, p<0.001). Significant association between vitamin D status and occupation was also observed (p<0.001). However, no significant association was found between vitamin D status and monsoon season [$\chi^2(1)=0.076$, p=0.783]. **Conclusion:** Seasonal and occupational factors should be considered while evaluating individual serum 25(OH)D concentration and in comparing community studies, especially among workers.

Keywords: 25-hydroxyvitamin D, occupation, monsoon, sunlight exposure

INTRODUCTION

Known as the 'sunshine vitamin', sunlight exposure is a major and natural source of vitamin D. Although vitamin D can be obtained from the diet (foods or supplements), skin exposure to solar ultraviolet B (UVB) radiation (wavelength

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doi: https://doi.org/10.31246/mjn-2020-0038

290-315 nm) covers 90% of vitamin D production in humans (Holick, 2010). Therefore, any factors that prevent UVB radiation will reduce the cutaneous synthesis of vitamin D. Endogenous (e.g. skin pigmentation and thickness) and exogenous factors such as latitude, season, time of day, pollution, weather condition, and lifestyle (use of sunscreen, clothing, and indoor living) influence the cutaneous synthesis of vitamin D (Holick, 2010).

Vitamin D deficiency (as reflected by circulating serum 25-hydroxyvitamin D [25(OH)D] levels <50 nmol/l or 20ng/ml) is a global health problem affecting all age groups, even in low latitude countries where there is abundant UVB rays for cutaneous vitamin D synthesis, or in industrialised countries where fortification of foods with vitamin D has been implemented (Palacios & Gonzalez, 2014). In Malaysia, despite its close proximity to the equator and plentiful sunlight, high prevalence of vitamin D deficiency has been reported in adults (Chin *et al.*, 2014; Moy, 2011).

The relationship of vitamin D with occupation and season has been investigated. (Azizi *et al.*, 2009; Barger-Lux & Heaney, 2002; Cinar *et al.*, 2014; Devgun *et al.*, 1981; Vu *et al.*, 2011). It has been demonstrated that some occupational groups such as indoor workers, shift workers, and healthcare workers are at a higher risk of vitamin D deficiency (Sowah *et al.*, 2017). This risk will further accelerate during seasonal changes, especially in winter and spring (Cinar *et al.*, 2014; Vu *et al.*, 2011). To our knowledge, the effects of prolonged periods of rain during monsoon season on vitamin D levels are not well documented. Moreover, in Malaysia, the knowledge on the effects of different occupational groups on vitamin D levels is still scarce. Therefore, this study was conducted to characterise the effects of occupational sunlight exposure and monsoon season on serum 25(OH)D concentration among Malay workers during non-monsoon and monsoon season.

MATERIALS AND METHODS

Study design, setting and participants

A comparative cross-sectional study was conducted to compare the serum 25(OH)D concentration between outdoor and indoor workers in two different seasons (non-monsoon and monsoon). Outdoor workers were defined as those who experienced occupational sunlight exposure for >2 hours/day between 8.00 am to 2.00 pm (Azizi *et al.*, 2009), while indoor workers were those who stayed indoors more than half of their working hours. Based on this definition, fishermen and office staffs were assigned as outdoor and indoor workers, respectively. Malay workers were recruited for this study as Malays are the largest (>90%) ethnic group in Kelantan. Workers were eligible for inclusion in the study if they were apparently healthy, aged 20 – 50 years, and fulfilled the definition of outdoor and indoor workers. Exclusion criteria included any major illnesses including diseases of the liver, kidney or thyroid, and if they were pregnant and/or lactating. Purposive sampling was adopted to ensure that participants were recruited from the two groups of interest (outdoor versus indoor workers). The study protocol was approved by the Human Research Ethics Committee, Universiti Sains Malaysia [USMKK/PPP/JEPeM 247.3(10)], and a written informed consent was obtained from each subject before the study. Figure 1 shows the flowchart of the study.

Study location

Data collection for indoor workers took place at the government buildings of Wisma Persekutuan Kota Bharu, which involved 16 departments including the National Registration Department,

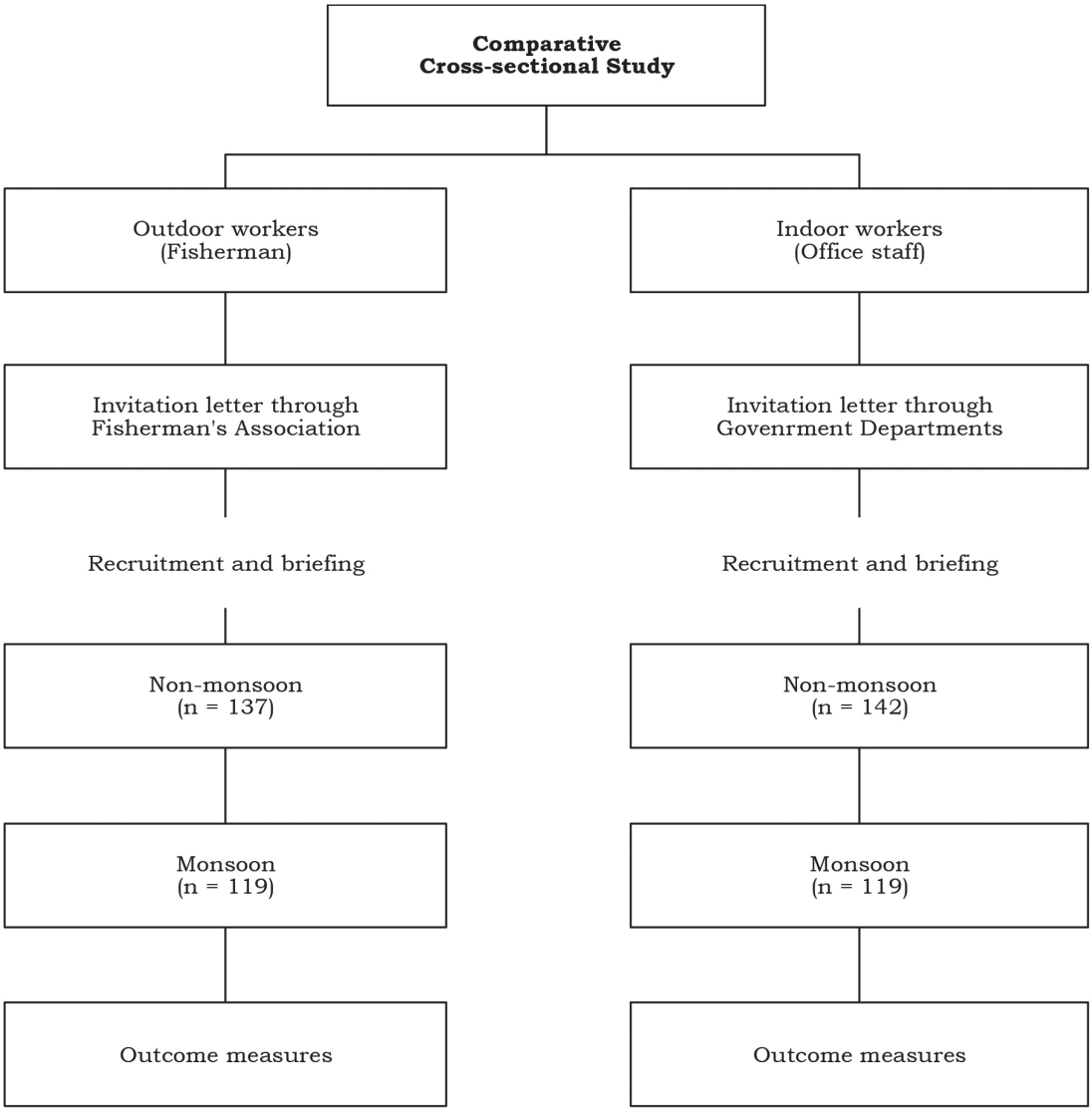


Figure 1. Flowchart of the study

Immigration Department, Department of Statistics, Valuation and Property Services Department, and Kelantan State Health Department. The Wisma Persekutuan was chosen because it is the only workplace with a high density of indoor working population in Kelantan. On the other hand, data collection for outdoor workers was conducted in four fishing villages namely Kampung Pantai Sabak (Kota Bharu District, Latitude 6°7'N), Kampung Pengkalan Petah (Bachok District, Latitude 6°4'N), Kampung Kandis, and Kampung Pachakan (Pasir Puteh District, Latitude 5°50'N). These villages were located along the Peninsula's east coast and facing the South China Sea.

Meteorological data

Information on the northeast monsoon and weather forecasting were obtained

from the Malaysia Meteorological Department (MMD). Samples collected during May to June 2012 represented the non-monsoon season, and those from January to February 2013 represented the northeast monsoon season. Data on environmental parameters such as temperature, relative humidity, and total rainfall for both non-monsoon and monsoon seasons were recorded at the Kota Bharu Meteorological Station (Latitude 6°10'N), and were retrieved from the National Weather Centre. Additionally, for monsoon season, the weather was also observed physically in order to get the precise time for data collection. Since the half-life of serum vitamin D concentration is approximately 15 days (Holick, 2010), data collection was conducted three weeks after a continuous rainfall.

Serum 25(OH)D concentration

Vitamin D status was determined by measuring serum 25(OH)D concentration, as it is considered the robust "gold standard" method. To measure serum 25(OH)D concentration, a series of two fasting venous blood samples (5 mL each) were collected from each participant, measured by electrochemiluminescence immunoassay (ECLIA) on the Cobas e411 analyser (Roche Diagnostic, Switzerland) with Elecsys® Vitamin D Total Kit (REF: 05894913 190, Roche Diagnostic, Switzerland). The inter- and intra-assay coefficients of variation were 4.2% and 6.6%, respectively. Vitamin D status was in accordance with the U.S. Endocrine Society Clinical Practice Guideline 2011, with classifications as follows: sufficient (serum 25(OH)D concentration ≥75 nmol/l), insufficient (serum 25(OH)D concentration 50 – 74 nmol/l), and deficient (serum 25(OH)D concentration <50 nmol/l).

Anthropometric measurements

Anthropometric measurements were performed at each time point in the morning by two trained enumerators, which included height, weight, and body fat. Standardised techniques and the same equipments were used for all measurements. Measurements were taken in duplicate and the average was recorded. Height was measured with subjects barefooted, using a mechanical measuring tape (Seca 206, Hamburg, Germany) to the nearest 0.1 cm. Body weight and body fat were measured using a total body composition analyser (Tanita SC-331S, Japan). Weight was recorded to the nearest 0.1 kg with subjects in light clothing and no shoes. Body mass index (BMI) was calculated as the ratio of weight in kilogram to the square of height in meters (kg/m^2). Participants were categorised into the following World Health Organization (WHO) BMI classification: underweight, <18.5 kg/m^2; normal, 18.5 – 24.9 kg/m^2; overweight, 25.0 – 29.9 kg/m^2, and obese, ≥30 kg/m^2. Body fat measurement was based on the bioelectrical impedance analysis (BIA) technique. Percentage body fat was classified as follows: (1) acceptable range, with body fat between 6%-24% in male and 9%-31% in female; (2) unhealthy range (too high), with body fat ≥ 25% in male and ≥ 32% in female (Nieman, 2003).

Sun exposure and sun protection assessment

Sun exposure was estimated using a questionnaire adopted from Moy (2011). The workers were interviewed about their exposure to direct sunlight, which included the type, frequency, and duration (in minutes per day in a week) of outdoor activities. Besides, the participants were asked about their sun protection measures, such as wearing of long sleeves, long skirt, long pants, veils, hat/cap, gloves, and the use of sun block lotion and an umbrella. Sun exposure score was calculated by

multiplying the duration (in minutes) of sun exposure per day with the number of days per week, whereas sun protection score was calculated by the total usage of sun protection and protective clothing (maximum = 8, minimum = 0).

Physical activity level

The short version of the Malay International Physical Activity Questionnaire (IPAQ) was used to estimate participants' physical activity levels. IPAQ measures the specific types of activity that are vigorous-intensity, moderate-intensity, and walking for the past seven days. Participants were asked about the frequency (days) and duration per day (in minutes) per week for each specific type of activity. Recorded data were then analysed using the Excel spreadsheet, following the IPAQ's guidelines for data processing and analysis (IPAQ Group, 2005). Physical activity was expressed as a continuous score (Total MET-minute/week) and physical activity level (high, moderate and low).

Vitamin D intake

Vitamin D intakes of participants were assessed using a food frequency questionnaire (FFQ) provided and adapted from Wu *et al.* (2009). The modified version consisted of 30 foods with ten response options ranging from 'never or <1 per month' to '>2 times per day' for the frequency of consumption. The serving sizes were based on household measurements (e.g. cups, spoons) and natural units (e.g. 1 slice). Participants were asked to rank serving sizes as medium (standard portion size), small (half of medium), or large (twice medium). The amount of vitamin D from foods were analysed using the Nutritionist Pro™ Diet Analysis software (Axxya Systems LLC., USA) based on the U.S. Department of Agriculture (USDA) Foods database. The amount of vitamin D intake was calculated from the FFQ according to the following formula: participant's frequency of intake × amount of the item consumed (calculated as 0.5 for smaller than average serving size, and 1.5 for larger than average serving size) × amount of nutrient in the serving size indicated.

Statistical analysis

Statistical analysis was performed using the IBM SPSS Statistics for Windows, Version 23.0 (Armonk, NY: IBM Corp.). Descriptive analysis was performed to describe the basic features of the data. Data were presented according to occupation (outdoor and indoor), season (non-monsoon and monsoon), and sex (male and female). Categorical variables were presented as frequency (percentages), while numerical variables were presented as mean and standard deviation (SD) for normally distributed data, or median and inter-quartile range (Q1, Q3) for skewed data. In order to compare the environmental characteristics and other parameters between outdoor and indoor groups or males and females, the independent-sample *t*-test or Mann-Whitney test was conducted for continuous variables. Within each study group, the differences in study variables of monsoon and non-monsoon seasons were assessed by paired-sample *t*-test or Wilcoxon Signed Rank test depending on the distribution of the data. Chi-square test was performed for categorical data to test for the associations between (i) vitamin D status and occupation; (ii) vitamin D status and sex; (iii) vitamin D status and season. For this analysis, vitamin D status was re-grouped into two categories (sufficient and insufficient), in order to fulfil the assumption of chi-square analysis. This was done by combining the vitamin D deficient and insufficient groups together. All analyses conducted were two-tailed, and a *p*-value

Table 1. General characteristics of study participants by season, occupation and sex

Characteristics	*Non-monsoon season*			*Monsoon season*			*Non-monsoon vs. Monsoon*	
	Outdoor (n = 119)[a]	*Indoor (n = 119)[b]*	*p-value*	*Outdoor (n = 119)[c]*	*Indoor (n = 119)[d]*	*p-value*	*Outdoor (a vs. c) p-value*	*Indoor (b vs. d) p-value*
Male	*n=111*	*n=37*		*n=111*	*n=37*		*n=111*	*n=37*
Age (yrs.)†	42.6 (9.78)	41.5 (10.87)	0.571					
SE score (hrs./wk.)‡	49.0 (42.0, 56.0)	3.00 (2.0, 4.9)	<0.001	33.3 (10.0, 35.0)	2.50 (1.5, 5.0)	<0.001	<0.001	0.004
SP score†	2.85 (1.10)	1.84 (0.83)	<0.001	2.42 (1.28)	1.97 (0.96)	0.051	0.001	0.257
PA score (MET-min/wk.)‡	5760 (3291, 7590)	1332 (452, 2276)	<0.001	2640 (1140, 4620)	909 (698, 1520)	<0.001	<0.001	0.019
Vitamin D intake (µg/day)†	17.9 (5.90)	9.84 (5.65)	<0.001	16.9 (5.65)	9.40 (4.45)	<0.001	0.198	0.124
Body mass index (kg/m^2)†	24.9 (4.67)	26.7(3.78)	0.036	25.1 (4.64)	26.8 (3.82)	0.044	0.032	0.486
Body fat (%)†	22.2 (6.08)	24.9 (4.96)	0.019	23.0 (6.16)	24.6 (4.82)	0.138	<0.001	0.492
Female	*n=8*	*n=82*		*n=8*	*n=82*		*n=8*	*n=82*
Age (yrs.)†	44.9 (10.20)	39.5 (10.70)	0.174					
SE score (hrs./wk.)‡	20.0 (27.8, 40.3)	1.50 (1.0, 2.6)	<0.001	14.5 (7.3, 40.3)	1.00 (0.1, 2.0)	<0.001	0.042	<0.001
SP score†	4.00 (0.76)	3.79 (0.84)	0.505	4.13 (0.64)	3.88 (0.90)	0.449	0.785	0.310
PA score (MET-min/wk.)‡	1680 (1431, 2280)	689 (462, 1091)	<0.001	1140 (960, 3360)	558 (405, 851)	<0.001	0.345	0.029
Vitamin D intake (µg/day)†	14.5 (3.60)	9.20 (3.96)	0.003	14.4 (3.47)	9.43 (3.47)	0.002	0.499	0.139
Body mass index (kg/m^2)†	29.0 (3.90)	26.6 (5.22)	0.224	29.0 (3.30)	26.8 (5.13)	0.232	0.787	0.076
Body fat (%)†	40. 6 (4.55)	36.6 (7.71)	0.156	41.4 (3.57)	37.3 (7.01)	0.101	0.133	0.025
Male vs. Female (*p*-value)								
Age	0.519	0.343						
SE score	0.001	<0.001		0.614	<0.001			
SP score	0.004	<0.001		<0.001	<0.001			
PA Score	0.025	0.030		0.456	0.010			
Vitamin D intake	0.141	0.634		0.279	0.980			
Body mass index	0.023	0.907		0.020	0.983			
Body fat	<0.001	<0.001		<0.001	<0.001			

Abbreviation: SE, sun exposure; SP, sun protection; PA, physical activity

†Data expressed as mean (SD)

‡Data expressed as median (Q1, Q3)

p-values were estimated using independent t-test/ Mann-Whitney U test (outdoor *vs.* indoor, male *vs.* female), and paired t-test/ Wilcoxon Signed-Rank test (non-monsoon *vs.* monsoon)

of ≤0.05 was considered as statistically significant.

RESULTS

The study recruited 279 healthy workers, of which 137 (49.0%) were outdoor workers and 142 (51.0%) were indoor workers. Forty-one subjects (14.7%) were dropped because of incomplete data, and 238 (85.0%) qualified for the analysis. The number of people who remained in the analysis was similar in the two groups (119 per group). Participants were all Muslims.

Figure 2 illustrates the patterns of average rainfall, relative humidity, and daily temperature during the months of monsoon and non-monsoon seasons. The warmest months were May and June, while most rainfalls occurred in December. As expected, the environmental parameters changed significantly from non-monsoon to monsoon season. Daily temperature decreased by 1.3°C during monsoon compared to non-monsoon season. Besides, there were increments of 6.23% in relative humidity and rainfall by 240% during the monsoon season, compared with the non-monsoon season.

Table 1 shows the general characteristics of the participants. The mean age for outdoor and indoor workers were 42.75±9.78 and 40.11±10.74 years, respectively. Comparisons between outdoor and indoor workers revealed that outdoor workers had significantly higher sunlight exposure, physical activity, and vitamin D intake than indoor workers regardless of sex and season. Sun protection score was significantly higher in male outdoor workers than male indoor workers during non-monsoon season, but was similar during monsoon season. No significant difference was observed in sun protection score between female outdoor and indoor workers in both seasons. BMI and fat percentage

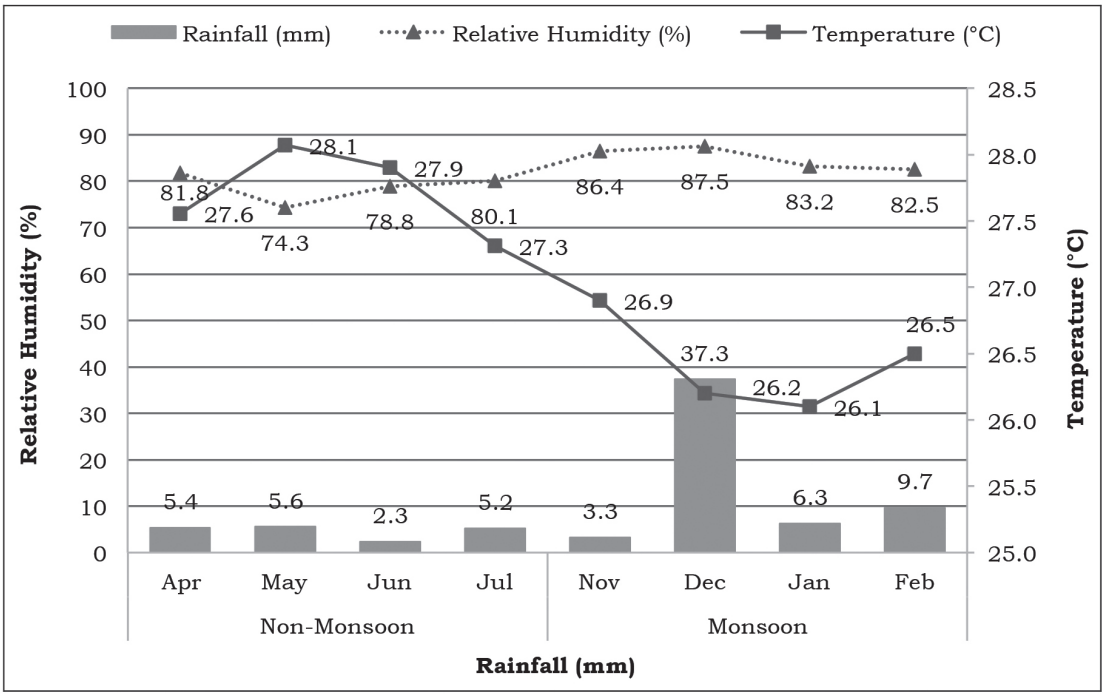


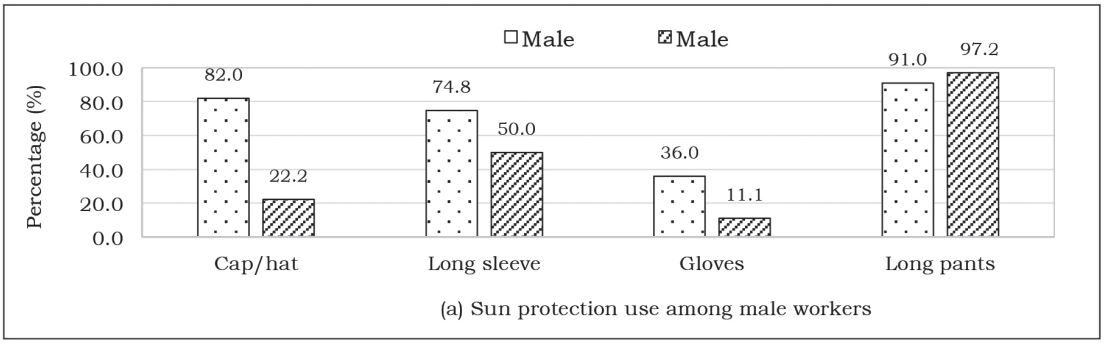
Figure 2. Average rainfall, relative humidity and 24 hours mean temperature during non-monsoon and monsoon season

(non-monsoon only) were significantly lower in outdoor than indoor workers. However, female workers of both groups showed similar BMI and fat percentage.

Monsoonal differences revealed that sun exposure and physical activity scores were significantly decreased from non-monsoon to monsoon season in all participants, while vitamin D intake and sun protection score remained similar in both seasons. But these changes were not observed in female outdoor workers for physical activity score (p=0.345) and male outdoor workers for sun protection score (p=0.001). Increased BMI and body fat were observed among outdoor workers. Both BMI and body fat remained unchanged in male indoor and female outdoor workers. Meanwhile, body fat but not BMI, increased significantly among female indoor workers from non-monsoon to monsoon season.

Sex differences showed that male workers spent significantly more hours under the sunlight with lesser use of sun protection, and had higher physical activity in both occupations and seasons. However, in monsoon season, sunlight exposure and physical activity scores were equal between male and female outdoor workers. In terms of vitamin D intake, no significant differences were observed between male and female workers in both occupations and seasons. BMI (except in indoor workers) and body fat were significantly lower in male than female workers.

Figure 3 shows the distribution in the use of sun protection among male and female workers during non-monsoon season. Among male workers, the use of sun protection items included long pants, cap/hat, long sleeve, and gloves. On the other hand, veil, long sleeve,



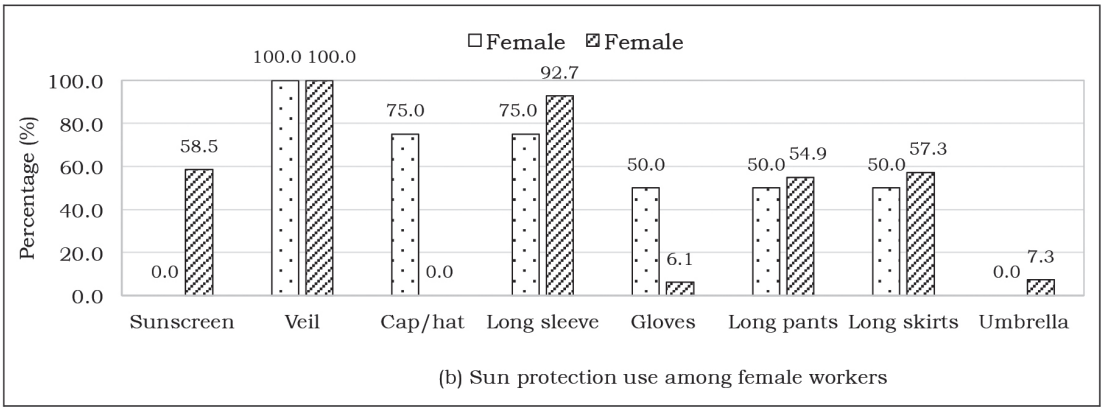


Figure 3. Distribution of sun protection use among male and female workers

long pants, and long skirts were the most commonly used items by female workers. Only female indoor workers used sunscreen.

Table 2 provides the results of serum 25(OH)D concentration and vitamin D status according to season, occupation and sex. The results clearly demonstrated that serum 25(OH) D concentrations were significantly higher in outdoor workers compared to indoor workers irrespective of season and sex (p<0.001). Furthermore, serum 25(OH)D was significantly lower in females compared with their male counterparts (p<0.001). Significant seasonal (monsoon) difference in serum 25(OH)D concentration was only found in male outdoor workers (p<0.001). The distribution of vitamin D status showed that majority of outdoor workers (96.4% males and 62.5% females) had sufficient levels of vitamin D. Among indoor workers, majority of male and female workers were vitamin D insufficient and deficient, respectively. Chi-square tests revealed that whether in non-monsoon or monsoon season, there was a significant association between vitamin D status and occupation. Besides, a significant association between vitamin D status and sex was also observed [non-monsoon, $\chi^2(1)=123.2$, p<0.001; monsoon, $\chi^2(1)=122.0$, p<0.001]. However, no significant association was found between vitamin D status and season [$\chi^2(1)=0.076$, p=0.783).

DISCUSSION

This study sought to determine the effects of occupation and season on serum 25(OH)D concentrations. The results of this comparative cross-sectional study indicated that for both seasons, the 25(OH)D concentration of outdoor workers was about two-fold that of indoor workers. Furthermore, this study found a significant association between the type of occupation and vitamin D status. The results also showed that occupation such as indoor work was related to a higher prevalence of vitamin D insufficiency and deficiency. However, no significant association was found between season and vitamin D status.

Occupation and vitamin D

To the best of our knowledge, this is the first study to report the highest serum 25(OH)D concentration in Malaysian adults. The concentration observed among outdoor workers in this study was higher than that in Korean fishermen during summer with a mean of 59.3±22.2 nmol/l (Lee *et al.*, 2018). Besides, lower serum 25(OH)D concentrations have also been reported among outdoor workers in Israel and India, which ranged between 57 and 74 nmol/l (Azizi *et al.*, 2009; Goswami *et al.*, 2016). In fact, serum concentrations of 25(OH)D above 200 nmol/L are not rare among healthy persons with ample sunlight exposure (Barger-Lux and Heaney, 2002). On the other hand, the concentrations of serum 25(OH)D in indoor workers were about the same as those of previous studies that have examined the relationship between occupation and vitamin D levels (Azizi *et al.*, 2009; Cinar *et al.*, 2014).

In this study, the different work environments between outdoor and indoor workers contributed to significant differences in sunlight exposure. Outdoor workers exposed themselves to the sunlight chronically and spent more than half of their day under sunlight, especially during peak hours of UVB radiation (10.30 a.m. and 3.30 p.m.). In contrast, indoor workers spent most of their day inside the building, hence exposure to sunlight was limited. As a major source of vitamin D, sunlight exposure contributes 90% of vitamin D production in humans through cutaneous synthesis after solar UVB

Table 2. Serum 25(OH)D concentrations (nmol/l) and vitamin D status by season, occupation, and sex

Serum 25(OH)D concentrations (nmol/ 1) and vitamin D status	*Non-monsoon season*			*Monsoon season*			*Non-monsoon vs. Monsoon*	
	Outdoor (n = 119)[a]	*Indoor (n = 119)[b]*	*p-value*	*Outdoor (n = 119)[c]*	*Indoor (n = 119)[d]*	*p-value*	*Outdoor (a vs. c) p-value*	*Indoor (b vs. d) p-value*
Male	*n=111*	*n=37*		*n=111*	*n=37*		*n=111*	*n=37*
25(OH)D concentration, mean (SD)[†]	129.7 (36.1)	67.6 (15.0)	<0.001	119.3 (32.4)	66.7 (16.4)	<0.001	<0.001	0.383
Vitamin D status, *n* (%)[‡]								
Sufficient	107 (96.4)	14 (37.8)	<0.001	107 (96.4)	12 (32.4)	<0.001	0.999	0.626
Insufficient	4 (3.6)	20 (54.1)		4 (3.6)	19 (51.4)			
Deficient	0 (0.0)	3 (8.1)		0 (0.0)	6 (16.2)			
Female	*n=8*	*n=82*		*n=8*	*n=82*		*n=8*	*n=82*
25(OH)D concentration, mean (SD)[†]	78.2 (12.4)	39.2 (14.4)	<0.001	76.0 (19.1)	40.8 (13.9)	<0.001	0.168	0.063
Vitamin D status, *n* (%)[‡]								
Sufficient	5 (62.5)	2 (2.4)	<0.001	5 (62.5)	1 (1.2)	<0.001	0.999	0.556
Insufficient	3 (37.5)	19 (23.2)		2 (25.0)	17 (20.7)			
Deficient	0 (0.0)	61 (74.4)		1 (12.5)	64 (78.0)			
Male vs. Female (*p*-value)								
25(OH)D concentration[†]	<0.001	<0.001		<0.001	<0.001			

[†]*p*-values were estimated using independent t-test (outdoor *vs.* indoor, male *vs.* female), and paired t-test (non-monsoon *vs.* monsoon)

[‡]*p*-values were estimated using chi-square test (vitamin D status *vs.* occupation, vitamin D status *vs.* season)

radiations (Holick, 2010). This factor best explains the difference in serum 25(OH) D concentrations between outdoor and indoor workers.

Another factor that contributed to the higher 25(OH)D concentrations in outdoor compared to indoor workers was a higher mean intake of vitamin D in outdoor than indoor workers. The mean daily vitamin D intake in this study (>9.2 ug) was considerably higher than the levels observed in Malaysian athletes aged ≥18 years from the National Sports Institute, that were based on food consumption only (6.1±5.2 ug) (Leong & Azhanie, 2013). Majority of outdoor workers (60.5%) achieved the daily recommended level of vitamin D intake (15 µg/day), but not so in the case of indoor workers (11.9%). As fishermen (outdoor workers), seafood is their main food source (Coutinho *et al.*, 2019). Fatty fish and eggs are major food sources of vitamin D. Lehmann *et al.* (2015) reported that fish consumption increased concentrations of serum 25(OH)D, although recommended fish intake cannot optimise vitamin D status. Other than supplements, dietary sources of vitamin D are limited. Therefore, skin synthesis of vitamin D by UVB rays remains an alternatively inexpensive source of vitamin D in humans (Coutinho *et al.*, 2019).

The current study revealed that none of the outdoor workers were classified as vitamin D deficient (serum 25(OH)D <50 nmol/l), except for 1 (0.8%) female participant during the monsoon season. In contrast, more than half of the indoor workers (53.8%, non-monsoon; 58.8%, monsoon) were identified with vitamin D deficiency. High prevalence of vitamin D deficiency among indoor workers was due to long working hours that led to sunlight deprivation, hence reducing the cutaneous synthesis of vitamin D (Sowah *et al.*, 2017). The study conducted among Israeli workers showed that indoor workers had four- to eight-folds lower occupational exposure to solar UVB than outdoor workers (Azizi *et al.*, 2009). According to Godar (2005), indoor workers receive about 3% of total annual available UV compared to 10% received by outdoor workers.

Monsoon and vitamin D

The present study is first of its kind in Malaysia to provide evidence with respect to the effects of monsoon season (also known as rainy season) on serum 25(OH)D concentrations. The monsoonal differences in serum 25(OH) D concentration was observed only in outdoor workers, despite the significant decrease in sunlight exposure scores for both groups during monsoon. However, the results of this study did not show any significant association between vitamin D status and season (p=0.783), meaning there was no difference in the occurrence of vitamin D sufficiency/ insufficiency between non-monsoon and monsoon season.

The observed results of serum 25(OH)D concentration in indoor workers was similar to those reported in pregnant Thai women (18 to 45 years), which found no significant difference in serum 25(OH)D concentrations between rainy and winter season (Pratumvinit *et al.*, 2015). Tangoh *et al.* (2018) also found that rainy or dry season had no significant effects on vitamin D level in non-pregnant participants (≥35 years) in Cameroon. In contrast, research conducted in countries with four seasons (summer, fall, winter, and spring) found that serum 25(OH)D concentrations were significantly affected by seasons (Azizi *et al.*, 2009; Barger-Lux & Heaney, 2002; Cinar *et al.*, 2014; Devgun *et al.*, 1981; Vu *et al.*, 2011).

Another important finding was that outdoor workers showed higher serum 25(OH)D concentrations than indoor workers in both seasons. Similar results

were reported in four seasons studies among Israeli (Azizi *et al.*, 2009) and Scottish workers (Devgun *et al.*, 1981), suggesting that despite seasonal changes on serum 25(OH)D concentrations, outdoor workers maintained the highest levels at all seasons. It is possible that in outdoor workers, occupational sunlight exposure lasted into monsoon, hence vitamin D synthesis continued from the *de novo* synthesis of vitamin D precursor (Devgun *et al.*, 1981), which was produced and stored during the non-monsoon season.

The noticeable effect of monsoon on serum 25(OH)D concentration in male outdoor workers is best explained by the fact that monsoon weather affected fishing activities among workers. The northeast monsoon is described as a wet season that is associated with cloudy conditions and frequent afternoon showers. During monsoon season, four to five episodes of monsoon surges are expected. The monsoon surges bring a continuous, moderate to heavy rainfall lasting two to five days, occasionally windy conditions and a few days of cooler temperatures with unavailability of sunlight (MMD, 2017). During this period, participants of both groups were more likely to spend more time indoor based on the declining sunlight exposure and lesser physical activity. Strong winds, high wave and rough seas put outdoor workers off work and they stay indoor during this time. A local study has revealed that monsoon weather significantly affects fishing operation, with 75% of fisherman not being able to go to sea (Yaakob & Chau, 2005). Lack of outdoor work during this time may explain the significant increase in body weight, BMI and body fat percentage in male outdoor workers.

Additionally, significant changes in weather conditions may also contribute to decreased serum 25(OH) D concentrations during monsoon in outdoor workers. Firstly, distribution of UV erythemal dose is strongly correlated with the monsoon seasons and atmospheric variables in Malaysia, which is highest in April (non-monsoon) and lowest in December (monsoon) (Tan *et al.*, 2018). Secondly, a strong positive correlation has been observed between relative humidity and cloud cover (Walcek, 1994). At 80% humidity, the average cloud cover is about 50%. In this study, the relative humidity during monsoon was more than 80%, for which the expected cloud cover was greater than 50%. A cloud cover of more than 50% was found to significantly reduce UVB radiation (Németh *et al.*, 1996) and thus, decreases the synthesis of pre-vitamin D3 by 20% on a cloudy day (Holick, 2010).

Sex and vitamin D

The current study found that female workers had lower serum 25(OH) D concentrations than male workers regardless of season and occupation. A high prevalence of vitamin D deficiency (74.4%, non-monsoon; 78.8% monsoon) was observed among female indoor workers. The proportion of deficiency (serum 25(OH)D <50 nmol/L) reported in this study was lower compared to a study conducted among Malay women who were public university employees, with a prevalence of 86.9% (Moy 2011). More time spent in indoor and high sun protection measures among females are accounted for these findings. Moreover, avoiding the sun by using sunscreen and an umbrella contributed to the deficient level of serum 25(OH)D concentrations among female indoor workers. As a common practice in Muslim culture, the female participants dressed modestly which ranged from using a simple scarf/ veil to full body covering (except face), which limited skin exposure to sunlight (Moy, 2011). In this study, 100% of female workers wore a veil, and majority

of them wore long clothes whenever they went outdoor. Previous studies have confirmed that vitamin D is negatively correlated with the Islamic dressing as part of culture influence (Shakir, 2012).

In addition, higher body fat might have contributed to lower serum 25(OH) D concentrations in female workers. This study showed that majority of the female workers were overweight/obese (87.5% outdoor, 63.4% indoor), and had excessive body fat (100% outdoor; 74.4% indoor). The inverse relationship between BMI and body fat with vitamin D has been conclusively shown (Chin *et al.*, 2014; Touvier *et al.*, 2014; Wortsman *et al.*, 2000). As vitamin D is a fat-soluble vitamin, obesity enhances the uptake of vitamin D by adipose tissue. This causes synthesised vitamin D to be trapped in the body fat compartment (adipose tissue), which results in lower bioavailability of serum 25(OH)D in the blood circulation (Wortsman *et al.*, 2000).

In this study, both male and female outdoor workers had higher physical activity levels than indoor workers. It has been demonstrated that physical activity, as measured using various different tools, is associated with vitamin D level (Chin *et al.*, 2014; Touvier *et al.*, 2014). Higher physical activity level in outdoor than indoor workers was mainly because of the differences in occupational physical workloads, which involved heavy work, repetitive activities or forced static postures (BAuA, 2019). In a previous study, physical activity was often used as a surrogate for the amount of time spent outdoors. Therefore, participants who were physically active also tended to spend more time under the sun (Touvier *et al.*, 2014).

One of the limitations of this study was the unavailability of solar UVB radiation data. The meteorological data collected and explored countered this limitation. Besides that, a small sample size of female outdoor workers, although common in this population, might have contributed to the non-significant monsoonal differences in serum 25(OH) D concentration among this population.

CONCLUSION

This study indicated that occupational sunlight exposure of serum 25(OH) D concentration was about two times greater in outdoor than indoor workers. A significant monsoon deficit of serum 25(OH)D concentration was observed only among outdoor workers. Regardless of season and occupation, female workers had significantly lower serum 25(OH) D concentrations than male workers. People should be advised to have more outdoor activities and sun exposure for getting an adequate level of vitamin D. Besides, seasonal and working environment should be considered while evaluating individual serum 25(OH) D concentration and when comparing community studies, especially among workers.

Acknowledgement

The vitamin D analysis kit was provided by Roche (Malaysia) Sdn. Bhd. The authors acknowledge Prof. Dr. Moy Foong Ming and Prof. Dr. Susan Whiting for their contributions by facilitating some of the research materials. This project was funded by a research grant from the Fundamental Research Grant Scheme (FRGS), Malaysia (203/PPSK/6171141).

Authors' contributions

NA, conducted the study, data analysis and interpretation, prepared the draft of the manuscript and reviewed the manuscript; AKM, assisted in drafting of the manuscript and reviewed the manuscript; WMIBWM, medical advisor and reviewed the manuscript; WAMBWM, conceptualised and designed the study; HJBJM, principal investigator and reviewed the manuscript.

Conflict of interest

The author(s) declared no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

References

Azizi E, Pavlotsky F, Vered I & Kudish AI (2009). Occupational exposure to solar UVB and seasonal monitoring of serum levels of 25-hydroxy vitamin D3: a case-control study. *Photochem Photobiol* 85(5):1240-1244.

Barger-Lux MJ & Heaney RP (2002). Effects of above average summer sun exposure on serum 25-hydroxyvitamin D and calcium absorption. *J Clin Endocrinol Metab* 87(11):4952-4956.

BAuA (2019). *Physical Workload (Federal Institute for Occupational Safety and Health).* From https://www.baua.de/EN/Topics/Work-design/Physical-workload/_functions/Publications-search_Formular.html?queryResultId=null&pageNo=0 [Retrived Feb 2019].

Chin KY, Ima-Nirwana S, Ibrahim S, Mohamed IN & Wan Ngah WZ (2014). Vitamin D status in Malaysian men and its associated factors. *Nutrients* 6(12):5419-5433.

Cinar N, Harmanci A, Yildiz BO & Bayraktar M (2014). Vitamin D status and seasonal changes in plasma concentrations of 25-hydroxyvitamin D in office workers in Ankara, Turkey. *Eur J Intern Med* 25(2):197-201.

Coutinho RCS, Santos AFD, Costa JGd & Vanderlei AD (2019). Sun exposure, skin lesions and vitamin D production: evaluation in a population of fishermen. *An Bras Dermatol* 94(3):279-286.

Devgun MS, Paterson CR, Johnson BE & Cohen C (1981). Vitamin D nutrition in relation to season and occupation. *Am J Clin Nutr* 34(8)1501-1504.

Godar DE (2005). UV doses worldwide. *Photochem Photobiol* 81(4):736-749.

Goswami R, Saha S, Sreenivas V, Singh N & Lakshmy R (2016). Vitamin D-binding protein, vitamin D status and serum bioavailable 25(OH)D of young Asian Indian males working in outdoor and indoor environments. *J Bone Miner Metab* 35(2):177-184.

Holick MF (2010). *Vitamin D: Physiology, Molecular Biology, and Clinical Applications.* Springer Science & Business Media, New York.

IPAQ Group (2005). *In: Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ)-short and long forms.* From https://sites.google.com/site/theipaq/scoring-protocol [Retrieved January 22 2019].

Lee DH, Park KS & Cho MC (2018). Laboratory confirmation of the effect of occupational sun exposure on serum 25-hydroxyvitamin D concentration. *Medicine (Baltimore)* 97(27):e11419.

Lehmann U, Gjessing HR, Hirche F, Mueller-Belecke A, Gudbrandsen OA, Ueland PM, Mellgren G, Lauritzen L, Lindqvist H, Hansen AL, Erkkilä AT, Pot GK, Stangl GI & Dierkes J (2015). Efficacy of fish intake on vitamin D status: a meta-analysis of randomized controlled trials. *Am J Clin Nutr* 102(4):837-847.

Leong L & Azhanie AN (2013). Vitamin D Intake and Sun Exposure Among Malaysian Athletes in National Sports Institute, Bukit Jalil. *Malaysian Journal of Medicine and Health Sciences* 9(1):21-28.

Malaysia Meteorological Department, MMD (2017). *Monsoon.* Fromhttp://www.met.gov.my/web/metmalaysia/education/weather/weatherphenomena/monsoon [Retrieved 4 January 2018].

Moy FM (2011). Vitamin D status and its associated factors of free-living Malay adults in a tropical country, Malaysia. *J Photochem Photobiol B* 104(3):444-448.

Németh P, Tóth Z & Nagy Z (1996). Effect of weather conditions on UV-B radiation reaching the earth's surface. *J Photochem Photobiol B* 32(3):177-181.

Nieman DC (2003). *Exercise testing and prescription: a health-related approach.* McGraw-Hill New York.

Palacios C & Gonzalez L (2014). Is vitamin D deficiency a major global public health problem? *J Steroid Biochem Mol Biol* 144(Pt A):138-145.

Pratumvinit B, Wongkrajang P, Wataganara T, Hanyongyuth S, Nimmannit A, Chatsiricharoenkul S, Manonukul K & Reesukumal K (2015). Maternal vitamin D status and its related factors in pregnant women in Bangkok, Thailand. *Plos One* 10(7):e0131126.

Shakir DK (2012). *In: Vitamin D deficiency and cultural influences among Muslim women in Southern Illinois.* (Dissertation). Master of Science Degree, Southern Illinois University Carbondale. From https://opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1963&context=theses. [Retrieved 19 Oct 2018]

Sowah D, Fan X, Dennett L, Hagtvedt R & Straube S (2017). Vitamin D levels and deficiency with different occupations: a systematic review. *BMC Public Health* 17(1):519.

Tan KC, Lim HS & Mat Jafri MZ (2018). Study on solar ultraviolet erythemal dose distribution over Peninsular Malaysia using Ozone Monitoring Instrument. *The Egyptian Journal of Remote Sensing and Space Science* 21(1):105-110.

Tangoh DA, Apinjoh TO, Mahmood Y, Nyingchu RV, Tangunyi BA, Nji EN, Azhar A & Achidi EA (2018). Vitamin D status and its associated risk factors among adults in the Southwest Region of Cameroon. *J Nutr Metab* 2018:4742574-4742574.

Touvier M, Deschasaux M, Montourcy M, Sutton A, Charnaux N, Kesse-Guyot E, Assmann KE, Fezeu L, Latino-Martel P, Druesne-Pecollo N, Guinot C, Latreille J, Malvy D, Galan P, Hercberg S, Le Clerc S, Souberbielle JC & Ezzedine K (2014). Determinants of vitamin D status in Caucasian adults: influence of sun exposure, dietary intake, sociodemographic, lifestyle, anthropometric, and genetic factors. *J Invest Dermatol* 135(2):378-388.

Vu LH, Whiteman DC, van der Pols JC, Kimlin MG & Neale RE (2011). Serum vitamin D levels in office workers in a subtropical climate. *Photochem Photobiol* 87(3):714-720.

Walcek CJ (1994). Cloud Cover and Its Relationship to Relative Humidity during a Springtime Midlatitude Cyclone. *Monthly Weather Review* 122(6):1021-1035.

Wortsman J, Matsuoka LY, Chen TC, Lu Z & Holick MF (2000). Decreased bioavailability of vitamin D in obesity. *Am J Clin Nutr* 72(3):690-693.

Wu H, Gozdzik A, Barta JL, Wagner D, Cole DE, Vieth R, Parra EJ & Whiting SJ (2009). The development and evaluation of a food frequency questionnaire used in assessing vitamin D intake in a sample of healthy young Canadian adults of diverse ancestry. *Nutr Res* 29(4):255-261.

Yaakob O & Chau QP (2005). Weather downtime and its effect on fishing operation in Peninsular Malaysia. *Jurnal Teknologi* 42(A):13-26.

Mal J Nutr 26(3): 441-452, 2020

Nutritional status and other predictors of immune response recovery among HIV-AIDS patients receiving antiretroviral therapy in Dr. Sardjito Hospital, Yogyakarta, Indonesia: a retrospective cohort study

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ABSTRACT

Introduction: Nutritional status and immune response of Human Immunodeficiency Virus-Acquired Immune Deficiency Syndrome (HIV-AIDS) patients are closely connected. There are limited studies assessing the influence of Body Mass Index (BMI) on immune response recovery among HIV patients in Indonesia. This study aimed to identify the BMI and other predictors of immune response recovery among HIV-AIDS patients following two years of Antiretroviral (ARV) therapy. **Methods:** This research was a retrospective cohort study among HIV-AIDS patients who started ARV therapy from January 2014 to December 2016 at Dr. Sardjito Hospital, Yogyakarta. Data were collected from ARV registry and medical reports. Data were analysed using linear regression. **Results:** A total of 255 patients were included in the study, with a median BMI of 20.07 kg/m^2. Results showed that BMI was not significantly correlated with immune response recovery at the 6th, 12th, 18th, and 24th months of ARV therapy (p>0.05). But, the increase in cluster of differentiation 4 (CD4) cell count was higher in overweight and pre-obese patients than underweight patients, especially in the 18th and 24th months of therapy. Factors related to immune response recovery were the regularity of treatment at the 12th, 18th, and 24th months of ARV therapy, and the use of Tenofovir at 18th-month therapy (p<0.05). **Conclusion:** Immune response recovery was higher in overweight and pre-obese patients. Using Tenofovir type ARV and doing treatment regularly can increase CD4 cell counts. Underweight patients need to enhance their nutritional status to improve their immune response during ARV therapy.

Keywords: Nutritional status, body mass index, human immunodeficiency virus, immune response, CD4

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doi: https://doi.org/10.31246/mjn-2020-0018

INTRODUCTION

Nutritional status and immune cell function are interrelated. The review conducted by Alwarawah, Kiernan & Maclver (2018) underlined the effects of nutrition on immune cells. T cells are the main component of the immune system that regulate all immune responses in the body. T cells are very sensitive to nutritional deficiencies or excesses, so the immunity of individuals who experience undernutrition and excess nutrition also needs to be understood (Alwarawrah *et al.*, 2018).

Human Immunodeficiency Virus (HIV) is a virus attacking the immune cells, particularly cluster of differentiation 4 (CD4) cells, a part of T cells, causing decreased number of CD4 cells and loss of immunity, leading to susceptibility towards infection by pathogenic microorganisms and other opportunistic infections (Makvandi-Nejad, 2016). Antiretroviral (ARV) therapy is used to slow the progression of HIV infection and reduce mortality. ARV therapy can control virus replication and improve immune response by increasing the number of CD4 cell counts. Research showed that ARV therapy would increase CD4 cell counts of patients with HIV-AIDS (Dravid *et al.*, 2011; Walker & Mcmichael, 2012).

There are some researches which studied about the factors influencing immune response recovery of HIV patients following ARV therapy. Nutritional status is one factor that needs to be considered. The interaction between immune response and nutritional status in HIV infected people is complex and interrelated. HIV infection can cause malnutrition through opportunistic infections, failure of food absorption, and also anorexia. On the other hand, malnutrition in HIV infected people will accelerate the progression of HIV into Acquired Immune Deficiency Syndrome (AIDS). Both malnutrition and HIV can decrease the number of CD4 cell counts (Duggal, Chugh & Duggal, 2012).

Body Mass Index (BMI), which is a measure for indicating nutritional status in adults, has a strong relationship with immune response. In a recent study, underweight women with ARV therapy had twice a higher risk of mortality compared to normal weight women (Sharma *et al.*, 2015). The increase in CD4 cell counts after 12 months of ARV therapy was found to be greater in patients with an initial BMI of 25-30 kg/m^2 (p=0.03) (Koethe *et al.*, 2011). Therefore, it is necessary to evaluate the effect of nutritional status at the initiation of ARV therapy on the immune response recovery of HIV-AIDS patients. This study aimed to identify the BMI and other predictors of immune response recovery among HIV-AIDS patients following two years of ARV therapy.

MATERIALS AND METHODS

Study design and participants

This study was a retrospective cohort study at Dr. Sardjito Hospital, Yogyakarta, one of the first national hospitals that conducted ARV therapy in Central Java and Yogyakarta. The hospital also provides comprehensive HIV-related services.

This study evaluated the relation between nutritional status and other factors at the first time of ARV with immune response recovery following two years of ARV therapy. Nutritional status was measured based on BMI status. Immune response recovery was marked by the changes in CD4 cell count at 6th, 12th, 18th, and 24th months of ARV therapy. CD4 cell count changes were calculated from the reduction of CD4 cell count at 6th, 12th, 18th, and 24th months of ARV therapy from CD4 cell count at the first time of ARV therapy.

The subjects of this study were

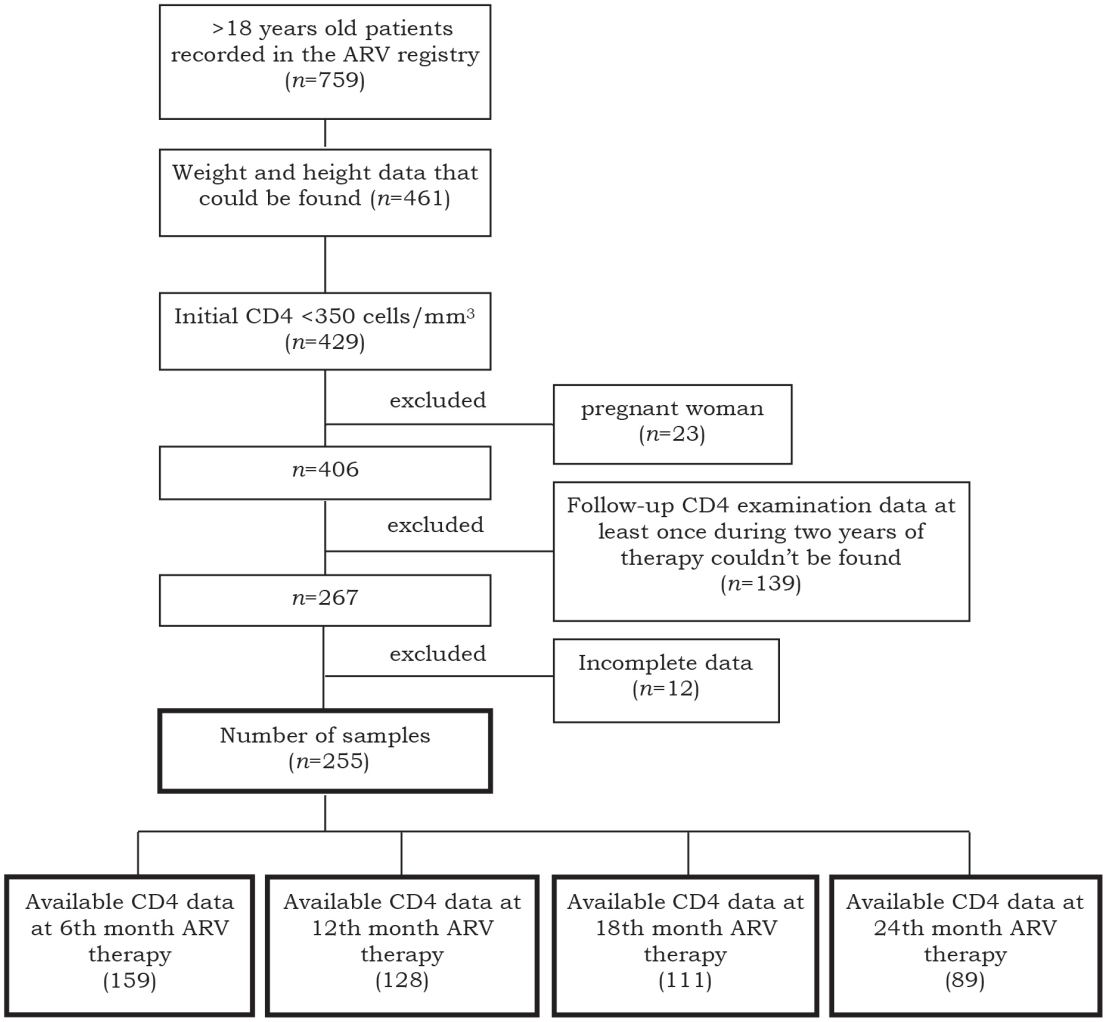

Figure 1. Sampling flow

all patients with HIV-AIDS who had undergone ARV therapy, recorded in the ARV registry and medical records at Dr. Sardjito Hospital from January 2014 to December 2016. The inclusion criteria were >18 years old, first time on ARV therapy at Dr. Sardjito Hospital from January 2014 until December 2016 or referral patients with complete medical records, available weight and height data at the beginning of ARV therapy, and CD4 cell count of <350 cells/mm^3. The subject exclusion criteria were pregnant at the beginning of ARV therapy, no CD4 examination data available during ARV therapy and any incomplete data. A total of 255 subjects were included in this study. The number of patients that could be analysed in the 6th, 12th, 18th, and 24th months of ARV therapy were 159, 128, 111, and 89 subjects, respectively (Figure 1).

Data collection

Data were collected by recording the data from medical records and ARV registry at Dr. Sardjito Hospital from January to April 2019. Data were recorded in

the data collection form according to the variables required. Nutritional status, determined by BMI, was an independent variable. BMI status was categorised based on the World Health Organization (WHO) Asia Pacific criteria. Underweight was defined as BMI <18.5 kg/m^2, normal as BMI 18.5 – 22.9 kg/m^2, overweight as BMI 23 – 24.9 kg/m^2, and pre-obese as BMI 25 – 29.9 kg/m^2. The other independent variables were demographic factors (age, education, sex, and occupation), clinical factors [the type of ARV: Nucleoside reverse transcriptase inhibitors (NRTI) and non-nucleoside reverse transcriptase inhibitors (NNRTI), initial CD4 cell count, clinical stage, and co-infection tuberculosis], and regularity of treatment. The dependent variables were the changes in CD4 cell count at the 6th, 12th, 18th, and 24th months of ARV therapy.

Data analysis

We conducted data analysis using STATA/IC 13.1. Bivariate data analysis was done using simple linear regression to identify independent predictors of CD4 change at all time points. Multivariate analysis was done using multiple linear regression. Variables included in the analysis were BMI and variables that had a *p*-value of <0.25 in the bivariate analysis. The best model was selected by looking at the smallest Bayesian Information Criterion (BIC) value. The level of significance was set at a *p*-value of less than 0.05 and 95 % confidence interval (CI). Multi-collinearity for independent variables was checked before multivariate analysis.

Ethical approval

Ethical approval was obtained from the Medical and Health Ethics and Research Committee of the Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada (KE/FK/0046/EC/2019). As this study only used secondary data and did not conduct any interviews with HIV-AIDS patients, therefore, it did not require any consent.

RESULTS

Baseline characteristics

There were 255 subjects included in this study. A total of 201 (78.82%) were males with a median age of 31 years old. The median for BMI was 20.07 kg/m^2. Most of them were in normal BMI (52.55%), started ARV therapy at <40 years old (77.25%), had higher education level (83.53%), and had a job (72.94%).

Most of the patients used Tenofovir (TDF) (84.71%) and Efavirenz (90.59%) as the type of ARV. The median initial CD4 cell count was 102 cells/mm^3. Most patients had an initial CD4 cell count of <200 cells/mm^3 (68.63%). The number of patients who started therapy with high (3 and 4) and low (1 and 2) clinical stages were relatively the same. There were 58 patients (22.75%) who had tuberculosis co-infection. The number of patients who sought treatment regularly decreased every six months. At the 24th month of ARV therapy, there were 154 patients (60.39%) who still routinely sought treatment (Table 1).

Immune response recovery

On the 6th, 12th, 18th, and 24th months of ARV therapy, the increase in CD4 cell counts from the start of therapy were 109 cells/mm^3, 115 cells/mm^3, 135 cells/mm^3, and 148 cells/mm^3, respectively. Graphs of CD4 cell count increase by nutritional status showed that in the 18th and 24th months of ARV therapy, normal weight, overweight, and pre-obese patients had higher CD4 cell count increases than underweight patients (Figure 2).

Table 1. Characteristics of HIV-AIDS patients at the first time of therapy

Characteristics	*n (%)*
BMI	
Underweight	75 (29.4)
Normal	134 (52.6)
Overweight	25 (9.8)
Pre-obese	21 (8.2)
Median : 20.07 kg / m^2	
Min-Max : 12.12 – 29.75 kg / m^2	
Age in years	
≥40	58 (22.8)
<40	197 (77.3)
Median : 31	
Min-Max : 18 - 60	
Sex	
Male	201 (78.8)
Female	54 (21.2)
Education	
Low	42 (16.5)
High	213 (83.5)
Occupation status	
Unemployed	69 (27.1)
Employed	186 (72.9)
ARV NRTI types	
Zidovudine (AZT)	39 (15.3)
Tenofovir (TDF)	216 (84.7)
ARV NNRTI types	
Neviraprine (NVP)	24 (9.4)
Efavirenz (EFV)	231 (90.6)
Initial CD4 cell count	
≤200 cells/mm^3	175 (68.6)
200-349 cells/mm^3	80 (31.2)
Median : 102 cells/mm^3	
Min-Max : 1 – 349 cells/mm^3	
Clinical stage	
High (3 and 4)	120 (47.1)
Low (1 and 2)	135 (52.9)
Tuberculosis co-infection	
No	58 (22.8)
Yes	197 (77.3)
Treatment regularity	
6^{th} month	
Irregular	34 (13.3)
Regular	221 (86.7)
12^{th} month	
Irregular	68 (26.7)
Regular	187 (73.3)
18^{th} month	
Irregular	83 (32.6)
Regular	172 (67.5)
24^{th} month	
Irregular	101 (39.6)
Regular	154 (60.4)

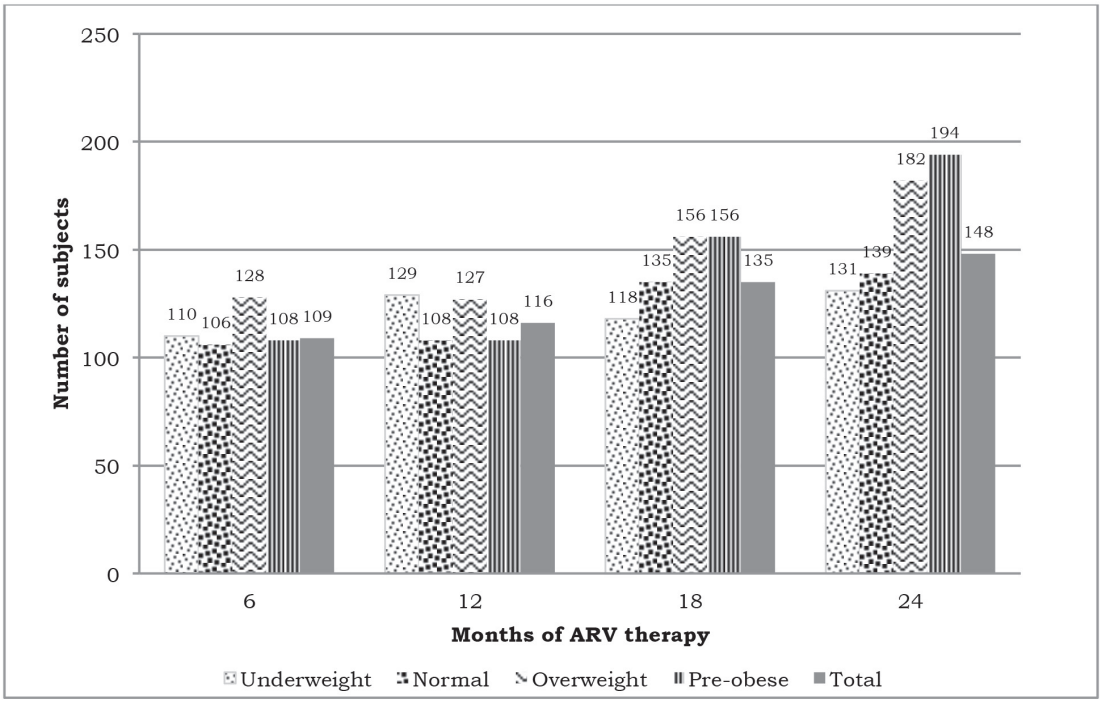

Figure 2. CD4 cell count increase at 6th, 12th, 18th, and 24th months of ARV therapy by BMI status

Factors related to immune response recovery at 6th, 12th, 18th and 24th months of ARV therapy

Immune response recovery at 6 months

There were no significant factors related to the immune response recovery at the 6th month of ARV therapy, but CD4 cell counts of overweight patients increased 16.77 cells/mm^3 (p=0.478) compared to underweight patients (Table 2).

Immune response recovery at 12 months

Treatment regularity was the only independent variable that was significantly related to the immune response recovery at the 12th month of ARV therapy. CD4 cell counts of patients who did regular treatment increased 66.88 cells/mm^3 (p=0.003*)* compared to patients who did not undertake regular treatment. CD4 cell counts of overweight patients decreased 9.638 cells/mm^3 (p=0.807) compared to underweight patients (Table 3).

Immune response recovery at 18 months

NRTI type of ARV and treatment regularity were independent variables that were significantly related to immune response recovery at the 18th month of ARV therapy. CD4 cell counts of patients who used TDF increased 74.83 cells/mm^3 (p=0.001) compared to Zidovudine (AZT). CD4 cell counts of patients who did regular treatment increased by 70.07 cells/mm^3 (p=0.005) compared to patients who did not undertake regular treatment. In comparison to underweight patients, CD4 cell counts of overweight and pre-obese patients were higher. The increase in CD4 cell count was 39.55 cells/mm^3 (p=0.274) among overweight patients and 33.38 cells/mm^3 (p=0.302) among pre-obese patients (Table 3).

Table 2. Bivariate analysis of BMI status and other predictors of CD4 cell count increase following ARV therapy

	6th month B (95% CI)	*12th month* B (95% CI)	*18th month* B (95% CI)	*24th month* B (95% CI)
BMI				
Underweight	Reference	Reference	Reference	Reference
Normal	-3.86 (-34.82, 27.11)	-21.24 (-61.75, 19.27)	17.13 (-28.97, 63.23)	9.07 (-52.98, 71.12)
Overweight	16.77(-29.84, 63.38)	-2.47 (-83.02, 78.07)	37.87 (-38.92, 114.66)	51.12 (-45.48, 147.72)
Pre-obese	-1.71 (-51.75, 48.33)	-21.37 (-91.07, 48.33)	38.47 (-32.39, 109.33)	63.87 (-28.36, 156.09)
Age in years				
≥40	Reference	Reference	Reference	Reference
<40	11.08 (-19.39, 41.55)	17.71 (-21.65, 57.07)	3.86 (-37.36, 45.09)	10.49 (-43.34, 64.32)
Sex				
Male	Reference	Reference	Reference	Reference
Female	6.68 (-26.65, 40.00)	-24.50 (-69.43, 20.43)	-13.53 (-56.63, 29.58)	-23.15 (-89.09, 42.79)
Education				
Low	Reference	Reference	Reference	Reference
High	-14.32 (-48.04, 19.40)	8.89 (-36.23, 54.02)	-45.91 (-97.42, 5.59)*	-14.81 (-75.89, 46.28)
Occupation status				
Unemployed	Reference	Reference	Reference	Reference
Employed	-22.52 (-52.05, 7.01)*	17.91 (-25.11, 60.94)	-2.14 (-42.96, 38.69)	32.56 (-24.61, 89.74)
ARV NRTI types				
Zidovudine (AZT)	Reference	Reference	Reference	Reference
Tenofovir (TDF)	25.37 (-14.04, 64.77)*	-40.85 (-92.55, 10.85)*	62.67 (19.34, 106.01)*	29.48 (-51.26, 110.22)
ARV NNRTI types				
Neviraprine (NVP)	Reference	Reference	Reference	Reference
Efavirenz (EFV)	-2.40 (-55.25, 50.44)	-43.72 (-104.71, 12.28)*	42.89 (-10.26, 96.04)*	-64.14 (-174.33, 46.06)
Initial CD4 acell count				
≤200 cells / mm^3	Reference	Reference	Reference	Reference
200-349 cells /mm^3	5.09 (-24.42, 34.60)	-39.28 (-78.86, 0.30)*	-3.34 (-45.00, 38.32)	-33.14 (-87.75, 21.47)
Clinical stage				
High (3 and 4)	Reference	Reference	Reference	Reference
Low (1 and 2)	-2.29 (-28.52, 23.93)	-23.63 (-59.27, 12.01)*	5.12 (-32.71, 42.97)	-17.44 (-68.02, 33.14)
Tuberculosis co-infection				
No	Reference	Reference	Reference	Reference
Yes	8.15 (-23.26, 39.56)	-15.08 (-60.15, 29.99)	-16.84 (-62.62, 28.93)	-39.42 (-98.58, 19.74)
Treatment regularity				
Irregular	Reference	Reference	Reference	Reference
Regular	-4.04 (-47.97, 39.88)	64.36 (20.78, 107.93)*	56.42 (6.72, 106.11)*	90.90 (36.25, 145.55)

*p<0.25

Immune response recovery at 24 months
Treatment regularity was the only independent variable that was significantly related to immune response recovery at the 24th month of ARV therapy. CD4 cell counts of patients who did regular treatment increased by 85.77 cells/mm^3 (p=0.003) compared to patients who did not undertake regular treatment. CD4 cell counts of overweight patients increased 38.14 cells/mm^3 (p=0.409) compared to underweight patients. Also, CD4 cell counts of pre-obese patients increased 49.36 cells/mm^3 (p=0.265) compared to underweight patients (Table 3).

Table 3. Multivariate analysis of BMI status and other predictors of CD4 cell count increase following ARV therapy

	6th month	*12th month*	*18th month*	*24th month*
BMI				
Underweight	Reference	Reference	Reference	Reference
Normal	-3.86 (-34.82, 27.11)	-26.64 (-65.96, 12.67)	6.52 (-36.83, 49.87)	6.85 (-51.75, 65.45)
Overweight	16.77 (-29.84, 63.38)	-9.64 (-87.62, 68.35)	39.55 (-31.75, 110.84)	38.14 (-53.44, 129.73)
Pre-obese	-1.71 (-51.75, 48.33)	-24.72 (-92.11, 42.68)	33.38 (-32.89, 99.65)	49.36 (-38.21, 136.94)
Treatment regularity				
Irregular		Reference	Reference	Reference
Regular		66.88 (22.88, 110.88)*	70.07 (21.16, 118.98)*	85.77 (30.11, 141.43)*
ARV NRTI types				
Zidovudine (AZT)			Reference	
Tenofovir (TDF)			74.83 (32.12, 117.55)*	

*p<0.05

DISCUSSION

BMI did not have a significant relationship to immune response recovery at the first time of ARV therapy. This means that across all nutritional status, immune response recovery is the same. But, on the 18th and 24th months of ARV therapy, the increase in CD4 cell counts of underweight patients was the lowest compared to the others. This is in line with the study by Hussen, Belachew & Hussien (2016), which showed that malnutrition was associated with lower CD4 recovery, although there was no significant relationship statistically.

This can be explained by a previous finding that undernourished individuals experience a reduction in leukotrienes, which promote leukocyte accumulation and enhance macrophage phagocytosis. Such a condition will negatively affect the host's ability to kill microbial, fungal, and parasitic agents (Bresnahan & Tanumihardjo, 2014). A study by Sudfeld *et al.* (2013) showed that low baseline BMI was associated with an increased incidence of oral thrush, pneumonia, and tuberculosis. It showed that the immune response gets worse in

HIV patients with low baseline BMI, so the incidence of opportunistic infections increases.

Underweight usually occurs as a result of protein-energy and micronutrient malnutrition. Although this study did not specify the role of micronutrients, we can explain that lack of micronutrients at the first time of ARV therapy maybe the barrier of immune response recovery. There were some micronutrients, including vitamins A, D, C, E, B6, and B12, folate, zinc, iron, copper, and selenium, which play vital roles at every stage of the immune response. Adequate amounts of micronutrients are essential to ensure proper functioning of the immune cells. It is well established that overt micronutrient deficiencies can adversely affect the immune system and predispose individuals to infections (Gombart, Pierre & Maggini, 2020).

On the other hand, we could tell that there was enough protein-energy and also micronutrients in normal, overweight, and obese patients at the first time of ARV therapy. So, the increase in CD4 cells remained better than underweight patients. The CD4 cell counts in overweight and pre-obese patients showed a higher increase, especially in the 18th and 24th months of ARV therapy. The study by Palermo *et al* (2011) showed that overweight and obese patients had higher CD4 cell counts increases at 96th and 144th weeks of ARV therapy, but not in the 48th week. Research by Blashill *et al.* (2013) in male HIV patients who had sex with men showed that HIV-positive men who were overweight (>25 kg/m^2) had a higher CD4 cell count than normal-weight men. Research conducted by Koethe *et al.* (2015a) also showed that compared with a BMI of 22 kg/m^2, a BMI 30 kg/m^2 was associated with higher CD4 cell counts at the 12th month of ARV therapy, both in women and men infected with HIV.

The latest trend showed an increase of overweight and obesity in people with HIV-AIDS (Koethe *et al.*, 2015b). In HIV-AIDS patients with a higher BMI, several studies showed an interaction between adipose tissue in the body with immune system. Adipose tissue represents one of the largest organs in the body and comprises of various types of cells with diverse energy storage, metabolic regulation, neuroendocrine, and immunological functions. HIV infection and ARV can cause alterations to adipose tissue distribution and biology, with the effects on cytokines and hormone expression, lipid storage, and the composition of adipose-resident immune cell populations. There is a positive relationship between adipose tissue and lymphocyte proliferation, CD4 cell counts, and lymphocyte activation (Koethe, Hulgan & Niswender, 2013a).

Adipose tissue in the body also acts as an endocrine gland. It secretes cytokine-like hormones commonly called adipokines. One of the adipokines that play an important immune function is leptin. Leptin regulates energy homeostasis, neuroendocrine function, metabolism, immune function, and other systems. Leptin regulates innate and adaptive immune responses. Leptin in the hypothalamus is bound by receptors in T cells. It clears the connection between adipose cells and the immune system. Research on mice that have lost their leptin encoding genes showed a disruption in T helper-1/Th1 cells (Park & Ahima, 2015; Francisco *et al.*, 2018).

Research by Koethe *et al.* (2013b) showed that higher median leptin in HIV-AIDS patients on ARV therapy is also in line with a higher BMI. Research by Al-Fadhli *et al.* (2012) showed that there is a positive correlation between the amount of leptin in the body of an HIV-infected person and CD4 cell count.

However, some other studies showed different results. Research by Crum-Cianflone *et al.* (2011) showed that obese HIV patients have lower CD4 cell counts compared with normal weight patients. A recent study by Tiliscan *et al.* (2015) also found that there was no significant relationship between the amount of leptin in the body and the immune system in HIV patients on ARV therapy.

This also can be explained by the role of the metabolism process in patients with higher BMIs. Lipid metabolism also plays a role in the immune response. T lymphocyte proliferation is highly dependent on glycolysis and lipogenesis. The activation of T cells requires glycolysis to support their proliferation. T cell proliferation is highly dependent on mitochondria respiration. It is speculated that T lymphocyte requires lipids during proliferation to maintain and remodel cell membranes (Ganeshan & Chawla, 2014; Hubler & Kennedy, 2016).

The <40 years old patients always showed a higher increase in CD4 cell counts, although not significantly. Other studies have shown the association between younger age on ARV therapy and improved immune response. Research conducted by Montarroyos *et al.* (2014) and Hunt *et al.* (2015) showed that ≥40 years old patients had a lower CD4 cell count increase than <40 years old patients. Gender, education, and occupation did not show a significant relationship with CD4 cell count increase. It is because all patients at Dr. Sardjito Hospital had the same opportunity to get ARV therapy.

The results showed that variables that have a significant relation with CD4 cell count increase were TDF type ARV and treatment regularity. TDF is an ARV regimen recommended by WHO. Some studies showed that TDF increases immune response more than AZT. A retrospective cohort study conducted by Ayele, Jarso & Mamo (2017) for two years in Ethiopia showed that the TDF regimen had better immune improvements. A prospective study conducted by Badii & Buabeng (2018) in Ghana also showed that patients taking TDF ARVs had a higher CD4 cell increase compared to those using ZDV.

The regularity of treatment is important in improving the immune response of HIV-AIDS patients on ARV therapy. Research by Abrogoua *et al.* (2012) showed that adherence was the most significant factor related to immune response compared to initial CD4 cell count for two years of antiretroviral therapy. Research by Annison, Dompreh & Adu-Sarkodie (2013) also showed that the CD4 cell count increase of patients who were adherent to treatment was higher than those who were not adherent to treatment.

Regularity of treatment was the main factor in ARV therapy. The higher proportion of patients seeking treatment regularly were patients with tuberculosis co-infection. So, the increase in CD4 cell counts was also higher in these patients than patients without tuberculosis co-infection. Healthy diet and lifestyles during therapy are also possible factors that can improve the immune response of HIV patients on ARV therapy. But, we did not measure this in this study.

The limitation of this study was the incomplete CD4 examination data, resulting in a different number of subjects analysed and the inability to conduct further sub-sample analysis. We did not have complete weight and height data over time, so we could not look at the relationship between nutritional status and immune response over time.

CONCLUSION

This study showed that higher BMI levels, the use of TDF ARVs , and regular treatment resulted in a higher increase

in CD4 cell counts. Understanding the predicting factors for the increase in CD4 cell counts could benefit in bettering HIV and ARV services.

Acknowledgement

The authors would like to give thanks to the Magister of Public Health, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada which had given support to this study. Thanks to Dr. Sardjito Hospital for permitting us to collect the research data and also to the Board for Development and Empowerment Human Resources of Health, Ministry of Health of Indonesia, that has provided funding for this research.

Authors' contributions

IPA, conceptualised and designed the study, collected and analysed the data, prepared the draft of the manuscript; YWS, advised on data analysis and interpretation, and reviewed the manuscript; NAK, advised on data analysis and interpretation, and reviewed the manuscript.

Conflict of interest

The authors declare no conflict of interest.

References

Abrogoua DP, Kablan BJ, Thierry BA, Aulagner G, N'Guessan K & Zohore C (2012). Assessment of the impact of adherence and other predictors during HAART on various CD4 cell responses in resource-limited settings. *Patient Prefer Adherence* 6:227–237.

Al-Fadhli M, Saraya M, Qasem J, Azizieh F, Shahab S & Raghupathy (2012). Relationship between leptin levels and suppressed CD4 counts in HIV patients. *Med Princ Pract* 22(1):54–58.

Alwarawrah Y, Kiernan K & Maclver NJ (2018). Changes in nutritional status impact immune cell metabolism and function. *Front Immunol* 9(1055):1–14.

Annison L, Dompreh A & Adu-Sarkodie Y (2013). The immunological response of HIV-positive patients initiating HAART at the Komfo Anokye Teaching Hospital, Kumasi, Ghana. *Ghana Med J* 47(4):164–170.

Ayele T, Jarso H & Mamo G (2017). Immunological outcomes of tenofovir versus zidovudine-based regimens among people living with HIV/AIDS: a two years retrospective cohort study. *AIDS Res Ther* 14(1):1–11.

Badii VS & Buabeng KO (2018). Tenofovir-based highly active antiretroviral therapy is associated with superior CD4 t cells repopulation compared to zidovudine-based HAART in HIV 1 infected adults. *Int J Chronic Dis* 2018:1–8.

Blashill AJ, Mayyer KH, Crane HM, Grasso C & Safren SA (2013). Body mass index, immune status, and virological control in HIV-infected men who have sex with men. *J Int Assoc Provid AIDS Care* 12(5):319–324.

Bresnahan KA & Tanumihardjo SA (2014). Undernutrition, the acute phase response to infection, and its effect on micronutrient status indicators. *Adv Nutr* 5(6):702-711.

Crum-Cianflone NF, Roediger M, Eberly LE, Vyas K, Landrum ML, Ganesan A, Weintrob A, Johnson E & Agan BK (2011). Impact of weight on immune cell counts among HIV-infected persons. *Clin Vaccine Immunol* 18(6):940–946.

Dravid MN, Kulkarni SD, Khadse R & Adchitre HR (2011). Two years CD4 count follow-up of rural patients on antiretroviral therapy: a study in government hospital. *Indian J Sex Transm Dis AIDS* 32(1):59–60.

Duggal S, Chugh TD & Duggal AK (2012). HIV and malnutrition : effects on immune system. *Clin Dev Immunol* 2012:1–7.

Francisco V, Pino J, Capos-Cabaleiro V, Ruiz-Fernandez C, Mera A, Gonzalez-Gay MA, Gomez R & Gualillo O (2018). Obesity, fat Mass and immune system: role for leptin. *Front Physiol* 9:1–20.

Ganeshan K & Chawla A (2014). Metabolic rehulation of immune responses. *Annu Rev Imunol 32*:609-634.

Gombart AF, Pierre A & Maggini S (2020). A review of micronutriants and the immune system-working in harmony to reduce the risk of infection. *Nutrients* 12(236):1-41.

Hubler MJ & Kennedy AJ (2016). Role of lipids in the metabolism and activation immune cells. *J Nutr Biochem* 34:1-7.

Hunt K, Mondal P, Konrad S, Skinner S, Gartner K & Lim HJ (2015). Identifying factors associated with changes in CD4+ count in HIV-infected adults in Saskatoon, Saskatchewan. *Can J Infect Dis Med Microbiol* 26(4):207–211.

Hussen S, Belachew T & Hussien N (2016). Nutritional status and its effect on treatment outcome among HIV infected clients receiving HAART in Ethiopia : a cohort study. *AIDS Research and Therapy. BioMed Central* 13(32):1–8.

Koethe JR, Jenkins CA, Shepherd BE, Stinnette SE & Sterling TR (2011). An optimal body mass index range associated with improved immune reconstitution among HIV-infected adults initiating antiretroviral therapy. *HIV. AIDS* 53:952–960.

Koethe JR, Hulgan T & Niswender K (2013a). Adipose Tissue and immune function: a review of evidence relevant to HIV infection. *J of Infect Dis* 208(8):1194–1201.

Koethe JR, Dee K, Bian A, Shintani A, Turner M, Bebawy S, Sterling T & Hulgan T (2013b). Circulating interleukin-6, soluble CD14, and other inflammation biomarker levels differ between obese and nonobese HIV-infected adults on antiretroviral therapy. *AIDS Res Hum Retroviruses* 29(7):1019–1025.

Koethe JR, Jenkins CA, Lau B, Shepherd BE, Silverberg MJ, Brown TT, Blashill AJ, Anema A, WIllig A, Stinette S, Napravnik S, Gill J, Crane HM & Sterling TR (2015a). Body mass index and early CD4+ T-cell recovery among adults initiating antiretroviral therapy in North America, 1998-2010. *HIV Med* 16(9):572–277.

Koethe JR, Jenkins C A, Lau B, Shepherd BE, Justice AC, Tate JP, Buchacz K, Napravnik S, Mayor AM, Horberg MA, Blashill AJ, Willig A, Wester CW, Silverberg MJ, Gill J, Thorne JE, Klein M, Eron JJ, Kitahata MM, Sterling TR & Moore RD (2015b). Rising obesity prevalence and weight gain among adults starting antiretroviral therapy in the United States and Canada. *AIDS Res Hum Retroviruses* 32(1):50–58.

Makvandi-Nejad S (2016) *Human Immunodeficiency Virus (HIV).* Oxford.

Montarroyos UR, Miranda-Filho DB, Cesar CC, Souza WV, Lacerda HR, Albuquerque MFPM, Aguiar MF & Ximenes RAA (2014). Factors related to changes in cd4+ t-cell counts over time in patients living with HIV/AIDS: A Multilevel Analysis. *PLoS ONE* 9(2):1-9.

Palermo B, Bosch RJ, Bennet K & Jacobson JM (2011). Body mass index and CD4+ T-lympocyte in HIV Infected men with viral suppression on antiretroviral therapy. *HIV Clin Trials* 12(4):222–227.

Park H & Ahima RS (2015). Physiology of leptin: energy homeostatis, neuroendovrine function and metabolism. *Metabolism* 64(1):24-34.

Sharma A, Hoover DR, Shi Q, Gustafon D, Plankey WM, Herwhow RC, Tien PC, Golub ET & Anastos K (2015). Relationship between body mass index and mortality in HIV-infected HAART users in the women' s interagency HIV study. *PLoS ONE* 10(2):1–16.

Sudfeld CR, Isanaka S, Mugusi FM, Aboud S, Wang M, Chalamila GE, GIovannuci WL & Fawzi WW (2013). Weight change at 1 mo of antiretroviral therapy and its association with subsequent mortality, morbidity , and CD4 T cell reconstitution in a Tanzanian HIV-infected adult cohort 1 – 3'. *Am J Clin Nutr* 97(3):1278–1287.

Tiliscan C, Arama V, Mihailescu R, Munteanu DI, Streinu-Cercel A, Ion DA, Radulescu MA, Popescu C, Lobodan AE, Negru AR & Arama SS (2015). Leptin expression in HIV-infected patients during antiretroviral therapy. *Germs* 5(3): 92–98.

Walker B & Mcmichael A (2012). The T-Cell response to HIV. *Cold Spring Harb Prespect Med* 2(a0070554):1–19.

Mal J Nutr 26(3): 453-460, 2020

Fish oil capsule supplementation in children with obesity reduced c-reactive protein and improved blood pressure

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ABSTRACT

Introduction: Excessive accumulation of body fat in obesity increases morbidities such as hypertension and cardiovascular diseases. This study investigated the effect of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) supplementation on the level of high-sensitivity C-reactive protein (hs-CRP) and blood pressure in children with obesity. **Methods:** Fifty obese children, aged 6-10 years, were randomly assigned to the supplementation group (*n*=25) who received EPA and DHA supplementation or to the placebo group (*n*=25) for eight weeks. The trial was done in a single centre in Denpasar, Bali, Indonesia. Randomisation and allocation to the trial group were done by a computer system. The primary analysis was comparing the blood pressure and hs-CRP level between groups. Analysis of covariance (ANCOVA) and multivariate analysis of covariance (MANCOVA) tests were done to compare the differences between groups, with a *p*-value <0.05 considered as significant. **Results:** A total of 44 children completed the study, 24 (54.5%) were males and 20 (45.5%) were females. Initially, the systolic/diastolic blood pressure and hs-CRP level in the supplementation and placebo groups were 109.5/72.7 mmHg and 3.5 mg/L, 107.9/68.4 mmHg and 2.8 mg/L, respectively. At the end, they were 106.3/67.7 mmHg and 1.7 mg/L, and 108.1/71.8 mmHg and 2.8 mg/L, respectively. Systolic-, diastolic blood pressure and hs-CRP level were decreased by -2.6 mmHg (95% CI: -6.9 to 1.6; *p*=0.220), -7.5 mmHg (95% CI: -12.4 to -2.6; *p*=0.004), and -1.15 mg/L (95% CI: -2.1 to -0.2; *p*=0.022), respectively. **Conclusion:** EPA and DHA supplementation in obese children showed significant decrease in diastolic blood pressure and hs-CRP level.

Keywords: Fatty acid, inflammation, cytokine

INTRODUCTION

Obesity is a global health problem, including in Indonesia. Based on the data from the Basic Health Research (Riset Kesehatan Dasar/Riskesdas) in Indonesia, the prevalence of obesity in children is still high, although it decreased from 12.2% in 2007 to 11.9% in 2010, and further to 8.0% in 2018 (Kemenkes RI, 2018).

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doi: https://doi.org/10.31246/mjn-2019-0132

Obesity is associated with increased blood pressure and the development of hypertension. In obese children or adults, their blood pressure is high even in a resting position. Many studies reported that obese individuals showed higher blood pressure than non-obese individuals even though they were still within the range of normal limits (Badeli *et al.*, 2016; Cheung *et al.*, 2017; Zhao *et al.*, 2017).

C-reactive protein (CRP) is a major inflammatory cytokine that functions as a non-specific defense of the immune system against tissue injury or infection. Many studies reported that increased levels of CRP in the blood was strongly associated with the occurrence of cardiovascular diseases (Fonseca & Izar, 2016; Badimon *et al.*, 2018; Zhuang *et al.*, 2019). In obesity, the increasing levels of CRP as a response to increased cytokine secretion in fat tissue has been used as a cardiovascular risk marker (Soeki & Sata, 2016).

Omega-3 fatty acids, especially their active metabolites, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) have been known to have several beneficial effects on health (Gammone *et al.*, 2019; Sakamoto *et al.*, 2019). A study in young healthy adults reported that blood omega-3 fatty acid levels were inversely associated with blood pressure (Filipovic *et al.*, 2018). Another study reported that omega-3 fatty acid and omega-6 fatty acid modulate blood pressure regulation and vascular function in obese children (Bonafini *et al.*, 2018). However, controversial results were documented. One study in children and adolescents reported that the beneficial effects of high omega-3 fatty acid levels were observed on the blood pressures of thin/normal-weight children, but not in overweight/obese children (Wolters *et al.*, 2016). A meta-analysis reported that increased omega-3 fatty acids had little or no effect on cardiovascular health (Abdelhamid *et al.*, 2018). Based to these evidences, this study investigated the effect of fish oil (containing EPA and DHA) supplementation on C-reactive protein and blood pressure in children with obesity.

MATERIALS AND METHODS

Study design

This study was a randomised, double-blind clinical trial conducted on children aged 6 to 10 years old with obesity. Obesity was classified according to their Body Mass Index (BMI) based on two standard deviation (SD) or above the median of the World Health Organization (WHO) BMI growth reference for age and sex. They were excluded from the study if they were suffering from infections, chronic diseases, neoplasms, and autoimmune diseases, consuming anti-inflammatory medications, and consuming omega-3 fatty acids. Informed consent was obtained from all children who met the study criteria. This study was performed at a single centre in Denpasar, Bali, Indonesia from January 2017 to June 2018. This study was conducted after obtaining ethical approval from the Ethics Committee of Udayana University – Sanglah General Hospital, Bali, Indonesia (No. 92/UN.14.2/Litbang/2016).

Data collection

Data collection included food recall, activity score assessment, anthropometric, blood pressure measurement, and blood samples for hs-CRP examination. Food recall and activity score assessments were obtained by giving a questionnaire to the parents before the intervention. Food recall was obtained from three days of dietary intake and counted for total calories, protein, fat, and omega-3 fatty acid intakes. The physical activity questionnaire was modified from the

Physical Activity Questionnaire-Children (PAQ-C). Anthropometric measurements included weight, height, and BMI (kg/m^2), which was calculated and then plotted onto the WHO BMI growth chart. Blood pressure was measured using a mercury sphygmomanometer and hs-CRP was measured using the particle enhanced immunoturbidimetric assay method. Blood sampling and laboratory tests were carried out by the Prodia® Clinical Laboratory. All data were collected at the beginning and at the end of the study.

Intervention

Children were randomly allocated to the supplementation or placebo groups. Random allocation was done using a computer system. The supplementation group received a fish oil capsule containing 90 mg EPA and 450 mg DHA twice per day, while the placebo group received a similar capsule twice per day containing cellulose flour. Both groups were followed for eight weeks. Investigators and children did not know whether they were in the supplementation or placebo groups before the study ended.

Parents/children met with the investigators for three times during the study period. The first time, they were given a total of 56 capsules (twice per day for 4 weeks). The second time, which was four weeks later, they were again given a total of 56 capsules with similar doses. The third time, at the end of the study, they reported the total capsules consumed.

Parents were asked to supervise and observe their children. The investigators monitored the compliance of children through telephone calls with their parents every week. The parents had to report how many capsules were consumed by their children in a week. They also reported the side effects of the interventions, such as nausea, vomiting, and itching, or other allergic manifestations that occurred. The intervention was stopped if side effects, such as allergic manifestations were found. Children who consumed less than 75% of the capsules were recorded as dropouts and they were not included in the final analysis.

Statistical analysis

The minimal sample size for detecting a difference of 0.17 mg/dL in hs-CRP, 10.8 mmHg in systolic blood pressure, and 6.7 mmHg in diastolic blood pressure between groups, with 80% power, and α=0.05 was 22 samples per group. The Kolmogorov-Smirnov test was performed on each numerical variable for normality. The association between categorical and numerical variables were analysed using chi-square and independent *t*-test. The effects of EPA and DHA supplementation on changes in blood pressure and hs-CRP level were analysed using analysis of covariance (ANCOVA) test. The multivariate analysis of covariance (MANCOVA) test was used to adjust the effects of several variables. The level of significance was *p*-value <0.05 and 95% confidence interval was also calculated. Data analysis was performed using SPSS statistics software version 20.0.

RESULTS

Of the total 92 children who were invited and came to the study centre, 34 children declined participation and 8 children did not meet the inclusion criteria. Fifty children were included in the study and signed the informed consent. They were then randomly allocated to the supplementation and placebo groups. During the study period, six children dropped out because they consumed less than 75% of the capsules. Finally, 44 children completed the study, with 22 children in each group, respectively (Figure 1).

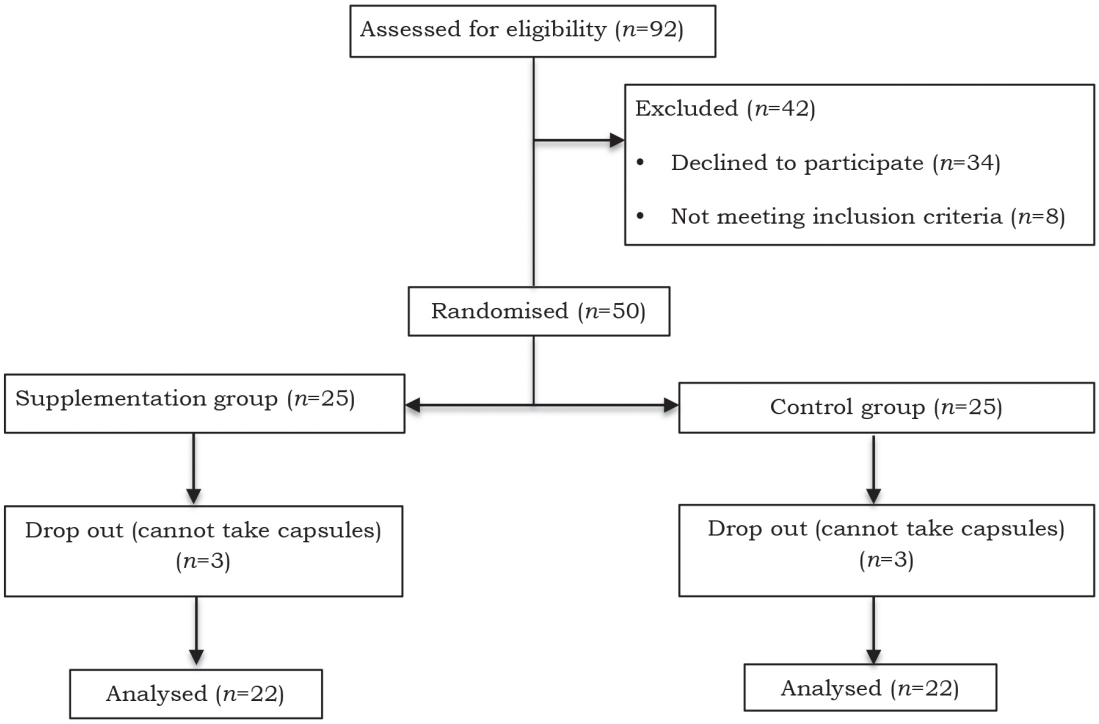

Figure 1. Flow diagram of subjects

Out of the 44 children who completed the study, 24 (54.5%) were males and 20 (45.5%) were females, with a mean age of 9.9±0.9 years and 9.7±0.7 years in the supplementation and placebo groups, respectively. Initially, the mean systolic-/diastolic blood pressure in all children was 108.7/70.5 mmHg and hs-CRP level was 3.2 mg/L, with a minimum and maximum level of 0.3 mg/L and 17.2 mg/L, respectively. Weight, height, BMI, physical activity, and nutrient intakes including calories, protein, fat, and polyunsaturated fatty acid (PUFA) were not statistically different in both groups (Table 1).

Table 2 shows the classification of blood pressure in all children at the beginning of the study, while Table 3 shows the anthropometric data in both groups at the end of the study. Finally, systolic blood pressure between groups was not statistically significant (p=0.220), but diastolic blood pressure and hs-CRP level between groups were statistically significant with p=0.004 and p=0.022, respectively (Table 4).

DISCUSSION

The prevalences of normal, pre-hypertension, and hypertension in this study were 61.4%, 6.8%, and 31.8%, respectively. The prevalence of hypertension in this study was similar to other studies. Badeli and colleagues (2016) reported that the prevalence of hypertension in obese children was 30.1% and they stated that the hypertension rates in obese children were higher than normal-weight children. A systematic review in children and adolescents in Africa reported that the prevalence of hypertension in obese children was 30.8%, which was six times higher than

normal-weight children (Noubiap *et al.*, 2017). On the other hand, several studies reported lower results, which varied between 4.5% to 11.5% (Cheung *et al.*, 2017; Diaz & Calandra, 2017). Although the prevalence of hypertension in obese children is low, it is still a worldwide health concern due to its relation to cardiovascular diseases and high mortality rates.

Obesity is a chronic disease that is characterised by the increase of

Table 1. Baseline characteristics of the children

Characteristics	*Group*		*p*
	Supplementation n=22	*Placebo n=22*	
Gender			0.54†
Male, *n*	13	11	
Female, *n*	9	11	
Age (y), mean±*SD*	9.9±0.9	9.7±0.7	0.43‡
Body weight (kg), mean±*SD*	54.3±8.9	51.8±7.7	0.33‡
Height (cm), mean±*SD*	142.9±7.2	142.9±7.2	0.98‡
BMI (kg/m^2), mean±*SD*	26.6±4.9	25.3±2.6	0.27‡
Physical activity score, mean±*SD*	2.5±0.4	2.4±0.5	0.54‡
Calorie intake (kcal), mean±*SD*	2322.0±489.8	2280.4±515.4	0.78‡
Protein intake (g), mean±*SD*	89.3±26.3	91.1±22.9	0.81‡
Fat intake (g), mean±*SD*	65.5±24.6	61.8±20.3	0.59‡
PUFA intake (g), mean±*SD*	23.6±5.9	23.9±5.2	0.84‡

†Chi-square test
‡Independent *t*-test
SD = standard deviation; BMI = body mass index; PUFA = polyunsaturated fatty acid

Table 2. Blood pressure classification of children

Classification	*n*	*%*
Normal	27	61.4
Pre-hypertension	3	6.8
1st degree hypertension	13	29.5
2nd degree hypertension	1	2.3

Table 3. Anthropometric data of both groups at the end of the study

Anthropometric	*Group*		*p*†
	Supplementation	*Placebo*	
Body weight (kg), mean±SD	54.5±8.4	52.7±8.0	0.49
Height (cm), mean±SD	143.7±7.0	143.7±7.3	0.99
BMI (kg/m^2), mean±SD	26.5±4.6	25.4±2.5	0.36

†Independent *t*-test
SD = standard deviation

pro-inflammatory cytokines such as interleukin 1β, interleukin 6, tumour necrosis factor-α, as well as c-reactive protein (Luciardi *et al.*, 2018). This inflammation is associated with the complications of obesity that affect adults as well as children, such as hypertension, insulin resistance, dyslipidaemia, and cardiovascular diseases (Luciardi *et al.*, 2018). In this study, the mean concentration of hs-CRP was 3.2 mg/L, which is between the range of 1.9 mg/L to 3.4 mg/L as reported by other publications (Luciardi *et al.*, 2018; Jain *et al.*, 2017). The levels of hs-CRP should be controlled as low as possible to prevent the complications of obesity in children.

This study showed significantly decreased diastolic blood pressure and hs-CRP level, but not systolic blood pressure in children with obesity after supplementation of fish oil capsules containing EPA and DHA for 8 weeks. The systolic-, diastolic blood pressure, and hs-CRP level decreased from 109.5 mmHg to 106.3 mmHg, 72.7 mmHg to 67.7 mmHg, and 3.9 mg/L to 1.7 mg/L, respectively. Comparing with the placebo group, the decreasing effects of EPA and DHA on systolic-, diastolic blood pressure, and hs-CRP level were -2.6 mmHg, -7.5 mmHg, and -1.15 mg/L, respectively. No study has ever published the effects of omega-3 fatty acid on both blood pressure and hs-CRP level in children with obesity. However, one study did report the effect of prenatal DHA supplementation on blood pressure in obese children. They reported that overweight or obese children whose mothers received DHA supplementation had lower blood pressure (Kerling *et al.*, 2019).

Several variables, such as age, gender, BMI, physical activity, and food intakes have been adjusted in the multivariate analysis of this study. At baseline, the characteristics including

Table 4. Systolic- and diastolic blood pressure and hs-CRP levels in both groups

Variables	*Supplementation*		*Placebo*		*Univariate*[†]		*Multivariate*[‡]	
	Before	*After*	*Before*	*After*	*Mean diff. (95% CI)*	*p*	*Mean diff. (95% CI)*	*p*
Systolic (mmHg)	109.5±13.9	106.3±12.6	107.9±11.7	108.1±11.2	-3.0 (-7.4 to 1.4)	0.17	-2.6 (-6.9 to 1.6)	0.22
Diastolic (mmHg)	72.7±9.9	67.7±7.1	68.4±11.0	71.8±11.2	-6.8(-11.1 to -2.4)	<0.01	-7.5 (-12.4 to -0.2)	<0.01
hs-CRP (mg/L)	3.9±3.5	1.7±1.1	3.5±2.8	2.8±1.9	-1.2 (-2.1 to -0.3)	<0.01	-1.15 (-2.1 to -0.2)	0.02

[†]ANCOVA
[‡]MANCOVA (adjusted: age, gender, BMI, physical activity, and PUFA intake)

age, gender, body weight, height, BMI, physical activity score, intakes of calories, protein, fat, and PUFA were similar between both groups. Physical activity and healthy diet interventions in children with overweight and obesity are effective in improving BMI and cardiovascular risk score (Larsen *et al.*, 2016). Therefore, physical activity and diet interventions should be promoted as they are closely associated with lowering pro-inflammatory cytokines and BMI in children with obesity.

There are several limitations to this study. Firstly, there was no calculation of sodium in food intake. This is important as it is widely recognised that dietary sodium intake is closely related to blood pressure or hypertension (Grillo *et al.*, 2019). Secondly, the limitation of sample size and duration of the study.

CONCLUSION

The study showed the effectiveness of EPA and DHA supplementation in improving blood pressure and decreasing hs-CRP levels among children with obesity. With that, it may be recommended to give EPA and DHA supplementation to children with obesity to prevent cardiovascular disease-related conditions such as high blood pressure and increased hs-CRP levels.

Acknowledgement

Many thanks to the children and their parents for their participation in this study, as well as the teachers for helping in this study.

Authors' contributions

IGLS, principal investigator, conceptualised and designed the study, prepared the draft of the manuscript and reviewed the manuscript; PDV, led the data collection, advised on the data analysis and interpretation, and reviewed the manuscript; IWBS, led the data collection and reviewed the manuscript.

Conflict of interest

None of the authors have any conflict of interest regarding the publication of this article.

References

Abdelhamid AS, Brown TJ, Brainard JS, Biswas P, Thorpe GC, Moore HJ, Deane KHO, AlAbdulghafoor FK, Summerbell CD, Worthington HV, Song F & Hooper L (2018). Omega-3 fatty acids for the primary and secondary prevention of cardiovascular disease. *Cochrane Database Syst Rev.* 7(7):CD012345.

Badeli H, Hassankhani A, Naaemi Z, Hosseinzadeh S, Mehrabi S, Pourkarimi M, Hosseini S, Nikoukar PR, Nezamdoust R, Rahimi A & Pourrajabi A (2016). Prevalence of hypertension and obesity-related hypertension in urban school-aged children in Rasht. *IJKD* 10(6):364-368.

Badimon L, Pena E, Arderiu G, Padro T, Slevin M, Vilahur G & Chiva-Blanch G (2018). C-reactive protein in atherothrombosis and angiogenesis. *Frontiers in Immunology* 9:430. Doi:10.3389/fimmu.2018.00430

Bonafini S, Giontella A, Tagetti A, Marcon D, Montagnana M, Benati M, Gaudino R, Cavarzere P, Karber M, Rothe M, Minuz P, Antoniazzi F, Maffeis C, Schunck WH & Fava V (2018). Possible role of CYP450 generated omega-3/omega-6 PUFA metabolites in the modulation of blood pressure and vascular function in obese children. *Nutrients* 10:1689. Doi:10.3390/nu10111689

Cheung EL, Bell CS, Samuel JP, Poffenbarger T, Redwine KM & Samuels JA (2017). Race and obesity in adolescent hypertension. *Pediatrics* 139(5):1-9.

Diaz A & Calandra L (2017). High blood pressure in school children and adolescents in Argentina over the past 25 years: A systematic review of observational studies. *Arch Argent Pediatr* 115(1):5-11.

Filipovic MG, Aeschbacher S, Reiner MF, Stivala S, Gobbato S, Bonetti N, Risch M, Risch L, Camici GG, Luescher TF, Schacky C, Conen D & Beer JH (2018). Whole blood omega-3 fatty acid concentrations are inversely associated with blood pressure in young healthy adults. *J Hypertens* 36(7):1548-1554.

Fonseca FAH & Izar MCO (2016). High-sensitivity c-reactive protein and cardiovascular disease across countries and ethnicities. *Clinics* 71(4):235-242.

Gammone MA, Riccioni G, Parrinello G & D'Orazio N (2019). Omega-3 polyunsaturated fatty acids: benefits and endpoints in sport. *Nutrients* 11:46. Doi:10.3390/nu11010046

Grillo A, Salvi L, Coruzzi P, Salvi P & Parati G (2019). Sodium intake and hypertension. *Nutrients* 11;1970. Doi:10.3390/nu11091970

Jain V, Kumar A, Agarwala A, Vikram N & Ramakrishnan L (2017). Adiponectin, interleukin-6 and high-sensitivity C-reactive protein levels in overweight/obese Indian children. *Indian Pediatrics* 54:848-850.

Kemenkes RI (2018). *Riset Kesehatan Dasar*. Badan Penelitian dan Pengembangan Kesehatan Kementerian Kesehatan RI, Jakarta.

Kerling EH, Hilton JM, Thodosoff JM, Wick J, Colombo J & Carlson SE (2019). Effect of prenatal docosahexaenoic acid supplementation on blood pressure in children with overweight condition or obesity. A secondary analysis of a randomized clinical trial. *JAMA Network Open* 2(2):e190088. Doi:10.1001/jamanetworkopen.2019.0088

Larsen KT, Huang T, Ried-Larsen M, Andersen LB, Heidemann M & Moller NC (2016). A multi-component day-camp weight-loss program is effective in reducing BMI in children after one year: A randomized controlled trial. *Plos One*. Doi:10.1371/journal.pone.0157182

Luciardi MC, Carrizo TR, Diaz EI, Aleman MN, Bazan MC & Abregu AV (2017). Proinflammatory state in obese children. *Rev Chil Pediatr* 89(3):346-351.

Noubiap JJ, Essouma M, Bigna JJ, Jingi AM, Aminde LN & Nansseu JR (2017). Prevalence of elevated blood pressure in children and adolescents in Africa: a systematic review and meta-analysis. *The lancet* 2:e375-e386.

Sakamoto A, Saotome M, Iguchi K & Maekawa Y (2019). Marine-derived omega-3 polyunsaturated fatty acids and hearth failure: current understanding for basic to clinical relevance. *Int J Mol Sci* 20:4025. Doi:10.3390/ijms20164025

Soeki T & Sata M (2016). Inflammatory biomarkers and atherosclerosis. *Int Heart J* 57:134-139.

Wolters M, Pala V, Russo P, Rise P, Moreno LA, Henauw S, Mehlig K, Veldebaum T, Molnar D, Tornaritis M, Galli C, Ahrens W & Bornhorst C (2016). Associations of whole blood n-3 and n-6 polyunsaturated fatty acids with blood pressure in children and adolescents – results from the IDEFICH/I.Family Cohort. *Plos One* 11(11):e0165981. Doi:10.1371/journal.pone.0165981

Zhao Y, Wang L, Xue B & Wang Y (2017). Associations between general and central obesity and hypertension among children: The childhood obesity study in China Mega-Cities. *Scientific Reports* 7:16895. Doi:10.1038/s41598-017-16819-y

Zhuang Q, Shen C, Chen Y, Zhao X, Wei P, Sun J, Ji Y, Chen X & Yang S (2019). Association of high sensitive C-reactive protein with coronary heart disease: a Mendelian randomization study. *BMC Medical Genetic* 20:170. https://doi.org/10.1186/s12881-019-0910-z

Mal J Nutr 26(3): 461-470, 2020

Sleep quality and body weight status of Malaysian university students

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ABSTRACT

Introduction: Inadequate sleep duration is a modifiable behaviour linked with body weight, yet limited is known on the role of sleep quality with body weight status among university students. The study aimed to determine sleep quality and its association with body weight status among university students. **Methods:** A cross-sectional study was conducted among 240 university students (24.6% males, 75.4% females) with a mean age of 21.22±1.24 years. Subjects were recruited from four faculties of University Putra Malaysia (UPM). Information on socio-demographic, sleep quality and anthropometric measurements were collected. Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality, whereby a summation score from seven components yielded a global score on sleep quality, with higher scores indicating poor sleep quality. **Results:** Majority of subjects were Malay (79.2%) with a mean body mass index of 22.6kg/m^2. A majority (61.3%) had normal body weight, with the prevalences of underweight (UW), overweight (OW), and obesity (OB) at 12.9%, 19.6% and 6.3%, respectively. The mean global PSQI score was 5.76±2.64, with half of the respondents (50.4%) experiencing poor sleep quality. OW-OB experienced poorer sleep quality (6.53±2.79, p=0.004) and longer sleep latency (1.34±0.10, p=0.008) relative to UW-NW. OB subjects had substantially more frequent sleep disturbances compared to non-OB subjects (1.53±0.64, p=0.012). **Conclusion:** Findings suggest that OW-OB students at university are at a greater risk of having reduced sleep quality with longer sleep latency and frequent sleep disturbances. There is a need for a wellness initiative to reduce the incidence of obesity while fostering healthier sleeping habits among university students.

Keywords: Sleep quality, university student, body weight status

INTRODUCTION

Malaysia is leading in the prevalence of adult obesity compared to other Southeast Asian countries, with nearly half of its adult population having a body mass index (BMI) of above 25kg/m^2 (IPH, 2019). Several initiatives have been made by the government to tackle the obesity issue such as the implementation of My body fit and fabulous MyBFF@ home and MyBFF@school (Mohamad Nor, Ambak & Aris, 2018) to encourage healthy eating habits and active lifestyle. However, the root factors for obesity

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doi: https://doi.org/10.31246/mjn-2020-0048

among the Malaysian population may not have been properly addressed as the prevalences of overweight and obesity (OW-OB) have consistently increased (IPH, 2015). This is observed in a series of National Health and Morbidity Survey (NHMS) conducted among the Malaysian population aged ≥18 years old, which showed consistent elevation trends in the prevalences of OW-OB from 29.1% and 14.5% in 2006 (IPH, 2008) to 30.0% and 17.7% in 2015 (IPH, 2015), and more recently to 30.4% and 19.7% (IPH, 2019), respectively.

Previous studies have suggested that the trend of obesity may start from as early as two years old (Robinson *et al.*, 2019), which then develops in a consistent trajectory pattern when entering university life (Vadeboncoeur, Townsend & Foster, 2015). Poor sleep quality has been associated with poor academic performance (Azad *et al.*, 2015), impaired judgement (Greer, Goldstein & Walker, 2013), and to some extent OW-OB (Krističevič, Štefan & Sporiš, 2018; Peltzer & Pengpid, 2017; Fatima, Doi & Mamun, 2016). Based on observational studies, a consistent pattern has been observed in the association between sleep quality with OW-OB. In a meta-analysis aimed to examine the association between poor sleep quality with OW-OB, higher odds of being OW-OB (OR=1.46, 95% CI: 1.24 to 1.72) were observed among respondents with poor sleep quality (Fatima *et al.*, 2016). This is in agreement with a study involving 2100 undergraduates that showed poor sleep quality was associated with a higher likelihood of being OW-OB (OR =1.45; 95% CI: 1.14 to 1.83) (Krističevič *et al.*, 2018).

In Malaysia, several studies have found a high prevalence of poor sleep quality among Malaysian university students (Nurismadiana & Lee, 2018; Tien Ngu *et al.*, 2017). However, the association between poor sleep quality with body weight remains inconclusive. While several studies conducted among Malaysian university students in Malaysia failed to find significant associations (Kumar, Othman & Jeppu, 2020; Lai & Say, 2013; Ganesh Kamath *et al.*, 2014), other local studies have noted the potential role of sleep quality in influencing body weight, but the association remains unclear (Kumar *et al.*, 2020; Lai & Say, 2013; Ganesh Kamath *et al.*, 2014). For example, a study conducted among Malaysian private university students (n=201, mean age 21.55±2.13 years old) noted a negative correlation between sleep quality score and body weight, suggesting that increasing body weight reduces overall sleep quality (Kumar *et al.*, 2020). Though the finding was not statistically significant, the study suggested that higher body weight elevates the risk of obstructive sleep apnea that consequently worsens sleep quality (Kumar *et al.*, 2020). Another local study conducted among Malaysian university students (n=191, aged between 18 to 25 years old) found that obese respondents had a higher tendency to overeat when they had poor sleep, suggesting a potential role for sleep in influencing appetite and eventually body weight (Greer, Goldstein & Walker, 2013).

University phase is a critical period when university students establish modifiable health-related behaviours that persist into adulthood. Tien Ngu *et al.* (2017) demonstrated that students are especially vulnerable to poor sleep quality resulting from increased academic demands, extensive use of electronic devices, and stress (Azad *et al.*, 2015). Therefore, this study was conducted to determine the association between sleep quality and body weight status among university students of Universiti Putra Malaysia (UPM).

MATERIALS AND METHODS

A cross-sectional study was conducted among undergraduate students from four randomly selected faculties of UPM. A total of 240 eligible respondents were recruited based on a single proportion formula after considering 10% of missing data. The selected faculties consisted of three different fields of studies, namely sciences, arts, and technical background, guided by the Ministry of Higher Education's categorisation. A random generator software picked a total of four faculties out of 16. Two faculties were chosen for the sciences field because of its large proportion, followed by one faculty each for the arts and the technical fields. Institutional permissions were obtained, and updated name lists and contact information were sourced from the administration office. The study included participants if they were Malaysian undergraduates aged 18 to 25 years old. Those who were pregnant, lactating, or diagnosed with chronic diseases were excluded. Information sheet, agreement of confidentiality and bilingual questionnaires (English and Malay) were distributed to eligible respondents during data collection. Ethical approval was granted by the Ethics Committee for Research Involving Human Subjects, UPM (JKEUPM) [Ref: FPSK(EXP16)P169].

Instruments

This study involved collecting anthropometric data and utilised a self-administered questionnaire to collect data on socio-demographic characteristics and sleep quality. Socio-demographic characteristics documented included age, gender, ethnicity, marital status, current residential, current year of study, the field of study, and faculty.

Sleep quality

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI). PSQI consisted of seven component scores; 1) subjective sleep quality, 2) sleep latency, 3) sleep duration, 4) habitual sleep efficiency, 5) sleep disturbances, 6) use of sleep medication, and 7) daytime dysfunction over the past one month. Each component had a range of 0 to 3 points on a Likert scale, with "0" indicating no difficulty, while a score of "3" indicating severe difficulty. The seven component scores were then added to yield one "global" score, where a score of ≥5 indicated "poor" sleeper. The Malay version of PSQI has been previously validated with a Cronbach's α of between 0.64 to 0.82, indicating good internal consistency, and a test-retest reliability of between 0.45 to 0.70, indicating low to moderate reliability (Musa, Moy & Wong, 2018; Yunus *et al.*, 2017).

Anthropometry

Anthropometric measurements were performed by a qualified and trained researcher to avoid inter-researcher variability. Weight was measured using a digital weighing scale (OMRON model HBF-375) placed on a hard and balanced surface. During weight assessment, respondents were in light clothing, reminded to remove any footwear, and ensured that their pockets were emptied. Zero-calibration of the scale was ensured before measurement. Respondents were asked to stand in the centre of the scale without any support and weight was distributed evenly on both feet.

Height was measured using the SECA 214 mobile stadiometer with a measuring range of 20-207cm (SECA 214). A stretch stature method was used

whereby the respondent stood with feet and heels closed together, and ensured that buttocks and upper part of the back touched the scale.

The height and weight measurements were indexed into BMI using the equation of weight (kg)/height (m^2). BMI was classified according to the World Health Organization categorisation of body weight status (WHO, 2000).

Statistical analysis

IBM SPSS 22.0 was used for data analysis. Descriptive data for categorical variables were presented as frequency and percentage, while continuous variables were presented as mean and standard deviation. Apart from being guided by the central limit theorem, normality of assumption was considered met by visual inspection of the histogram or with the results of normality from Kolmogorov-Smirnov or Shapiro-Wilk tests. Mann-Whitney U test was used to determine the significant differences between two groups if the variable was not normally distributed, while Kruskal-Wallis test was used to compare the differences between more than two variables. The level of significance was set at $p<0.05$.

RESULTS

Socio-demographic characteristics

A total of 240 respondents participated in the study. Table 1 shows the distribution of respondents according to their socio-demographic characteristics. The study population consisted of 24.6% males and 75.4% females, with a mean age of 21.22±1.23 years. Majority of the respondents were Malay (79.2%) and resided in the hostel, with an approximately equal distribution of students in their first (34.6%), second (31.7%) and third (33.8%) years of study. In terms of body weight status, 12.9% were underweight (UW), 19.6% OW, and 6.3% obese. Majority of the participants (61.3%) were of normal body weight.

Table 1. Socio-demographic characteristics of respondents, *N*=240

Socio-demographic	*n (%)*
Gender	
Male	59 (24.6)
Female	181 (75.4)
Ethnicity	
Malay	190 (79.2)
Chinese	33 (13.8)
Indian	15 (6.3)
Other	2 (0.8)
Current residence	
Hostel	228 (95.0)
Home with family	4 (1.7)
Rental	8 (3.3)
Year of study	
1st year	83 (34.6)
2nd year	76 (31.7)
3rd year	81 (33.8)
Field of study	
Arts	58 (24.2)
Technical	59 (24.9)
Sciences	123 (51.2)
Faculty	
Human Ecology (Art)	58 (24.2)
Engineering (Technical)	59 (24.6)
Biotechnology (Science)	60 (25.0)
Medicine & Health (Science)	63 (26.3)
BMI category	
Underweight (<18.5 kg/m^2)	31 (12.9)
Normal (18.5-24.9 kg/m^2)	147 (61.3)
Overweight (≥25.0 kg/m^2)	47 (19.6)
Obese (≥ 30 kg/m^2)	15 (6.3)

Sleep quality according to PSQI

Table 2 shows that 153 respondents (63.8%) subjectively rated their overall sleep quality as fairly good, while only 1.3% rated it as very bad. Approximately two-third of the respondents reported very good (33.3%) and fairly good (35.0%) sleep latency, while the remaining one-third (31.6%) reported taking more than 30 minutes to fall asleep. Only one-third

Table 2. Frequency distribution of sleep quality score of respondents, *N*=240

Component	*Question/Component scores*	*Very good n (%)*	*Fairly good n (%)*	*Fairly bad n (%)*	*Very bad n (%)*
1	Self-rate overall sleep quality	Very good 39 (16.3)	Fairly good 153 (63.8)	Fairly bad 45 (18.8)	Very bad 3 (1.3)
2	Sleep latency (how long does it take to fall asleep)	≤15 min 80 (33.3)	16-30 min 84 (35.0)	31-60 min 56 (23.3)	>60 min 20 (8.3)
3	Sleep duration (hours of actual sleep)	≥7 hours 72 (30.0)	6 hours 68 (28.3)	5 hours 68 (28.3)	<5 hours 32 (13.3)
4	Habitual sleep efficiency (% time in bed sleeping)	>85% 195 (81.3)	75-84% 33 (13.8)	65-74% 9 (3.8)	<65% 3 (1.3)
5	Overall sleep disturbances score*	Very good 24 (10.0)	Fairly good 171 (71.3)	Fairly bad 42 (17.5)	Very bad 3 (1.3)
6	Taken medication to aid in sleep?	Not during the past few months 228 (95.0)	<1/week 8 (3.3)	1-2 times/week 3 (1.3)	≥3 times/week 1 (0.4)
7	Daytime dysfunction (trouble staying awake while driving, eating meals or engaging in social activity?)	Not during the past few months 168 (70.0)	<1/week 47 (19.6)	1-2 times/week 18 (7.5)	≥3 times/week 7 (2.9)
7	Daytime dysfunction (how much of a problem has it been for you to keep up enough enthusiasm to get things done?)	Not problem at all 62 (25.8)	Only a very slight problem 123 (51.3)	Somewhat problem 50 (20.8)	A very big problem 5 (2.1)
5	Overall sleep disturbances (individual questions)	Not during the past few months	<1/week	1-2 times/week	≥3 times/week
	*Q5. During the past few months, how often have you had trouble sleeping because you..				
	...cannot get to sleep within 30 minutes	104 (43.3)	48 (20.2)	46 (19.2)	42 (17.5)
	...wake up in the middle of the night or early morning	81 (33.8)	53 (22.1)	68 (28.3)	38 (15.8)
	...have to get up to use the bathroom	116 (48.3)	55(22.9)	41 (17.1)	28 (11.7)
	...cannot breath comfortably	194 (80.8)	28 (11.7)	13 (5.4)	5 (2.1)
	...cough or snore loudly	190 (79.2)	33 (13.8)	9 (3.8)	8 (3.3)
	...feel too cold	114 (47.5)	68 (28.3)	32 (13.3)	26 (10.8)
	...feel too hot	127 (52.9)	60 (25.0)	39 (16.3)	14 (5.8)
	...had bad dreams	130 (54.2)	69 (28.8)	30 (12.5)	11 (4.6)
	...suffer from pain	193 (80.4)	28 (11.7)	12 (5.0)	7 (2.9)

Table 3. Sleep quality of respondents according to body weight status, *N*=240

Sleep quality	*Underweight, n=31 (BMI<18.5 kg/m²) n (%)*	*Normal, n=147 (BMI 18.5-24.9 kg/m²) n (%)*	*Overweight, n=47 (BMI ≥25 kg/m²) n (%)*	*Obese, n=15 (BMI ≥30 kg/m²) n (%)*	*p-value*
Good	21 (67.7)	77 (52.4)	18 (38.3)	3 (20.0)	<0.001*
Poor	10 (32.3)	70 (47.6)	29 (61.7)	12 (80.0)	

*Mann-Whitney U test significant at *p*-value <0.05

(30.0%) of respondents experienced ≥7 hours of adequate sleep duration, while 13.3% had very poor sleep duration (five hours or less per night) during the past month.

Majority of respondents (81.3%) reported experiencing good to very good sleep, indicating very minimal sleep disturbances, while 18.8% of respondents experienced fairly bad to very bad sleep disturbances according to the PSQI algorithm. Based on specific responses to sleep disturbances, 44.1% of respondents reported waking up in the middle of the night or early morning at least once per week, 17.1% reported that they had bad dreams at least once per week. Among respondents who reported 'others' as their reason of sleep disturbances, at least once or twice per week was stress-related thoughts associated with anxiety, stress, overthinking, fatigue, and stress-related symptoms including back pain, headache, and rapid heartbeats.

Meanwhile, 10.4% reported experiencing daytime dysfunction such as trouble staying awake while driving, eating meals or engaging in social activity at least once per week. More than half of the respondents (51.3%) were slightly concerned about their day time dysfunction affecting their daily life, while 20.8% of respondents reported this as being somewhat a problem and five respondents (2.1%) reported day time dysfunction heavily affected their daily life activity. Among the respondents, 1.7% reported having taken sleeping medication at least once per week within the past month.

Association between components of sleep quality and body weight status

Table 3 shows that there was a significant association between sleep quality and body weight status. More OW (61.7%) and OB (80.0%) respondents experienced poor sleep quality compared to those UW (32.3%) and normal weight (NW) (47.6%). The association between components of sleep quality and body weight status is shown in Table 4.

Results showed that Global PSQI, sleep latency, and sleep disturbances were associated with body weight status. Participants with OB had the highest score for Global PSQI (7.67±3.06), sleep latency (1.73±1.16), and sleep disturbances (1.53±0.64) compared to those with other body weight statuses. Meanwhile, OW participants had a higher score for Global PSQI (6.17±2.62) and sleep latency (1.21±0.91) compared to UW (Global PSQI: 4.90±1.83, sleep latency: 0.74±0.89) and NW (Global PSQI:5.61±2.65, sleep latency: 0.74±0.89) participants. This suggests that OW and OB are associated with poor sleep quality, longer sleep latency, and frequent experience of sleep disturbances compared to a leaner body weight status.

DISCUSSION

Body weight status

Almost a quarter of the respondents were classified in the body weight status of OW and OB. This result matched earlier studies reported in the Central region (Eow & Gan, 2018; Nurismadiana & Lee, 2018) and Northern region (Lai & Say, 2013) of Peninsular Malaysia, but lower

Table 4. Mean±SD scores of sleep quality and its component of PSQI according to body weight status (*N*=240)

Sleep quality	*Underweight (n=31)*	*Normal (n=147)*	*Overweight (n=47)*	*Obese (n=15)*	*p-value*
Global PSQI score	4.90±1.83	5.61±2.65	6.17±2.62	7.67±3.06	0.01*
†C1: Subjective sleep quality score	0.84±0.69	1.05±0.59	1.19±0.71	1.07±0.59	0.12
*C2: Sleep latency score	0.74±0.89	1.02±0.92	1.21±0.91	1.73±1.16	0.01*
C3: Sleep duration score	1.19±1.05	1.18±1.01	1.34±1.03	1.80±1.15	0.17
C4: Habitual sleep efficiency score	0.19±0.48	0.22±0.51	0.32±0.73	0.40±0.91	0.92
*C5: Sleep disturbances score	0.94±0.36	1.10±0.59	1.09±0.50	1.53±0.64	0.01*
C6: Use of sleeping medication score	0.06±0.25	0.08±0.40	0.04±0.20	0.07±0.26	0.97
C7: Daytime dysfunction score	0.94±0.68	0.97±0.67	0.98±0.71	1.07±0.59	0.90

Pittsburgh Sleep Quality Index (PSQI)
†C1-C7: Component scored from 0 to 3, where higher score indicates poor sleep quality
*Kruskal-Wallis test significant at *p*-value <0.05

compared to that previously reported in the National Health and Morbidity Survey of young adults (age ranged between 20 to 24 years old) (IPH, 2015).

Sleep quality

Majority of university students in this study had a shorter sleeping duration than the recommended ≥7 hours (Hirshkowitz *et al.*, 2015). Mean global PSQI score suggested respondents from this study had better sleep quality than previously reported (6.27±2.50 hours) in a study conducted among UPM and University of Malaya (UM) students (Tien Ngu *et al.*, 2017). Tien Ngu *et al.* (2017) highlighted that lower sleep quality among the students of both universities could have been a result of the data collection being conducted during examination week. Meanwhile, this study collected data during the early semester after inter-semester break, presumably after the respondents have had adequate rest. However, regardless of the period of data collection, university students consistently have poor sleep quality.

Despite a poor mean score of sleep quality, the majority of respondents (80.1%) in this study subjectively rated their overall sleep quality as 'good', based on their sleep quality in the past month. This suggested that majority of the respondents were not aware that they were experiencing poor sleep quality. This aligns with local (Tien Ngu *et al.*, 2017) and western (Vargas, Flores & Robles, 2014) studies that consistently showed university students were not aware of having poor sleep quality.

Sleep quality and its components with body weight status

This study suggested that there is a significant association between sleep quality with OW-OB. Results of the study are consistent with previous findings that supported the association between poor sleep quality and OW-OB (Krističevič, Štefan & Sporiš, 2018; Peltzer & Pengpid, 2017a; Fatima *et al.*, 2016). Although causal links between poor sleep quality and OW-OB are still unclear, previous studies suggested that poor sleep quality has a substantial impact on psychology, leading to poor eating and health-related behaviours that subsequently promote the development of OW-OB. For instance, prolonged periods of being awake during night time increases the tendency of snacking (Spaeth, Dinges & Goel, 2013). This behaviour is associated with a higher amount of calorie intake as most night time snacks contain fewer nutrients but are higher in energy density (Greer *et al.*, 2013). Poor sleep quality

also causes impairment in attention and poor judgement. With impaired decision making, individuals are more likely to make pleasure-seeking decisions and in this case, prefer foods with higher calorie densities (Ogilvie *et al.*, 2017) or even impulsive eating in the absence of hunger (Greer *et al.*, 2013). This further explains that to boost alertness, unrested and fatigue individuals tend to crave for snacks, consume caffeine and other sugar-sweetened beverages. Moreover, feeling tired during the day also impairs cognitive performance and lowers individual capacity to engage in physical activity (Štefan *et al.*, 2018). Hence, poor sleep promotes poor eating behaviours accompanied by reduced energy expenditure, subsequently promoting the development of OW-OB.

The current study found that OW-OB respondents have significantly poorer sleep and experienced longer sleep latency (longer time was taken from full awareness to falling asleep) as compared to UW-NW respondents. These findings are in agreement with a study conducted among university students in Australia (n=330, mean age 27.42±10.36 years) that found that OW-OB respondents had poorer sleep quality, characterised by shorter sleep duration and longer sleep latency (Yeh & Brown, 2014). This has been further supported by a previous prospective cohort study that showed OW-OB respondents (aged between 21 to 35 years old) with higher body fat percentage experiencing poorer sleep quality marked by longer sleep latency, shorter sleep duration, and time to awaken compared to non-overweight and obese respondents (Wirth *et al.*, 2015). However, the underlying mechanism behind such observation is yet to be known (Wirth *et al.*, 2015).

OB students were found to experience more frequent sleep disturbances compared to their leaner counterparts. This result is in line with previous evidence suggesting that excessive weight was associated with a higher frequency of sleep disturbances including chocking, awakening, and unrested sleep (Vargas *et al.*, 2014). Another study demonstrated that an elevation of six units in BMI increases the risk for obstructive sleep apnea (OSA), a condition that affects the continuity of sleep resulting in sleep disturbances, by four-times (Quintas-Neves, Preto & Drummond, 2016). Excessive weight especially visceral obesity affects metabolic hormones, influences secretion of inflammatory cytokines, promotes the severity of OSA that affects sleep-wake rhythm, and leads to sleep disturbances (Muscogiuri *et al.*, 2016). Individuals with sleep disturbances have lowered sleep continuity, increased daytime fatigue, and favour an unhealthy lifestyle that further aggravates the development of obesity (Tubbs, Khader, Fernandez & Grandner, 2020).

Several limitations should be taken into consideration when interpreting the findings of this study. The study design was cross-sectional, in which data collected among university samples was at a single point of time, therefore, the researcher was unable to draw conclusions on the cause and effect relationships between variables. Future research employing a longitudinal study design could better establish the temporal relationship between these variables. Qualitative studies could also be carried out to further explore the role of sleep quality in the development of obesity.

CONCLUSION

This research suggests that overweight and obese students at university are at greater risks of experiencing decreased sleep quality, having longer sleep latency and experiencing frequent sleep

disturbances. Thus, there is a need for a wellness programme to reduce the incidence of obesity while promoting healthy sleeping habits among university students.

Acknowledgements

The authors are grateful to all respondents who participated in this study. This study has been funded by Universiti Putra Malaysia under the Putra Grant scheme (GP-IPS/2016/9514300).

Authors' contributions

NFS, conducted the study, data analysis and interpretation, prepared the draft of the manuscript; ZI, principle investigator, conceptualised and designed the study, supervised the project and reviewed the manuscript; SNAA & SMN, supervised the project and reviewed the manuscript.

Conflict of interest

The authors have no conflict of interest.

References

Azad MC, Fraser K, Rumana N, Abdullah AF, Shahana N, Hanly PJ & Turin TC (2015). Sleep disturbances among medical students: a global perspective. *J Clin Sleep Med* 11(1):69–74. https://doi.org/10.5664/jcsm.4370

Eow SY & Gan WY (2018). Social media use, body image and body weight status: Comparison between university students with and without disordered eating in University Putra Malaysia. *International Journal of Public Health and Clinical Sciences* 5(1):129–145.

Fatima Y, Doi SAR & Mamun AA (2016). Sleep quality and obesity in young subjects: a meta-analysis. *Obes Rev* 17(11): 1154–1166. https://doi.org/10.1111/obr.12444

Ganesh Kamath M, Prakash J, Dash S, Chowdhury S, Ahmed ZB & Yusof MZZBM (2014). Is there an association between self-reported sleep duration, Body mass index and waist-hip ratio in young adults? A cross-sectional pilot study. *J Clin Diagnostic Res* 8(9):5–7. https://doi.org/10.7860/JCDR/2014/8918.4808

Greer SM, Goldstein AN & Walker MP (2013). The impact of sleep deprivation on food desire in the human brain. *Nat Commun* 4(2259): 1–7. https://doi.org/10.1038/ncomms3259

Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, Hazen N, Herman J, Katz ES, Kheirandish-Gozal L, Neubauer DN, O'Donnell AE, Ohayon M, Peever J, Rawding R, Sachdeva RC, Setters B, Vitiello MV, Ware JC & Adams Hillard PJ (2015). National sleep foundation's sleep time duration recommendations: Methodology and results summary. *Sleep Health* 1(1):40–43. https://doi.org/10.1016/j.sleh.2014.12.010

IPH (2008). *Nutritional Status. Report of the Third National Health and Morbidity Survey 2006 (NHMS III)* (pp. 1–75). Institute for Public Health, Ministry of Health Malaysia, Kuala Lumpur.

IPH (2015). *National Health and Morbidity Survey 2015 (NHMS 2015). Vol. II: Non-Communicable Diseases, Risk Factors & Other Health Problems.* Institute for Public Health, Ministry of Health Malaysia, Kuala Lumpur.

IPH (2019). *National Health and Morbidity Survey (NHMS) 2019: Vol. I: NCDs – Non-Communicable Diseases: Risk Factors and other Health Problems.* Institute for Public Health, Ministry of Health Malaysia, Kuala Lumpur.

Krističevič T, Štefan L & Sporiš G (2018). The associations between sleep duration and sleep quality with body-mass index in a large sample of young adults. *Int J Environ Res Public Health* 15(4). https://doi.org/10.3390/ijerph15040758

Kumar KA, Othman WA & Jeppu AK (2020). Association of Epworth Sleepiness Score with Anthropometric Measurements in Malaysian University Students. *Recent Advances in Biology and Medicine* 6(2020):1–6.

Lai PP & Say YH (2013). Associated factors of sleep quality and behavior among students of two tertiary institutions in Northern Malaysia. *Med J Malaysia* 68(3):196–203.

Mohamad Nor NS, Ambak R & Aris T (2018). An introduction to the My Body is Fit and Fabulous at home (MyBFF@home): A community-based weight loss intervention study among Malaysian housewives. *BMC Women's Health* 18(Suppl 1):1–4. https://doi.org/10.1186/s12905-018-0589-x

Musa NA, Moy FM & Wong LP (2018). Prevalence and factors associated with poor sleep quality among secondary school teachers in a developing country. *Ind Health* 56(5):407–418. https://doi.org/10.2486/indhealth.2018-0052

Muscogiuri G, Barrea L, Annunziata G, Di Somma C, Laudisio D, Colao A & Savastano S (2019). Obesity and sleep disturbance: the chicken or the egg? *Crit Rev Food Sci Nutr*, 59(13): 2158-2165. https://doi.org/10.1080/10408398.2018.1506979

Nurismadiana I & Lee K (2018). Factors associated with sleep quality among undergraduate students at a Malaysian public university. *International of Public Health and Clinical Sciences* 5(6):373–391.

Ogilvie RP, Lutsey PL, Widome R, Laska MN, Larson N & Neumark-Sztainer D (2017). Sleep indices and eating behaviours in young adults: Findings from Project EAT. *Public Health Nutr* 21(4):689–701. https://doi.org/10.1017/S1368980017003536

Peltzer K & Pengpid S (2017). Sleep duration, sleep quality, body mass index, and waist circumference among young adults from 24 low- and middle-income and two high-income countries. *Int J Environ Res Public Health* 14(6). https://doi.org/10.3390/ijerph14060566

Quintas-Neves M, Preto J & Drummond M (2016). Assessment of bariatric surgery efficacy on Obstructive Sleep Apnea (OSA). *Rev Port Pneumol* 22(6): 331-336. https://doi.org/10.1016/j.rppnen.2016.05.006.

Robinson HA, Dam R, Hassan L, Jenkins D, Buchan I & Sperrin M (2019). Post-2000 growth trajectories in children aged 4 – 11 years : A review and quantitative analysis. *Prev Med Rep* 14(March):1–14. https://doi.org/10.1016/j.pmedr.2019.100834

Spaeth AM, Dinges DF & Goel N (2013). Effects of Experimental Sleep Restriction on Weight Gain, Caloric Intake, and Meal Timing in Healthy Adults. *Sleep 36*(7):981–990. https://doi.org/10.5665/sleep.2792

Štefan L, Sporiš G, Krističevič T & Knjaz D (2018). Associations between sleep quality and its domains and insufficient physical activity in a large sample of Croatian young adults: a cross-sectional study. *BMJ Open* 8(7): e021902. https://doi.org/10.1136/bmjopen-2018-021902

Tien Ngu S, Masalamany K, Abd Manan N & Adam SK (2017). Sleep Quality among Pre-Clinical Medical Students in Universiti Putra Malaysia and Universiti Malaya, Malaysia. *Education in Medicine Journal* 9(3): 23–31. https://doi.org/10.21315/eimj2017.9.3.3

Tubbs AS, Khader W, Fernandez F, Grandner MA (2020). The common denominators of sleep, obesity, and psychopathology. *Curr Opin Psychol* 34: 84-88. https://doi.org/10.1016/j.copsyc.2019.11.003.

Vadeboncoeur C, Townsend N & Foster C (2015). A meta-analysis of weight gain in first year university students: is freshman 15 a myth? *BMC Obesity* 2(22): 1–9. https://doi.org/10.1186/s40608-015-0051-7

Vargas PA, Flores M & Robles E (2014). Sleep quality and body mass index in college students: The role of sleep disturbances. *J Am Coll Health* 62(8): 534–541. https://doi.org/10.1080/07448481.2014.933344

Wirth MD, Hébert JR, Hand GA, Youngstedt SD, Hurley TG, Shook RP, Paluch AE, Sui X, James SL & Blair SN (2015). Association between actigraphic sleep metrics and body composition. *Ann Epidemiol* 25(10): 773–778. https://doi.org/10.1016/j.annepidem.2015.05.001

WHO (2000). Obesity: Preventing and managing the global epidemic. In *World Health Organization – Technical Report Series*. https://doi.org/10.1016/S0140-6736(03)15268-3

Yeh SSS & Brown RF (2014). Disordered eating partly mediates the relationship between poor sleep quality and high body mass index. *Eat Behav* 15(2):291–297. https://doi.org/10.1016/j.eatbeh.2014.03.014

Yunus RM, Wazid SW, Hairi NN, Choo WY, Hairi FM, Sooryanarayana R, Ahmad SN, Razak IA, Peramalah D, Aziz SA, Mohamad ZL, Mohamad R, Ali ZM & Mahmud ABA (2017). Association between elder abuse and poor sleep: A cross-sectional study among rural older Malaysians. *PLoS ONE* 12(7):1–14. https://doi.org/10.1371/journal.pone.0180222

Mal J Nutr 26(3): 471-485, 2020

A qualitative study of motivators and barriers to weight reduction practices among overweight and obese suburban Malay adults

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ABSTRACT

Introduction: Designing an effective and comprehensive weight reduction intervention requires an understanding of the motivating factors and barriers to losing weight. This study explored the motivating factors and barriers to weight reduction through the experiences, emotions and ideas shared among suburban overweight and obese Malay adults. **Methods:** In this qualitative study, 23 overweight or obese Malay adults aged 30-59 years old were divided into three focus group discussion (FGD). The Socio-Ecological Model (SEM), consisting of four levels (intrapersonal, interpersonal, community, and policy) was utilised in this study. **Results:** The motivating factors were: (1) Intrapersonal level: self-awareness, health concern, self-confidence, and desire to have good physical appearance, (2) Interpersonal level: social support from family and friends, (3) Community level: availability and accessibility of physical activity facilities and health information, and (4) Policy level: healthy lifestyle programme. The barriers were: (1) Intrapersonal level: lack of knowledge about diet, physical limitations, lack of self-control, and emotion/mood, (2) Interpersonal level: spouse and children, career or housework commitment, (3) Community level: lack of neighbourhood safety, and availability and accessibility of outside foods, and (4) Policy level: availability and accessibility of outside foods. **Conclusion:** Eight factors were identified as motivating factors and barriers for weight reduction practices. Support from family and friends should be considered when developing an effective and comprehensive weight loss programme as it was both a motivating factor as well as a barrier.

Keywords: Motivator, barrier, weight reduction, obesity, qualitative study

INTRODUCTION

The World Health Organization estimates that obesity rates around the world have nearly tripled between 1975 and 2016. It was estimated that in 2016, 1.9 billion adults over the age of 18 years were overweight. Of these adults, more than 650 million were obese. These figures indicated that in 2016, 39% of the world's adult population was overweight and 13% obese (WHO, 2017). According to the National Health and Morbidity Survey (NHMS) 2019, the prevalence of adult obesity in Malaysia was 19.7% and overweight 30.4%. The prevalence of obesity in adults aged ≥18 years increased from 15.1% in 2011 to 17.7% in 2015, and to 19.7% in 2019

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doi: https://doi.org/10.31246/mjn-2019-0139

(IPH, 2020). As reported in NHMS 2015, the states with the highest prevalence of obesity in Malaysia were the Federal Territory of Putrajaya (43.0%), followed by Malacca (36.0%) (IPH, 2015).

Unhealthy diet and lack of physical activities are associated with weight gain and increased risks of many health problems. Obesity contributes to health problems such as cardiovascular diseases, type 2 diabetes, osteoarthritis, and cancer, as well as negatively impacting quality of life (Lau *et al.,* 2013). However, reducing weight through healthy eating and being physically active is challenging and involves many barriers (Fitzgerald & Spaccarotella, 2009).

Therefore, understanding the motivating factors and barriers to losing weight is important in developing effective weight loss programmes and for long-term positive results (Hammarstrom *et al.,* 2014). Barriers reduce the tendency of individuals to get involved in health intervention programmes. Lack of self-control, thus cheating during diet intervention, was identified as a major barrier to weight loss among participants, while family, friends and project-related support were motivators for them to lose weight (Hammarstrom *et al.,* 2014).

In order to improve and optimise future behavioural lifestyle intervention programmes, a greater understanding of the barriers and motivating factors of obese people from the individual level to socio-environment level is required. The whole ecological system must be given attention in understanding human development, as it consists of subsystems that assist, support and guide human development. They include relationships between individuals and their immediate environment such as school and family, up to the macro system, which is the cultural pattern of institutions (Fitzgerald & Spaccarotella, 2009).

Ecological model approach for health promotion focuses on both individual and social environmental factors. Any changes in the social environment will influence changes in an individual, and the support of individuals in the population is important for implementing environmental changes. It has been used as a basis for identifying determinants of behaviour such as smoking, physical activity, and nutrition. According to the Socio-Ecological Model (SEM) of health behaviour, four main factors that influence health behaviour include intrapersonal, interpersonal, community, and policy factors (Fitzgerald & Spaccarotella, 2009).

However, barriers and motivating factors on behavioural changes for healthy eating and physical activity are generally focused on individual or intrapersonal level, although environmental factors are important for a multifaceted approach in behavioural lifestyle changes (Fitzgerald & Spaccarotella, 2009). In Malaysia, studies on motivators and barriers in weight reduction from a multifaceted approach are still lacking. Most studies and intervention programmes that have been carried out focus on intrapersonal factors which influence obesity such as individual knowledge, attitudes and skills, and the effects of intervention on anthropometric and metabolic variables (Noor Safiza *et al.,* 2016; Roszanadia *et al.,* 2016). In addition, there were only a few qualitative studies on self-perception and barriers that had been conducted among Malaysian obese individuals (Nur Shahida *et al.,* 2016) and body weight perception among adolescents (Kuan *et al.*, 2011). Therefore, the aim of our qualitative study is to gain more insight into the motivating factors and barriers associated with weight loss, based on the four levels of factors that influence health behaviour in the SEM framework.

MATERIALS AND METHODS

Study design

The study design was a qualitative research and data were collected through focus group discussions (FGD) to explore the motivating factors and barriers to losing weight. FGD was used to obtain qualitative data on specific topics from multiple individuals through informal group discussions. This method provides data or feedback that may not be found in any record or documentation via dynamic conversation when a group of people ask questions from each other or debate in a short time period. Another advantage of FGD is the environment, which is socially oriented to help individuals express their experiences and perceptions, and discuss their ideas, opinions and thoughts. The study protocol was reviewed and approved by the Universiti Kebangsaan Malaysia Research Ethics Committee (UKM/PPI/111/8JEP-2016-207).

Study participants

Purposive sampling method was used to obtain the sample for this study. Sample selection was conducted in Alor Gajah, Malacca as Malacca is the second state with the highest prevalence of obesity in Malaysia (IPH, 2015). Thirty-seven participants were recruited from the Fit, Eat, Active, Training (F.E.A.T.) programme, which was designed as a quasi-experimental study (Wirdah *et al.*, 2020). Screening was conducted to identify participants based on the inclusion criteria of this study. Inclusion criteria were Malay adults aged 30-59 years old with a body mass index (BMI) ≥25.0 kg/m^2, without physical disabilities or any serious hearing or speech problems, interested to lose weight and at the contemplation phase in reference to the Transtheoretical Model (TTM) (Lenio, 2006). These inclusion criteria had taken into account the national population surveys, which have reported that the prevalence of overweight and obesity among the middle age group was doubled compared to other age groups, and the study subjects who were all Malay adults, as they appeared to have a faster rate of increase in obesity, compared to Indian and Chinese adults (Ghee, 2016).

Development of FGD interview guidelines

FGD interview guidelines were developed by the research team and reviewed by two qualitative researchers from the Malaysian Ministry of Health. The interview guidelines had a list of open-ended questions to enable respondents to fully express their personal opinions, perceptions and experiences during the discussions. The questions were divided into four topics: (1) motivators for weight loss, (2) respondents' experiences in their attempts to lose weight, (3) barriers to obtaining a weight loss, and (4) the ideal weight loss programme. The questions on experiences in attempts to lose weight and the ideal weight loss programme provided unprompted answers for motivating factors and barriers in weight loss, which enabled the researcher to obtain maximum input from the participants. The topics were chosen after consideration of relevant factors on motivators and barriers to lose weight through some references (Fitzgerald & Spaccarotella, 2009; Bethancourt *et al.,* 2014; Christaldi & Dejoy, 2012) and expert's opinion.

Pre-testing of FGD interview guidelines was done twice and included 30 overweight individuals in suburban Kuala Lumpur and eight overweight individuals in Seremban. The first pre-test was done to assess the relevance and understandability of the questions, while the second pre-test was done to test the appropriate environment and to improve the skill of the moderator.

Data collection

Data for the study were obtained via FGDs conducted among the participants at Alor Gajah, Malacca. A total of 37 participants were invited to participate in the study through letters and phone calls, and appointments were scheduled for subjects to participate in the FGDs. However, only 23 participants showed up for the FGD sessions. The participants were divided into three groups. The FGDs were conducted in a closed and comfortable room, with each group scheduled separately. The participants provided written consent and brief socio-demographic information before the start of the discussion. The participants granted permission for audio and visual recordings of the sessions to be made. All discussions were conducted for approximately an hour and a half to two hours, facilitated by the same trained moderator.

Data analysis

Audio files were transcribed verbatim and internal reliability was checked by research team members who read the transcripts and listened to the audio files several times to confirm that the data had been correctly transcribed. Interaction data were obtained from the audio tapes, video records, and notes taken by the observer during the discussion sessions to ensure rigorous data analysis.

The transcripts were coded independently by two researchers (WM and SE). The codes were interpreted into two content areas, which were motivating factors and barriers to losing weight (Bethancourt *et al.,* 2014; Christaldi & Dejoy, 2012). Thematic analysis was carried out to identify condensed main themes through these coded segments. After that, the codes were brought together into preliminary sub-themes, which were then sorted into themes after discussion among the researchers and external peer reviewers, and lastly into final sub-themes and themes. Two researchers then identified and categorised themes based on the SEM, which comprised of four levels: (1) interpersonal, (2) intrapersonal, (3) community, and (4) policy (Fitzgerald & Spaccarotella, 2009).

Each FGD transcript was imported into the NVivo computer software (version 11, 2015) as a rich text document. NVivo was used to extract codes and themes from the participants' responses and to obtain reference numbers (*n*) for all themes referring to the statements issued by the participants.

Theme consensus with the researcher

Two external peer reviewers read the transcripts to identify and form the themes. After the external peer reviewers have determined the appropriate themes, two researchers (WM and SE) compared and discussed the themes. The validation of themes was achieved through consensus between the two researchers and the two external peer reviewers. The identified codes, sub-themes and themes for two content areas of motivating factors and barriers to losing weight are described in Table 1.

RESULTS

Themes for motivating factors to lose weight

Table 2 shows the themes for motivating factors to lose weight and the responses from participants during the FGD sessions. All participants were those who were interested in weight reduction and many had previous experiences in weight loss, whereby majority of them had previously tried to lose weight in different ways, but without success. They expressed a general wish to lose weight in order to avoid chronic diseases and had a high self-awareness about their health. They stressed that the health hazards of being overweight were more

important than the desire to have a nice appearance. Participants also had self-confidence to lose weight with guidance and support. From the FGDs, we also found the need for social support. Social support was very important as their motivator to lose weight. Other than that, the availability and accessibility of physical activity facilities and health information were also needed as a

Table 1. Codes, sub-themes, themes and number of reference for motivating factors and barriers to losing weight

Codes	*Sub-themes*	*Themes*	*n*
Motivating factors to losing weight			
• Easy to find attire that fits • Want to have beautiful body and image • Looks attractive like other people	• Appearance • Beautiful body	• Desire to have good physical appearance	17
• Increased risk of diseases • Advice by doctor • Uncomfortable with self-condition	• Concern about potential diseases • Deterioration of health conditions	• Health concern	24
• Knows their own body weight status • Ageing	• Overweight and obese • Age and risk of diseases	• Self-awareness	29
• Want to lose weight • Confident to lose weight • Need help and guidance	• Can reduce weight by guidance on how to weight loss	• Self confidence	17
• Want to be like spouse • Spouse and family ask to lose weight • Need friend to exercise with	• Family and spouses' concern • Friends' influences	• Family and friends	25
• Facilities for exercise provided in the community • Safe and convenient facilities for exercise • Information on physical activity and exercise provided in the community • Information about diet and exercise for weight loss	• Facilities provided in community • Information provided in community	• Availability and accessibility of physical activity facilities and health information	20
• Healthy lifestyle activities conducted by nearest health clinic • Join healthy lifestyle activity, such as 10,000 steps programme, and free medical check-up	• Healthy lifestyle activity conducted by nearest health clinic	• Healthy lifestyle programme	7

(to be continued)

Table 1. Codes, sub-themes, themes and number of reference for motivating factors and barriers to losing weight [Cont'd]

Codes	*Sub-themes*	*Themes*	*n*
Barriers factors to losing weight			
• Does not take breakfast	• Wrong diet practices	• Lack of knowledge about diet	24
• Skip meals and strict dieting			
• Avoid rice and other myths about diet	• Misunderstanding about diet		
• Lazy to exercise regularly	• Feel lazy to exercise	• Emotion/mood	11
• Tired and want to rest			
• Feel shy to exercise in public	• Feel shy to exercise		
• Feel pain when exercise	• Body pain	• Physical limitation	15
• Knee pain when exercise			
• Uncomfortable	• Uncomfortable		
• Breathless			
• Work and career commitment	• Job and house commitment	• Career and housework commitment	23
• Housework commitment			
• Does not have extra time to exercise	• Time constraint		
• Uncomfortable doing exercise at open place	• Not comfortable	• Lack of neighbourhood safety	5
• Not suitable for older person			
• Feel worried about snatch thieves and traffic accidents	• Feel unsafe		
• Old facilities/tools and unsafe to use			
• Outside foods are cheaper	• Affordable prices	• Availability and accessibility of outside foods	14
• Variety of outside foods and deliciousness	• Availability of food		
• Easy and save time to prepare food			
• A lot of food served during special occasions	• Difficult to control their diets	• Lack of self-control	9
• A lot of community activity and occasion			
• Difficult to control food cravings and appetite	• High food cravings		
• Influence for unhealthy foods by spouse	• Unsupportive spouse and children	• Spouse and children	7
• Difficult to practise healthy diet at home			

n= reference numbers for all themes

Table 2. Themes for motivating factors to lose weight

Themes	*Example 1*	*Example 2*
Self-awareness	(B2): "I feel heavy; I'm not satisfied with my weight. I'm overweight… There are times when my weight goes up and down. I know I have to reduce my weight".	(H1): "I know I am obese. Hahaha… It's hard for me to go up and down the stairs. I feel uncomfortable doing my daily activities. I tried to lose weight but I couldn't".
Health concerns	(C2): "Having a healthy life is very important. We can avoid a lot of diseases like heart disease and high cholesterol level".	(B3): "I am afraid of getting sick. I want to avoid chronic diseases. I always feel uncomfortable with knee pain and I have difficulty to sit down and get up".
Self-confidence	(E1): "It's for my own self. I want a healthy life. So, we have to show our own efforts to achieve it!"	(C1): "I am confident I can lose my weight if I know the right way to do it. We must try, then we will know".
Desire to have good physical appearance	(A3): "First, of course, I want to look beautiful. Secondly, it is because all my clothes do not fit me anymore".	(I2): "See, other people are beautiful and slim. But I am fat. They make me envious! I want people to look at me and see me becoming slimmer, beautiful and attractive and I can wear and dress up in anything".
Family and friends	(A1): "My husband and children always talk about my weight and sometimes my husband and I go jogging together".	(G1): "I have a lot of friends who support me. My friends try to help me to reduce my weight".
Availability and accessibility of physical activity facilities	(F2): "The place is good and it's near the rubber plantation. It's cool and I get fresh and clean air".	G3): "Like what others said, there are many physical activity facilities provided in this residential area. We have parks, jogging track and a gymnasium. Everything is here and we can use it at any time".
Availability and accessibility of health information	(H1): "Sometimes they put up the banners and sometimes they spread the info about health through WhatsApp group".	(A3): "We always get information about health programme or any activities in our community from our leader".
Healthy lifestyle programme	(B2): "Sometimes we will hear about healthcare programmes, such as 10,000 steps, organised by the nearest clinic. We will join if we know about these".	(F3): "The nearest clinic also offers free medical check-up for blood glucose and cholesterol".

motivator to be more concerned about their weight and to be more active. Healthy lifestyle programmes organised by the nearest government clinics had also influenced them to be more active.

Themes for barriers to losing weight

Table 3 shows the themes for barriers to losing weight among the participants. The main barriers to weight loss were the lack of knowledge about diet, having physical limitations to be involved in physical activities or to exercise, lack of self-control in adhering to healthy diets, and feeling shy or uncomfortable to exercise alone. Some spouses and children influenced them to eat unhealthy foods, and their career or house-work commitment has resulted in a lack of time, which was an obstacle for them to lose weight. From the discussion, some of the participants mentioned safety issues and expressed their concerns about the rise in kidnapping cases and accidents, which made them worried to exercise outdoors. They also complained that they cannot control their desire for foods and were always looking out for unhealthy foods.

Socio-ecological model for motivating factors and barriers of weight loss among the participants

The identified themes for motivating factors and barriers to weight loss presented at the intrapersonal, interpersonal, community, and policy levels of Socio-Ecological Model (Fitzgerald & Spaccarotella, 2009) are described in the conceptual framework titled "Motivating factors and barriers of weight loss found in the study" (Figure 1). Eight motivators and barriers had been identified and categorised into four levels of SEM. Intrapersonal level factors are factors mostly within the control of an individual. The motivating factors for intrapersonal level were self-awareness, health concern, self-confidence, and desire to have good physical appearance. Intrapersonal barriers to losing weight were lack of knowledge about diet, lack of self-control, physical limitations, and emotion or mood.

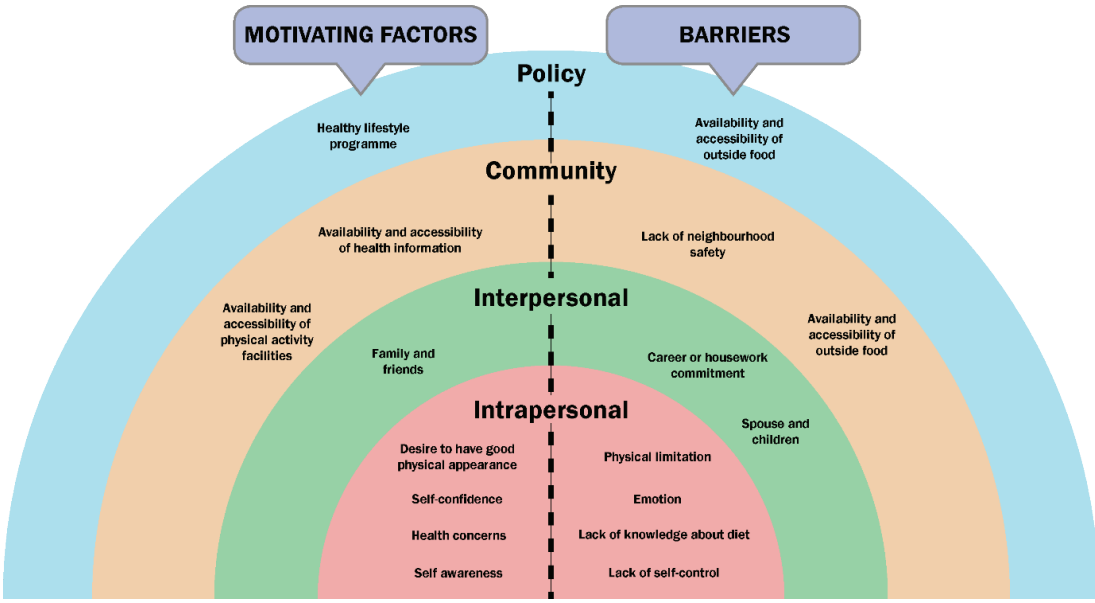

Figure1. Motivating factors and barriers of weight loss found in the study

Table 3. Themes for barriers to losing weight

Themes	*Example 1*	*Example 2*
Lack of knowledge about diet	G3): "I don't take rice and bread for two weeks. Just eat vegetables, meat, chicken and eggs".	(D2): "I always skip my breakfast. Taking breakfast makes me eat too much. Sometimes I take my first meal at 10 am and eat a late lunch".
Physical limitation	(D1): "I want to exercise but I can't. I can't jog. My knees are painful. So, I want to learn from you how to do it properly".	(H1): "I have problem with my legs, knee pain, and doctor said my feet cannot support my body weight. So I have to do indoor or sitting exercises to reduce my difficulty".
Lack of self-control	(H1): "I really want to lose weight but it is very difficult to control my diet".	(D3): "There are a lot of food and *kuih* served during our community meeting, at masjid and other *kenduri* in our community. I really can't control myself".
Emotion/mood	(F1): "I feel shy to jog alone in the park. It is boring doing it alone, it's good if we have friends together".	(E2): "Sometimes I feel lazy and have no mood to do exercise. I just want to relax at home. I don't know why".
Spouse and children	(D2): "I will take supper with my husband even though I have had my dinner earlier. My husband asks me to eat with him".	(H3): "My husband asks me to eat anything I like as long as I am healthy. My children also like to eat burger, so I join them".
Career or housework commitment	(B2): "Not enough time. My schedule is full. I have many things to do. I have to fetch my children to school, cook and others. I am also a babysitter for two children".	(A1): „It doesn't work for me. I have to work from Monday to Sunday. I work every day. There is no free time for me to exercise".
Lack of neighbourhood safety	(F2): "Some of the facilities are old and broken, I am worried I will get hurt. In addition, some of the facilities are not suitable for us to use".	(B2): "I am afraid when I exercise alone, there are a lot of cases nowadays. Cases like snatch thief and kidnapping are dangerous and scary".
Availability and accessibility of outside food	(I3): "I work every day and I have to eat out every day. The price is quite affordable and the taste ok".	(F1): "Outside foods are unhealthy. They contain preservatives, additives, high fat, sugar and high salt. But they are delicious and easy on me".

Interpersonal level involves the social relationships surrounding an individual (friends, family, spouse and children). Only one motivating factor was determined at the interpersonal level - social support from family and friends. However, family members, especially spouses and children, were also categorised as a barrier at this level, in addition to career or housework commitment.

Availability and accessibility of physical activity facilities and health information were motivating factors, and lack of neighbourhood safety was a barrier at the community level. The availability and accessibility of outside foods can be addressed as a barrier, both at the community and policy levels. Finally, healthy lifestyle programmes conducted by health clinics was identified as a motivator to weight reduction practices at the policy level.

DISCUSSION

Motivating factors to lose weight

Most of the participants had good self-awareness in developing healthy lifestyles as they showed concern about their health. This result is similar to Lofrano-Prado (2013), who reported that self-awareness was the strongest predictor to losing weight, especially among women. It has also been reported that motivation for weight loss in obese adults can be divided into three broad categories: health (50.0%), appearance (35.0%), and mood (15.0%) (Lofrano-Prado *et al.,* 2013). Many have the self-confidence to reduce their weight with the assistance of the right diet and proper exercises. Women often want to look slim and have a good appearance. Therefore, having high self-motivation and the desire to have good physical appearance play an important role in influencing women to reduce their weight (Fleary & Ettienne, 2014). A study conducted in the United States showed that women who were overweight and obese wanted to lose weight to look better (Christaldi & Dejoy, 2012), as well as to have the physique to wear attractive, stylish and fashionable clothing (Fleary & Ettienne, 2014). With that, extension programmes to increase awareness, knowledge, skills, motivation, and confidence would be best suited for overcoming these barriers for being physically active (Fitzgerald & Spaccarotella, 2009).

This study also showed the importance of social support in motivating the participants to lose weight. A majority of the participants, especially women, reported that they needed support from friends and family as an encouragement. Social support from family, friends and co-workers had been identified as a key factor in successful weight loss and maintenance, as well as to practise healthy lifestyle, especially among women (Metzgar *et al.,* 2015). Spouses are also one of the motivators for weight loss as some of participants had the support and motivation from their husbands. Relationship between two individuals, particularly husband and wife, can be an effective method to begin and sustain weight loss (Carson *et al.,* 2013).

In addition, weight loss intervention programme should involve a group approach as social support. Peer support group and the involvement of influential people in the community are needed to provide social, physical and motivational support in effective and comprehensive obesity interventions. Group-based physical activity that encourages social interaction has become a major impetus for adults to engage in physical activities (Fitzgerald & Spaccarotella, 2009; Bethancourt *et al.,* 2014). Community partnership, for example, community gardening programme has been shown to improve vegetable intake, as well as reduce the BMI and waist circumference

among obese adults in a semi-urban community (Wirdah *et al.,* 2018).

The availability of and accessibility to physical activity facilities and health information were motivators for the participants to lose weight and practise healthy lifestyles. In addition, the participants also stated that the availability of free exercise facilities at their workplace or housing area would provide them with opportunities to practise a healthy lifestyle. The availability of sports facilities, recreational parks, and pedestrian walkways in the neighbourhood has been shown to increase physical activity and improve weight status among individuals who are overweight and obese (Siti Sabariah *et al.,* 2014). On the other hand, according to Bethancourt (2014), lack of information can be an obstacle for individuals to participate in any physical activities.

Healthy lifestyle programmes that have been promoted in health clinics influenced our subjects to get involved in practising healthy lifestyles and becoming more active. The subjects joined healthy lifestyle programmes, namely the 10,000 steps intervention, that was conducted at the nearest health clinic. Study has shown that the 10,000 steps intervention increased physical activity, improved health outcomes, and resulted in modest reduction of body weight among overweight adults (Mokhtar *et al.*, 2019). Therefore, it is important to increase the awareness among our community towards the importance of healthy lifestyle for overall wellbeing (Ridzuan *et al.*, 2018). The government and stakeholders at the policy level must recognise the opportunities and actions needed to develop environments that promote healthy lifestyles as the community and neighbourhood environments are important motivators for individual behavioural change (Stulberg, 2014)

Barriers to losing weight

The main barrier to losing weight was the lack of knowledge about diet. Although most of the participants were concerned about chronic diseases and had the confidence to lose weight, unfortunately many of them misunderstood the meaning of a healthy diet. The participants believed that skipping meals, such as breakfast or dinner, was an effective practice for losing weight. The lack of nutritional knowledge among participants was a barrier to losing weight and the practice of healthy lifestyles, and as such, learning about proper dieting practices are important for weight loss (Kruegle, 2012).

Most of the participants complained they had physical limitations such as knee and leg pains, which limited their involvement in daily physical activities or exercises. Body weight affects quality of life. Increased BMI decreases scores in all quality of life domains, with the most significant negative impact in the physical domain (Kolotkin & Andersen, 2017). This indicates that overweight individuals require help and guidance from professionals to do suitable exercises (Bethancourt *et al.,* 2014).

Intervention programme must promote a physically active lifestyle by encouraging participants to be more active throughout the day. Participants can be encouraged to park at the far end of the parking lot and walk to the office, or to take the stairs instead of the elevator. A study has shown that an active lifestyle is just as effective as prescribed exercises for improving physical activity, cardiorespiratory fitness, blood pressure, and body composition. In fact, a physically active lifestyle may be an even better option for obese persons who have poor fitness levels and struggle with engaging in exercise for longer periods of time (Kruegle, 2012).

Participants also complained that they could not control their cravings

for food. The participants took part in community activities such as feasts, meetings, discussions, and religious activities that serve a variety of foods. In particular, women with extended social contacts which required their participation in these community activities have access to high calorie foods served (Sharifi & Ebrahimi, 2013). This issue needs to be considered in the development of our educational materials for weight loss interventions.

Surprisingly, women participants identified their spouses and children as barriers to lose weight. They influenced women to eat unhealthy foods and have late dinners, which contributed to weight gain. Hammarstrom (2014) reported that partners could be a major barrier to weight loss by encouraging the eating of unhealthy foods. This barrier includes difficulty in combining dietary changes with being together with their family, friends and workmates. Friends and family members tended to tempt women with high-energy and savoury foods and did not support them regarding their healthy food choices when eating at social and family gatherings (Metzgar *et al.,* 2015).

Furthermore, career and housework commitments were reasons why participants did not exercise due to a lack of time and feeling of fatigue. One participant reported that her job as a chef and taking care of her family restricted her from doing any exercises. Similarly, one-third of low-income women in the United States claimed that time and cost were barriers for them to participate in weight loss programmes (Ciao *et al.,* 2012) and for women to do physical activities in Iran (Sharifi & Ebrahimi, 2013).

Most of the participants ate out several times a month to celebrate family occasions, and due to the availability and accessibility of foods outside, it was difficult to control their diets. Outside foods are cheaper, more delicious, had more variety and are available at all hours. This was one of the barriers for them to control their weight as most outside foods are unhealthy, high in calories, fat and salt. Socio-economic development in Asia, which had occurred in the past three decades, has resulted in increased food availability and changes in the diets of Asian populations. Many foods served are now refined, sweetened and fat-rich, especially in the low- and middle-income communities (Ramachandran *et al.,* 2012). Neighbourhood or community has now become a barrier for healthy eating as there are limited healthy foods available (Fitzgerald & Spaccarotella, 2009). Therefore, focusing on teaching people how to prepare quick and healthy meals and selecting healthier food options when eating out is important (Fitzgerald & Spaccarotella, 2009). Besides that, policies that can influence food pricing, food-related advertisement and regulations, are also important to influence people's food intake patterns and food choices.

Safety issues were also raised during discussions about physical activity. Most physical activity facilities are old and more suitable for younger rather than older persons. Clean, accessible and safe leisure facilities and parking areas are important factors in helping individuals become more active (Bethancourt *et al.,* 2014). Some of participants claimed that incidents involving snatch thieves and traffic accidents made them unwilling to exercise in public places. A study conducted in the United States showed that subjects would perform physical activity if the environment was safe for them (Abdel-Kader *et al.,* 2009). Therefore, the authorities should monitor safety and improve the facilities provided in the community in order to encourage people to be active.

The themes captured in this study can be referenced when developing future interventions and strategies in weight lost intervention programmes. The SEM of health behaviour, which emphasises on environmental, behavioural, social, and psychological factors provides a comprehensive framework for understanding multiple determinants of health behaviours. SEM can be used to develop a systematic intervention by targeting the changes in mechanism at the interpersonal, intrapersonal, community, and policy levels (Fitzgerald & Spaccarotella, 2009).

Limitations and strengths

This study has several limitations. One was the homogeneity of the sample, whereby the participants were middle-aged Malays who wanted to lose weight. This may have limited and caused bias in the answers provided. Overweight adults who were not interested in losing weight should be included in future studies to fully understand the barriers and motivators to weight loss. This will provide new insights for more effective weight management strategies for the population.

A strength of the study was that the FGDs were well-organised and discussions were lively. The discussions were led interactively by a trained moderator who was able to put the participants at ease. All the participants shared their knowledge, ideas and experiences. They were more relaxed as they knew each other and had the same socio-demographic background. A focus group is ideal when used with a comparatively homogeneous group, like ours, where the participants could contribute equally to the discussion. Future studies in this area should explore barriers and motivating factors for those not interested in losing weight and to examine the relationship between socioeconomic status with the barriers and motivating factors to lose weight.

CONCLUSION

In conclusion, there were eight factors that had been identified as motivators and barriers towards weight reduction practices among adults with overweight and obesity. Information regarding healthy diets should be disseminated extensively as lack of knowledge was a barrier to losing weight. The information should also help individuals overcome their attraction to unhealthy outside foods. Findings from this study suggest that researchers should focus on an effective way to increase physical activity and exercise as physical limitation to perform exercise was one of the barriers identified. The exercises prescribed should particularly be well-suited for people with obesity and are comfortable to encourage and increase the probability of long-term success. Families need to be encouraged to support the efforts by a family member to lose weight and to maintain weight loss on a long-term basis. From the SEM perspective, an intra- and interpersonal-focused intervention should be developed together with community level intervention in order to create an effective weight loss programme, especially targeted at individuals living in sub-urban communities.

Acknowledgement

This study was part of the "Fit, Eat, Active and Training (F.E.A.T) Project funded by Arus Perdana Grant (Code: AP 2014-025). Special thanks to external peer reviewers and all participants for their full cooperation. The efforts and dedications of the researchers, data collection team and all those involved in this project are also acknowledged.

Authors' contributions

RAT, principal investigator, conceptualised the paper and designed the study and reviewed the manuscript; PBK, assisted in drafting of the manuscript and reviewed the manuscript; WM &

SE, conducted the data collection, data analysis, interpretation and prepared the first draft of the manuscript. All authors read and approved the final manuscript.

Conflict of interest

None to declare.

References

Abdel-Kader K, Unruh ML & Weisbor SD (2009). Symptom burden, depression, and quality of life in chronic and end-stage kidney disease. *Clin J Am Soc Nephrol* 4(6):1057-1064.

Bethancourt HJ, Rosenberg DE, Beatty T & Arterburn DE (2014). Barriers to and facilitators of physical activity program use among older adults. *Clin Med Res* 12(1-2):10-20.

Carson TL, Eddings KE, Krukowski RA, Love SJ, Harvey-Berino JR & West DS (2013). Examining social influence on participation and outcomes among a network of behavioral weight-loss intervention enrollees. *J Obes* 2013(480630):1-8. http://dx.doi.org/10.1155/2013/480630.

Christaldi J & Dejoy D (2012). An exploration of the motivational influences of successful weight loss and maintenance. *J Acad Nutr Diet* 112 (9): A37.

Ciao A, Latner J & Durso L (2012). Treatment seeking and barriers to weight loss treatments of different intensity levels among obese and overweight individuals. *Eat Weight Disord-Studies on Anorexia, Bulimia and Obesity* 17(1): e9-e16.

Fitzgerald N & Spaccarotella K (2009). Barriers to a healthy lifestyle: from individuals to public policy. an ecological perspective. *Journal of Extension* 47(1):1–8.

Fleary SA & Ettienne R (2014). Inherited or behavior? What causal beliefs about obesity are associated with weight perceptions and decisions to lose weight in a US sample? *International Scholarly Research Notices* 2014(632940):1-10.

Ghee LK (2016). A review of adult obesity research in Malaysia. *Med J Malaysia*71(June): 1–19.

Hammarstrom A, Wiklund AF, Lindahl B, Larsson C & Ahlgren C (2014). Experiences of barriers and facilitators to weight-loss in a diet intervention - A qualitative study of women in Northern Sweden. *BMC Women's Health* 14(1): 59.

IPH (2015). *National Health and Morbidity Survey V (NHMS V)*. Ministry of Health Malaysia, Putrajaya.

IPH (2020). *National Health and Morbidity Survey (NHMS) 2019: Vol. I: NCDs – Non-Communicable Diseases: Risk Factors and other Health Problems*. Setia Alam: Institute for Public Health, National Institutes of Health, Ministry of Health Malaysia.

Kolotkin RL & Andersen JR (2017). A systematic review of reviews: exploring the relationship between obesity, weight loss and health-related quality of life. *Clin Obes* 7(5):273-289.

Kruegle E (2012). *Factors that motivate obese and overweight patients to adhere to lifestyle change*. Degree Thesis for Nursing (Bachelor of Nursing). Novia University of Applied Sciences, Vaasa, Finland.

Kuan PX, Ho HL, Shuhaili MS, Siti AA & Gudum HR (2011). Gender differences in body mass index, body weight perception and weight loss strategies among undergraduates in Universiti Malaysia Sarawak. *Mal J Nutr 17*(1):67–75.

Lau XC, Chong KH, Poh BK & Ismail MN (2013). Physical activity, fitness and the energy cost of activities: implications for obesity in children and adolescents in the tropics. *Adv Food Nutr Res* 70:49-101.

Lenio, J.A. (2006). Analysis of the Transtheoretical Model of behavior change. *Appl Psychol* 73–86.

Lofrano-prado MC, Hill JO, José H, Ms GS, Rodrigues C, Freitas MD & Maria C (2013). Reasons and barriers to lose weight : obese adolescents ' point of view. *Br J Med Med Res* 3(3):1–9.

Metzgar CJ, Preston AG, Miller DL & Nickols-Richardson SM (2015). Facilitators and barriers to weight loss and weight loss maintenance: A qualitative exploration. *J Hum Nutr Diet* 28: 593–603.

Mokhtar R, Halim HA, Zailani MH, Isa A, Fauzi NFM (2019). Penurunan berat badan dan peningkatan kesihatan metabolik melalui program berjalan berasaskan pedometer selama 10 minggu. *Jurnal Sains Kesihatan Malaysia* 17(1): 21-29.

Noor Safiza MN, Rashidah A, Mohd Azahadi O, Suzana S & Nur Shahida AA (2016). Methodology of the My Body is Fit and Fabulous at Home (MyBFF@home): An intervention study to combat obesity among housewives in Malaysia. *Journal of Women's Health, Issues and Care* 5:5.

Nur Shahida AA, Nor Azian MZ, Noor Safiza MN, Rashidah A & Cheong SM (2016). Perspective on obesity problems and associated factors to reduce weight among overweight and obese housewives: A qualitative study. *Journal of Women's Health, Issues and Care* 5(6).

Ramachandran A, Chamukuttan S, Shetty SA, Arun N & Susairaj P (2012). Obesity in Asia - is it different from rest of the world. *Diabetes/ Metabolism Research and Reviews* 28(28): 47–51.

Ridzuan AR, Karim RA, Marmaya NH, Razak NA, Khalid NKN, Yusof KNM (2018). Public awareness towards healthy lifestyle. *International Journal of Academic Research in Business and Social Sciences* 8(10): 927–936.

Roszanadia R, Suzana S, Lee XW & Zahara AM (2016). Effectiveness of a structured weight management programmeme at workplace among employees of a petroleum industry in Malaysia. *Jurnal Sains Kesihatan Malaysia* 14(2): 49–56.

Sharifi N, Mahdavi R & Ebrahimi-Mameghani M (2013). Perceived barriers to weight loss programs for overweight or obese women. *Health Promot Perspect* 3(1): 11–22.

Siti Sabariah B, Siti Farrah Zaidah MY, Poh BK & Ruzita AT (2014). The role of built environment in physical activity, diet and obesity among Malaysian children. *GJPAAS* 4(April): 42–47.

Stulberg B (2014). The key to changing individual health behaviors: Change the environments that give rise to them. *Harvard Public Health Review*. Fall 2.

Wirdah M, A'rif A & Ruzita AT (2018). Benefits of community gardening activity in obesity intervention: Findings from F.E.A.T. Programme. *Curr Res Nutr Food Sci* 6(3): 700-710.

Wirdah M, Poh BK, Nor Farah MF, Norhayati I & Ruzita AT (2020). Impak Program Fit, Eat, Active, Training (F.E.A.T) terhadap status pemakanan dan aktiviti fizikal dalam kalangan dewasa berlebihan berat badan. *Jurnal Sains Kesihatan Malaysia* 18 (1): 71-83.

World Health Organization (2017). *Obesity and overweight. Fact sheet Updated October 2017.* From http://www.who.int/mediacentre/factsheets/fs311/en/ [Retrived September 25 2017].

Mal J Nutr 26(3): 487-494, 2020

Smartphone-based application vs paper-based record: female adolescents acceptance on fluid record tool

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ABSTRACT

Introduction: Water is essential for normal functioning of the human body. Total fluid intake assessment using fluid record method is considered to be a burden for respondents, and the development of technology is expected to contribute favourably to this issue. My Fluid Diary is a smartphone-based application developed by the researcher as a fluid intake recording tool. This study aimed to evaluate the acceptance of manual, paper-based fluid intake recording compared to using My Fluid Diary as a trial among Indonesian vocational female students. **Methods:** A qualitative study was conducted to explore students' acceptance of fluid intake recording using the smartphone-based application. An exploratory case study approach involving 38 female students as key informants was used via focus group discussion and in-depth interview as a method of triangulation. **Results:** Based on the data, female adolescents admitted that the application was more acceptable for fluid intake than recording manually using a book, in consideration of three aspects - the benefits, the easiness, and the application display or features. Based on its benefits, My Fluid Diary was mentioned as easy to learn and use. However, in order to improve the application, there is still a need for research development. **Conclusion:** My Fluid Diary was an application with respectable acceptance for fluid record compared to the manual, paper-based method among female adolescents.

Keywords*:* Medical informatics application, qualitative research, adolescent

INTRODUCTION

Water is necessary for human life's survival and growth, with excessive and inadequate consumption of water having negative health effects (Zhang *et al.,* 2018). Consuming adequate amount of water is greatly important for dehydration prevention, which occurs mostly in adolescents and affects their level of physical activity, cognitive performance, and physiological disorder in the form of subjective feelings or mood, thereby reducing productivity (Ganio *et al.,* 2011).

Water adequacy is specifically influenced by gender and age, whereby women have higher risks to experience water deficit compared to men. Women could also be at a greater risk of dehydration since they have lower water reserves (Ritz *et al.,* 2008). While other researchers have addressed the importance of water and hydration, water as an essential nutrient is often

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doi: https://doi.org/10.31246/mjn-2019-0122

neglected (Rush, 2013). Furthermore, assessing fluid intake in adolescents is globally needed to know the intake patterns of different types of fluid in a day. This information is important to increase the adherence towards daily recommendation in adolescents (Guelinckx *et al.,* 2015).

Diet records are often regarded as the gold standard, but this method needs participants to be highly motivated and have the ability to record details (Lee *et al.,* 2017). It could be considered a burden for respondents to self-reportedly record their 7-day fluid-specific intake (Jimoh, Bunn & Hooper, 2015). Thus, this method has limitations that could influence the results of assessment (Bardosono *et al.,* 2015).

Technology can be seen, imagined, and described to be a potential adopter, in which the diffusion of innovation can evaluate what, why, and how ideas are adopted and communicated (Peslak, Ceccucci & Sendall, 2012). Mobile technology can help people to record their dietary intakes and monitor them in real time (Lee *et al.,* 2017). The results of recent studies appeared to show that there is no harm in using mobile devices to record dietary intake among participants who are familiar with mobile phone technology (Porter *et al.,* 2016).

Recently, a new smartphone-based application named "My Fluid Diary" was developed and is available on android. This application was designed to be used as a fluid intake monitoring system, allowing users to track and input their daily fluid intakes in real time via smartphone to achieve daily fluid intake adequacy, especially from beverages. This recording tool is expected to assist respondents to self-record their daily fluid intakes in seven days continuously. Such an application can have considerable potential as a meaningful tool among users to input their daily fluid intakes compared to paper-based record and recall, which are known to be a burden.

As an innovation, in order to achieve development in the future, this application requires an evaluation. This study aimed to assess and evaluate My Fluid Diary's acceptance to find the differences in daily fluid intake record using two instruments – smartphone-based application and paper-based record among Indonesian female vocational students.

MATERIALS AND METHODS

This was a qualitative research designed exploration study conducted in June and July 2019. The study was carried out at SMKN 1 Banyumas, a vocational High School located in Central Java, Indonesia. Focus group discussions (FGDs) and in-depth interview as a triangulation method was used to collect data on the acceptance of female adolescents in their daily fluid record. Eligible students were capable of using, reading, and understanding the application and record book in Indonesian language.

My Fluid Diary (Figure 1) is a recent application designed to record daily intake and frequency of fluid consumption, particularly from drinks. This smartphone-based application uses android programme studio 3.2.1 with Java programme language. This android-based application is only available in the minimum 4.0.3 version. Users need a good and stable internet connection to send data to the central server in order to use this request, so that data can be analysed by the researcher. Participants can choose their daily intake in the display of My Fluid Diary to record the portion of drinks in real time or in the same day. The recording feature also includes options of pictures, bottles, glasses, or other sizes of drink choices. The adolescents recorded their seven-

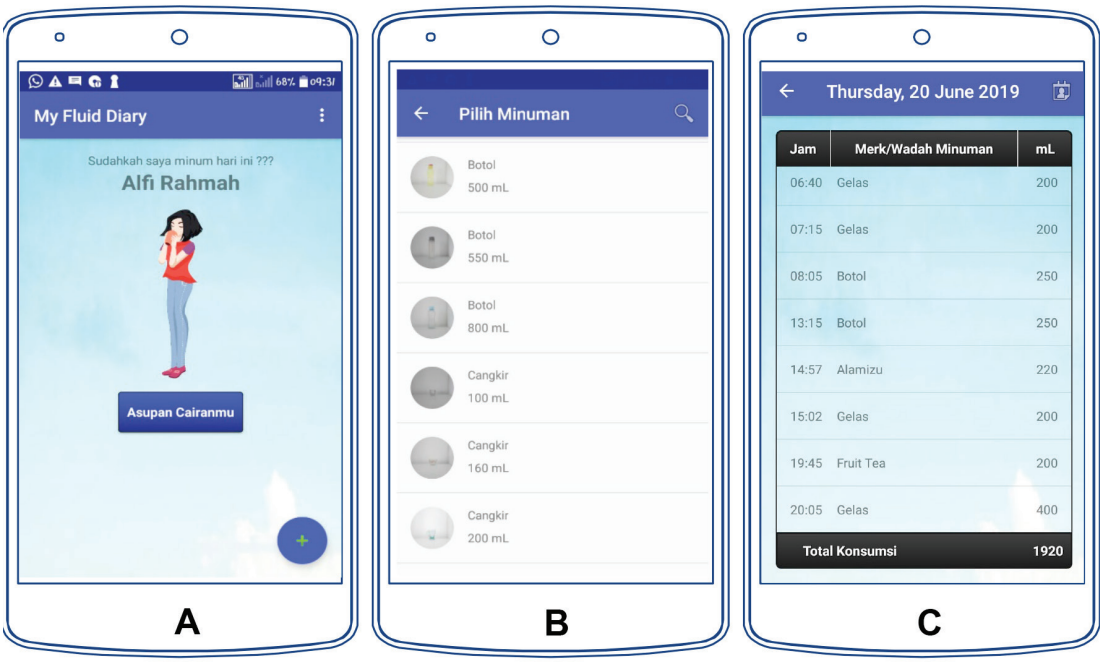

Figure 1. A. Display of "My Fluid Diary"; B. Features application for drink selection; C. Overview of daily fluid intake

day fluid intakes using this application on their own smartphones.

Another instrument used was the paper-based fluid intake record, using a book with formatted tables in pages to manually write down their daily drink intake, size, and frequency. This record book was also complete with a module consisting of description and some photos about bottle sizes, glasses, and other drink options. Participants also recorded their seven-day fluid intakes using this instrument in order to know their perceptions and experiences.

A total of 38 students were divided into two groups of 19 students. For the first period, group A did the paper-based fluid record and group B did the smartphone-based fluid record using My Fluid Diary. After a seven-day fluid record, each group participated in the FGDs. According to FGD procedures, approximately 8-10 participants are sufficient to reach saturation recommendation (Kekalih *et al.*, 2019). As a result, each group was divided into small groups consisting of 9-10 students for FGDs. There were four FGDs in the first period. After a wash-out period of two weeks, during the second period, the groups switched their fluid intake record methods. After seven days of recording fluid intake, the second FGDs were used to explore their experiences. In total, eight FGDs were completed in two parts.

The eight FGDs were homogenous in composition as participants were students of the same grade and same subject of study. The students were all 8th grade administration and office majors. Furthermore, all FGDs were done right after the students have filled out their seven-day fluid records using either paper or application. All facilitators were qualified in conducting these FGDs.

Each FGD lasted about 25 minutes, which was conducted in Indonesian language and audio recorded. All participants were told that the information collected from FGDs were

confidential and would only be used for research purposes. Before the FGDs, all students were informed about the purpose of the study and asked to sign an informed consent.

During FGDs, three big topics were discussed. First, the students' experiences on using the fluid intake record according to the method they were using at that time. Information about first impression, opinion, benefit, and the usefulness of the methods were asked. The second topic discussed was students' opinions about the layout of the paper-based fluid diary record and "My fluid Diary". The last topic explored was their acceptance and willingness to continue recording their fluid intakes using one of these methods. In the last part of the FGDs, students' opinions on the comparison of these two recording methods were additionally asked. The topics discussed in these FGDs were perceived variables in the Innovation Diffusion Theory (IDT) that can support how technology is accepted to be adopted (Rogers 1995; Oh & Yoon 2014).

In order to ensure the quality of the data collected, four facilitators had been recruited and trained to act as moderators, observers, note-takers, and photography or audio recording technicians. Data collection procedures and FGD guidelines were informed during training session to synchronise the facilitators' perceptions. It was an important way to optimise the role of facilitators. The role of facilitators can have a significant effect on the results and research findings. It should be considered in order to improve the trustworthiness of the research and quality of findings (Orvik *et al.* 2013).

As a form of triangulation, in-depth interviews were performed after every FGD. A total of 2-3 students from each FGD group were interviewed, to dig deeper on important statements. It was expected that data obtained from in-depth interviews would help and ensure that data previously obtained from FGD results were accurate.

Ethical approval for this study was obtained from the Ethical Committee of Faculty of Medicine, Universitas Jenderal Soedirman, with the number 3696/KEPK/VIII/2019. Prior to data collection, the research team had already gotten permission and also approval statement from the schools to do the research.

All data from the interviews were transcribed, then systematically analysed based on content analysis procedures by coding responses to identify the themes. Data coding is an interpretive technique to organise research data (Febrianingtyas, Februhartanty & Hadihardjono, 2019). With this, researchers noted the themes and notable quotations.

RESULTS

The research obtained three main themes related to female adolescents' perceptions of using smartphone-based application for fluid record compared to the paper-based fluid diary record. The first theme was related to students' perceptions on the benefits of the smartphone-based application compared to the fluid diary record. The next theme was the ease of use of this application based on their acceptance, and the final theme was the students' perceptions of the application's features.

Perception of the benefits

Compared to paper-based fluid diary record, it was much more practical to use smartphone-based application. The paper-based record was not as useful as the smartphone as students were unable to carry the diary everywhere. On the contrary, nearly all students always carried their smartphones in their pockets or in anywhere, which made

it easier to use this application. This application could also automatically save the amount of fluid intakes and different beverages that were selected in daily intake by users. Furthermore, this application could also provide them with practical ways to enter their fluid intakes.

During the time of using the paper-based method, students tended to skip or miss recording their fluid intakes. In comparison, students made real-time records after their fluid intakes using their smartphones, so this application reduced the risk of unrecorded drink intakes.

It was also less time consuming to understand and use this application. One of the students explained that compared to paper-based method, she took less than an hour to understand how to record fluid intake using the smartphone-based application:

"*It took less than 10 minutes to learn this application (My Fluid Diary) until I got used to using it*" (UN, 17 years old in one of the FGDs).

Another benefit offered by the smartphone-based application compared to the paper-based was the overview data on daily fluid intake (Figure 1 part C). One of the students stated that she could see her current fluid intake by using smartphone-based application and could also estimate the adequacy of her fluid intake. By inputting fluid intake into the application or book, the adolescents also knew how much their daily intake accumulation was in volume and how varied was their daily drinks.

The other benefit stated by the female adolescents was that My Fluid Diary is a modern instrument constructed based on the development of technology, so this app is suitable for them as a daily user of smartphones.

Easiness of the application

The other theme discussed in the FGDs was the easiness of the recording. Most students agreed that it was easier to use a smartphone-based application than a fluid diary record. When the smartphone-based application was first launched, most of the students already felt the easiness of the application. The students were able to easily understand the lesson about the application and to try recording their fluid intakes. By comparison, although fluid intake recording examples and guidance were given, many students still felt the difficulty with paper-based method.

"*First of all, we were told to record the fluid intake using the app.., felt the ease already then after we did, it's true that using the app was easier than using the paper-based…"* (S, 17 years old in one of FGDs).

The simplicity of My Fluid Diary was shown in the student's statement that this application was easy to learn and use. This application was more enjoyable due to its ease compared to the diary record book, and it did not take a long time to enter data. They also stated that image variation, description, brand, width and others were also user-friendly. By comparison, using paper-based diary fluid record was more difficult as many details had to be written manually. However, some students said it was easy to use paper-based record due to the availability of the guide and examples given.

The display and features of the application

Many students had an enjoyable view of the smartphone-based application. The simple font and suitability of the layout view made the display simpler to see. Most students also said that the blue colour used in the display was

appropriate for the theme (fluid and water). This interesting application was also accepted for use by the students based on its friendly display and fresh features. However, some students pointed out that the use of animated pictures could make the application more interesting. They found the smaller font and columns in paper-based record made them uncomfortable to write.

One of the students suggested making the app available in offline mode so they could still record and update their fluid record without relying on internet signal. In addition, the students also highlighted the importance of updating the list of beverages and drinks, as some kinds of drinks were not included in the database. For future improvement, one of the students suggested putting fluid intake-related alarm to remind the students of using the application to do fluid intake record:

"*I usually ignore the notification. It would be better if the notification came along with jingle songs, for example 'Lets drink... lets drink'. It would be much better"* (AA, 17 years old on one of FGDs).

DISCUSSION

Along with technological development, health practitioners, especially dietitians, have been encouraged to create smartphone-based applications for research and practice in health promotion (Pellegrini, Pfammatter & Conroy, 2015). User testing is necessary before an application is officially used by the community. Feedback on performance, functionality, satisfaction, incorporation into daily routine can be gathered through user testing to enhance the request. Focus group discussion is one of the common methods used to gather such information (Tonkin, Brimblecombe & Wycherley, 2017).

The study showed that using smartphone-based application provided several advantages compared to fluid diary record in recording fluid intake. There were three advantages using the smartphone-based application - practicality, the ease of recording, as well as the insightful features. These three advantages reduced the students' burden of recording their daily fluid intakes compared to paper-based record. Therefore, smartphone-based application also reduced the risk of forgetfulness and unrecorded drink intakes.

Previous studies on weight loss intervention have shown that using smartphone technologies reduced cost and burden to participants compared to traditional paper-based records (Lieffers, 2012; Martin *et al.,* 2012; Stumbo, 2013). Other than that, along with lowered burden on recording, smartphone-based application indirectly increases participants' awareness of food intake, thereby minimising the risk of unrecorded foods (Coughlin *et al.,* 2016).

In this research, students showed good responses on the smartphone-based application display. The display's attractiveness could be one of the contributing factors towards the students' preference for smartphone-based application compared to the diary. A scoping analysis on the features of nutrition applications on smartphones emphasised the importance of considering the use of interactive features, an attractive user interface, and non-repetitive images and colours, especially among low-socioeconomic status and young adult groups. These functional aspects are essential to maintain engagement with the application (Tonkin *et al.*, 2017).

Similar to other studies, students raised the importance of using the

smartphone-based application without having to rely on internet connection. Internet connection may affect user engagement as part of the common operational problem in the application. Updated fluid database was another issue raised by the students, emphasising the importance to culturally adapt the tool according to the specific community (Tonkin *et al.*, 2017).

This research obtained initial information about students' preferences and interest in using smartphone-based application. Information about students' experience using the application was important for its improvement. However, the results on students' preferences are enough to make smartphone-based fluid intake record as a tool to record fluid intake. Further research needs to be carried out on validating this smartphone-based application as a fluid intake record tool.

CONCLUSION

My Fluid Diary was an application with decent acceptance compared to manually paper-based recording of fluid intake among female adolescents. Students' preferences on the smartphone-based application are additional information about the benefits of nutrition-based smartphone applications. Understanding the community's experience on using the application could be useful information for researchers and developers to improve the application.

Acknowledgement

The authors thank all the respondents at SMKN 1 Banyumas, a vocational High School located in Central Java, Indonesia for their participation, as well as Nutrition Study Program, Jenderal Soedirman University, for the study conduct. The study was funded by a research grant from LPPM, Jenderal Soedirman University.

Author's contributions

HAR, principal investigator, conceptualised and designed the study, developed the application, prepared the draft of the manuscript and reviewed the manuscript; ISW, conducted the study, led the data collection and reviewed the manuscript; INK, led the qualitative data collection, data transcription, assisted in drafting of the manuscript, and reviewed the manuscript; PWH, led the qualitative data collection, data analysis and interpretation, and reviewed the manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

References

Bardosono S, Monrozier R, Permadhi I, Manikam NRM, Pohan R & Guelinckx I (2015). Total fluid intake assessed with a 7-day fluid record versus a 24-h dietary recall: a crossover study in Indonesian adolescents and adults. *Eur J Nutr* 54(2):17–25. doi: 10.1007/s00394-015-0954-6.

Coughlin SS, Whitehead M, Sheats JQ, Mastromonico J, Hardy D & Smith SA (2016). Smartphone Applications for Promoting Healthy Diet and Nutrition: A Literature Review. *Jacobs J Food Nutr* 2(3):021.

Febrianingtyas Y, Februhartanty J & Hadihardjono DN (2019). Workplace support and exclusive breastfeeding practice: a qualitative study in Jakarta, Indonesia. *Mal J Nutr* 25(1):129–142.

Ganio MS, Armstrong LE, Casa DJ, McDermott BP, Lee EC, Yamamoto LM, Marzano S, Lopez RM, Jimenez L, Le Bellego L, Chevillotte E & Lieberman HR (2011). Mild dehydration impairs cognitive performance and mood of men. *Br J Nutr* 106(10):1535–1543. doi: 10.1017/S0007114511002005.

Guelinckx I, Iglesia I, Bottin JH, De Miguel-Etayo P, González-Gil EM, Salas-Salvadó J, Kavouras SA, Gandy J, Martinez H, Bardosono S, Abdollahi M, Nasseri E, Jarosz A, Ma G, Carmuega E, Thiébaut I & Moreno LA (2015). Intake of water and beverages of children and adolescents in 13 countries. *Eur J Nutr* 54:69–79. doi: 10.1007/s00394-015-0955-5.

Jimoh FO, Bunn D & Hooper L (2015). Assessment of a self-reported drinks diary for the estimation of drinks intake by care home residents: Fluid intake study in the elderly (FISE). *J Nutr Health Aging* 19(5):491–496. doi: 10.1007/s12603-015-0458-3.

Kekalih A, Februhartanty J, Mansyur M & Shankar A (2019). Dietary diversity belief and practices among working mothers in Jakarta : a qualitative study. *Mal J Nutr* 25(Suppl):1–17.

Lee JE, Song S, Ahn JS, Kim Y & Lee JE (2017). Use of a mobile application for self-monitoring dietary intake: Feasibility test and an intervention study. *Nutrients* 9(7):E748. doi: 10.3390/nu9070748.

Lieffers JR HR (2012). Dietary assessment and self-monitoring with nutrition applications for mobile devices. *Can J Diet Pract Res* 73(3):253–260.

Martin CK, Correa JB, Han H, Allen HR, Rood JC, Champagne CM, Gunturk BK & Bray GA (2012). Validity of the Remote Food Photography Method (RFPM) for estimating energy and nutrient intake in near real-time. *Obesity* 20:891–899.

Oh J & Yoon S J (2014). Validation of Haptic Enabling Technology Acceptance Model (HE-TAM): Integration of IDT and TAM. *Telemat* 31(4):585–596. doi: 10.1016/j.tele.2014.01.002.

Orvik A, Larun L, Berland A & Ringsberg KC (2013). Situational factors in focus group studies: A systematic review, *Int J Qual Methods* 12(1):338–358. doi: 10.1177/160940691301200116.

Pellegrini CA, Pfammatter AF & Conroy DE SB (2015). Smartphone applications to support weight loss: current perspectives. *Adv Health Care Technol* 1:13–22.

Peslak A, Ceccucci W & Sendall P (2012). An empirical study of social networking behavior using theory of reasoned action. *JISAR* 5(3):12.

Porter J, Huggins C E, Truby H & Collins J (2016). The effect of using mobile technology-based methods that record food or nutrient intake on diabetes control and nutrition outcomes: A systematic review. *Nutrients* 8(12) :1–13. doi: 10.3390/nu8120815.

Ritz P, Vol S, Berrut G, Tack I, Arnaud MJ & Tichet J (2008). Influence of gender and body composition on hydration and body water spaces. *Clin Nutr* 27(5):740–746. doi: 10.1016/j.clnu.2008.07.010.

Rogers E M (1995). *Diffusion of Innovations (4th ed.)*. New York: The Free Press.

Rush EC (2013). Water: Neglected, unappreciated and under researched, *Eur J Clin Nutr* 67(5):492–495. doi: 10.1038/ejcn.2013.11.

Stumbo PJ (2013). New technology in dietary assessment: a review of digital methods in improving food record accuracy. *Proc Nutr Soc* 72(1):70–76.

Tonkin E, Brimblecombe J & Wycherley T (2017). Characteristics of smartphone applications for nutrition improvement in community settings : a scoping review characteristics of smartphone applications for nutrition improvement in community settings. *Adv Nutr* 8(2):308–322. doi: 10.3945/an.116.013748.

Zhang N, Morin C, Guelinckx I, Moreno LA, Kavouras SA, Gandy J, Martinez H, Salas-Salvadó J & Ma G (2018). Fluid intake in urban China: results of the 2016 *Liq.In*^{7} national cross-sectional surveys. *Eur J Nutr* 57(3):77–88. doi: 10.1007/s00394-018-1755-5.

Mal J Nutr 26(3): 495-500, 2020

SHORT COMMUNICATION

Effect of an educational intervention on nutrition literacy in teachers: a short communication

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ABSTRACT

Introduction: Teachers, by creating a culture of health within their classrooms, are agents of change and have an important role during students' formative years. This study aimed to investigate the effect of an educational intervention on the nutrition literacy of primary school teachers in Yasuj. **Methods:** In this quasi-experimental study, 110 primary school teachers in Yasuj, who were randomly selected from two areas of the city (intervention and comparison groups), were included in the study. Nutrition literacy was measured by using a validated tool for the Iranian society. After analysing the data, the educational content and structure were developed to improve nutrition literacy. The intervention consisted of two training sessions, provision of educational pamphlets and sending of two SMS messages. Data were analysed before and three months after the intervention by using SPSS16 software. **Results:** Before the intervention, the mean ± standard deviation of nutrition literacy in the comparison and intervention groups were 27.04±3.15 and 27.25±3.27, respectively. According to repeated measures ANOVA, nutrition literacy score improved significantly three months after the intervention ($p_{time} = 0.001$). Besides, there was a significant difference between the two groups ($p_{group} = 0.03$). The interaction between time and group was also significant ($p_{time \times group} = 0.001$). **Conclusion:** The educational intervention led to an improvement in the nutrition literacy of primary school teachers in Yasuj.

Keywords: Nutrition literacy, nutrition education, teachers

INTRODUCTION

In Iran, nutrition transition has happened owning to urbanisation and speedy socio-economic changes (Doustmohammadian *et al.*, 2020). This general change has resulted in a tendency towards a dietary pattern with low consumption of fruits and vegetables, fibre-rich foods, and dairy products, as well as high consumption of fatty, sugary, and convenience foods (Hajivandi *et al.*, 2020). Iran is facing the prevalence of malnutrition and the challenge of quantitative (the

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doi: https://doi.org/10.31246/mjn-2020-0014

intake of energy to alleviate hunger) and qualitative (the intake of other nutrients in addition to energy) food insecurity (Gorji *et al.*, 2017). Growing evidences have shown an association between high nutrition literacy and quality of eating habits (Spiteri & Moraes, 2015, Liao, Lai & Chang, 2019). Teachers are among the major groups contributing to the improved health of the society, especially students' health, by providing formal and informal educational opportunities relative to nutritious eating and healthy lifestyles. They can also have a substantial role in conducting health-related activities at schools, empowering students, and providing nutrition education to the students. Moreover, primary school students are massively influenced by their teachers. Therefore, increasing the nutrition literacy of teachers is a priority in the health services system. This research explored and discussed the effect of an educational intervention on the nutrition literacy of primary school teachers in Yasuj, in a resource-limited setting.

MATERIALS AND METHODS

This study was a before-and-after field trial with a comparison group. The target population of the study was primary school teachers of Yasuj city. To determine the comparison and intervention groups, a list of all primary schools in Yasuj was prepared. Yasuj has two educational districts and 75 primary schools in both districts. Given the close similarity in the demographic information of the primary schools of districts 1 and 2, seven schools from district 1 and seven schools from district 2 were randomly allocated into the comparison and intervention groups using computer-generated random numbers. There was no specific school or teacher's characteristic to consider for the selection. On average, there were eight teachers from each primary school. In each school, all teachers were included in the research.

Assuming that our intervention would increase nutrition literacy by at least 10%, the sample size in the intervention and comparison groups was set based on type I error of 0.05, test power of 80%, mean and standard deviation of nutrition literacy score in the pilot study (27.00 ± 3.17) (on a scale of 0 to 35), a possible attrition rate of 10%, and a design effect of 2. By including all teachers of the selected schools, the final sample size was calculated as 50 for each group (total 100 teachers). But during sampling, 57 teachers for the intervention group and 53 teachers for the comparison group were recruited.

The research scale was a standardised nutrition literacy questionnaire known as the Evaluation Instrument of Nutrition Literacy on Adults (EINLA), which had been developed and validated by Cesur, Koçoğlu & Sümer (2015) in Turkey. Following the translation-retranslation of this instrument, it was approved for the Iranian society with a reliability coefficient of 0.73 (Hemati *et al.*, 2018). After obtaining informed consent from the selected teachers, the questionnaire was provided to them. Teachers who taught first to sixth grades and agreed to take part in the study were included in this research. The following teachers were excluded from the research: teachers who were on longer than one month sick leave, educational missions, maternity leave or leave without pay, teachers who were absent from two training sessions, and teachers who were not available for completing the post-test questionnaire. After baseline data were collected, educational materials and intervention content were developed based on these baseline results. The baseline results showed which components of

the nutrition literacy were poor among teachers (number of servings, numerical literacy, and reading food label) and the educational intervention was focused on these poor components. The educational intervention consisted of two two-hour session training workshops, question and answer session, and group discussions. The first session covered the following topics: definition of nutrition, healthy nutrition, nutrition literacy, food groups, and the association between health and nutrition. The contents of the second session were about numeracy literacy, food labelling, calculation of daily needed calories, the number of servings, amount of the materials received by the body, and body mass index. All of the sessions were delivered by an expert in health/nutrition education. At the end of the second session, three pamphlets were distributed among teachers. These pamphlets covered all contents of the educational sessions. Furthermore, two short messages with the emphasis on the number of servings, numerical literacy, and reading food label were sent to the participants on the next three days after each session.

Due to the high number of members in the intervention group (57 members), the researchers classified them into two groups and each group was trained in two two-hour sessions. Three months following the educational intervention, the questionnaire was once again completed by the intervention and comparison groups. The data were analysed using SPSS version 16. We examined the mean and standard deviation score of nutrition literacy between the intervention and control groups before the study by applying the independent t-test. Repeated measures ANOVA was used to compare changes in the outcome (nutrition literacy score) across time. In this regard, the school and district were also included as possible confounding factors. We also examined the effect of time, group, and time–group interaction by using repeated measures ANOVA.

RESULTS

In this research, 79 participants were females (71.8%) and the rest were males. The mean ± standard deviation for age of the participants in the comparison and intervention groups were 39.62±6.92 and 39.35±6.96 years, respectively. Before the intervention, there was no significant difference in the demographic variables between the intervention and comparison groups (Table 1). Before the intervention, the mean ± standard deviation of nutrition literacy in the comparison and intervention groups were 27.04±3.15 and 27.25±3.27, respectively, and there was no significant difference between these two groups. The effect of the intervention on nutrition literacy is shown in Table 2. According to repeated measures ANOVA, the nutrition literacy score resulted in a significant change, where it improved significantly three months after the intervention ($p_{time} = 0.001$). Besides, there was a significant difference between the two groups ($p_{group} = 0.03$). Also, the interaction between time and group was significant ($p_{time \times group} = 0.001$).

DISCUSSION

It is very important to establish environments in schools that support healthy eating habits before students, especially primary school students, develop poor eating habits. Improving the nutrition literacy of primary school teachers can be an indirect, effective strategy to achieve this goal. In this study, we examined the effect of an educational intervention on the nutrition literacy of primary school teachers. Teachers in the treatment schools had significantly improved nutrition literacy compared with teachers in the comparison

Table 1. Demographic description of the participants

Variables	*n (%)*		*p value*
	Intervention group, n=57	*Comparison group, n=53*	
Sex			0.40
Male	14(24.6)	17 (32.1)	
Female	43 (75.4)	36 (67.9)	
Marital status			0.45
Single	8 (14)	5 (9.4)	
Married	49 (86)	47 (88.7)	
Widow/Divorced	0 (0)	1 (1.9)	
Teaching grade			0.77
First grade	11 (19.3)	11 (20.8)	
Second grade	9 (15.8)	11 (20.8)	
Third grade	11 (19.3)	6 (11.3)	
Fourth grade	8 (14)	11 (20.8)	
Fifth grade	10 (17.5)	8 (15.1)	
Sixth grade	8 (14)	6 (11.3)	
Degree			0.24
Diploma	5 (8.8)	4 (7.5)	
Associate degree	25(43.9)	14 (26.4)	
Bachelor	24 (42.1)	32 (60.4)	
Master's degree	3 (5.3)	3 (5.7)	
Years of job experience			0.15
1-5 years	4 (7)	2 (3.8)	
6-10 years	13 (22.8)	8 (15.1)	
11-15 years	6 (10.5)	15 (28.3)	
16-20 years	10 (17.5)	6 (11.3)	
>20 years	24 (42.1)	22 (41.5)	

Table 2. The repeated measures ANOVA of nutrition literacy between intervention and comparison groups

Variables	*Baseline*	*Three months later*	*p value*†		
			Time	*Group*	*Time*Group*
Nutrition Literacy			<0.001***	0.03*	<0.001***
Comparison group (*n*=53)	27.04±3.15	27.47±3.03			
Intervention group (*n*=57)	27.25±3.27	29.82±2.35			

Values are presented as mean ± standard deviation
†Repeated measures ANOVA
*p<0.05
***p<0.001

schools. This result is consistent with the findings of similar studies. A study was done by Ballance and Webb where five 60-minute sessions were held for teachers of child care centres to improve nutrition literacy among them. The results of their study showed much improvement in the areas of information literacy and nutrition literacy (e.g. how to read nutrition label and what defines whole grain) (Ballance & Webb, 2015). In a study by Montazeri and colleagues, nutrition education interventions were successful in modifying the food and eating patterns of teachers and students (Montazeri, Karaji-Bani & Mohammadi, 2005). Moreover, the study by Rustad & Smith (2013) showed a significant change in the knowledge of nutrition and desired eating behaviour compared to before intervention. In line with our study results, a study by Kupolati, MacIntyre & Gericke (2019) showed that nutrition education programme led to improvements in the teachers' and learners' nutrition knowledge, as well as the learners' nutrition attitudes.

The improvement in nutrition literacy among teachers from the intervention schools could be attributed to the exposure of the teachers to educational sessions, reading of pamphlets, and the messages they received. Our study has several limitations. This study was conducted in a confined area of two districts and with a relatively small sample size. Despite these limitations, the overall outcome of the project is considerably good. However, further researches among teachers of other provinces are needed. Our results have implications for managers of the education system. To improve nutrition literacy of teachers, they can include nutrition education sessions into retraining courses for teachers. It is expected that teachers with high nutrition literacy can have a positive impact on students' nutrition and eating behaviours. These results can also serve to improve the health of teachers in the Yasuj City and other areas of the Kohgiluyeh and Boyer-Ahmad Province.

CONCLUSION

According to the results of the study, educational interventions are effective in improving the nutrition literacy of primary school teachers. In this regard, it is recommended to provide a training course to improve the nutrition literacy of teachers in primary schools. Moreover, the results of this research can be presented to the decision makers in the education administration and also health policy makers to enable them to modify undesirable eating behaviours and promote proper diets. These results can also serve to improve the health of teachers in the Yasuj City and other areas of the Kohgiluyeh and Boyer-Ahmad Province.

Acknowledgment

This study was supported by the research deputy of Yasuj University of Medical Sciences. The authors would like to thank all the education administrations, school managers, and teachers.

Author contributions

MH, executive manager of the study, collected the data, helped writing the manuscript draft, and followed the modification of the revisions; MAT, conceived the statistical methodology; MS, conceived the statistical methodology, drafted the manuscript, conceived the study design and wrote the final manuscript; AB, wrote and consulted in study design and final version. All authors read and approved the final version of the manuscript.

Conflict of interest

There is no conflict of interest to declare.

References

Ballance D & Webb N (2015). For the mouths of babes: Nutrition literacy outreach to a child care center. *J Consum Health Internet* 19(1):1-12.

Cesur B, Koçoğlu G & Sümer H (2015). Evaluation instrument of nutrition literacy on adults (EINLA): A validity and reliability study. *IFNM* 2(1):127-130.

Doustmohammadian A, Omidvar N, Keshavarz-Mohammadi N, Eini-Zinab H, Amini M, Abdollahi M, Amirhamidi Z & Haidari H (2020). Low food and nutrition literacy (FNLIT): a barrier to dietary diversity and nutrient adequacy in school age children. *BMC Res Notes* 13(1):1-8.

Gorji HA, Alikhani M, Mohseni M, Moradi-Joo M, ziaiifar H & Moosavi A (2017). The prevalence of malnutrition in Iranian elderly: a review article. *Iran J Public Health* 46(12):1603-1610.

Hajivandi L, Noroozi M, Mostafavi F & Ekramzadeh M (2020). Food habits in overweight and obese adolescent girls with Polycystic ovary syndrome (PCOS): a qualitative study in Iran. *BMC Pediatrics* 20(1):1-7.

Hemati M, Akbartabar Toori M, Shams M, Behroozpour A & Rezaei A (2018). Measuring Nutritional Literacy in Elementary School Teachers in Yasuj: A Cross-Sectional Study. *Armaghane Danesh* 23(1):124-133.

Kupolati MD, MacIntyre UE & Gericke GJ (2019). A Contextual Nutrition Education Program Improves Nutrition Knowledge and Attitudes of South African Teachers and Learners. *Front Public Health* 7(258):1–12.

Liao LL, Lai IJ & Chang LC (2019). Nutrition literacy is associated with healthy-eating behaviour among college students in Taiwan. *Health Educ J* 78(7):756-769.

Montazeri Far F, Karaji Bani M & Mohammadi M (2005). The effect of education on the level of knowledge and attitude of school health educators and student performance in the field of correct nutrition in Zahedan. *Hormozgan Medical Journal* 9(4):279-286.

Rustad C & Smith C (2013). Nutrition knowledge and associated behavior changes in a holistic, short-term nutrition education intervention with low-income women. *J Nutr Educ Behav* 45(6):490-498.

Spiteri Cornish L & Moraes C (2015). The impact of consumer confusion on nutrition literacy and subsequent dietary behavior. *Psychol Mark* 32(5):558-574.

Mal J Nutr 26(3): 501-524, 2020

REVIEW

A review of national plans of action for nutrition in Southeast Asian countries

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ABSTRACT

This review describes national plans of action for nutrition (NPANs) in six Southeast Asia countries (Indonesia, Malaysia, Myanmar, Philippines, Thailand and Vietnam) in order to provide an understanding of the approach and framework undertaken by these countries in the formulation and implementation of NPANs, as well as the similarities and differences in various NPAN components. The six countries recognised the persistent undernutrition and escalating rates of obesity and other diet-related chronic diseases as the key drivers for nutrition action plan implementation. The prioritisation of nutrition interventions outlined in these NPANs are based on respective country context and needs. Although differing in strategies and targets set, these countries show similarities in several components including objectives, stakeholder involvement, nutritional issues to be addressed, implementation, monitoring and evaluation mechanism, programme/ activities identified and challenges in implementing NPANs. Countries have recognised that effective implementation, monitoring and evaluation are essential to successfully address both extremes of the challenging nutrition situation. Several important similarities in the NPANs studied suggest that closer collaboration among countries and stakeholders on NPANs would be beneficial. Opportunities should be created for periodic exchanges to enable sharing of experiences in the development and implementation of NPANs among the countries. Recommendations and conclusions drawn from this review could serve as useful reference for nutrition policy and planning in the future.

Keywords: National plan of action for nutrition, Southeast Asia, nutrition intervention programmes, implementation strategies, monitoring and evaluation

INTRODUCTION

Countries in Southeast Asia (SEA) region which had, in the past, carried a high burden of child undernutrition has experienced a shift of nutrition scene in which most countries in the region are facing a double burden of malnutrition. This is characterised by persistent undernutrition including stunting, wasting, micronutrient deficiencies and

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doi: https://doi.org/10.31246/mjn-review-26-3

coexisting overweight and obesity across the life cycle. Concern about diet-related chronic non-communicable diseases (NCDs) has also grown as they have been found to be responsible for major and growing proportion of the health burden (Shrimpton & Rokx, 2012; WHO, 2016).

The health systems of the region that were previously geared towards fighting widespread undernutrition, will now need to curb the rising rates of overweight and obesity in order to reduce NCDs. The focus of countries' food policies and national plan of action for nutrition (NPAN) have shifted to address the changes in nutrition scene. Well-established nutrition policies and plans are important tools in guiding the nations in dealing with nutritional issues as well as providing a framework for coordinated implementation of nutrition intervention activities by the government and cross-sectoral nutrition stakeholders in the country. Moreover, the World Health Organization (WHO) has emphasised that unless food and nutrition plans are implemented, unsafe food and poor nutrition will be responsible for an increased economic burden from food-related morbidity and premature mortality (WHO, 2000).

Many countries, including countries in the SEA region have reviewed their own NPAN following the Rome Declaration on Nutrition and the Framework for Action, arising from The Second International Conference on Nutrition (ICN2) in 2014. The present paper analysed NPANs in six SEA countries (Indonesia, Malaysia, Myanmar, Philippines, Thailand and Vietnam) in order to provide an understanding of the approach and framework undertaken by countries to formulate NPANs; stakeholder involvement, main nutritional problems targeted; strategies and programmes identified; and the implementation and monitoring mechanisms. Through this review, useful information on aspects of NPAN will become available for sharing with other countries which are developing or reviewing national nutrition action plans. Besides, conclusions drawn from this review could also serve as useful reference for nutrition policy and planning in the future.

METHOD

This review of NPANs in six SEA countries is based on the SEA-PHN Network's monograph on NPANs in SEA countries that was first published in 2018 (Tee *et al*, 2018). The intention of this review article is to provide a concise version of the 88-page monograph in a journal article that can have a wider reach to potential users. More details for the action plans that are beyond this review can be obtained from the monograph. Upon checking with the relevant authorities for any updated versions of these action plans, it was found that except for Myanmar and Thailand, all the documents cited in the monograph are still in use in the countries. The updated NPAN in Myanmar and Thailand are used in this journal review.

The NPANs used for this review are namely: National Food and Nutrition Action Plan (NFNAP) (*Rencana Aksi Nasional Pangan Dan Gizi, RANPG*) 2015-2019 (BAPPENAS Indonesia, 2015) (this plan is phasing out in 2019 and a new one is in preparation); National Plan of Action for Nutrition of Malaysia (NPANM) III 2016-2025 (NCCFN Malaysia, 2016); Myanmar's Multi-sectoral National Plan of Action on Nutrition (MS-NPAN) 2018/19 – 2022/23 (NNC Myanmar, 2018); Philippine Plan of Action for Nutrition (PPAN) 2017-2022 Executive Summary (NNC Philippines, 2017); Vietnam National Plan of Action for Nutrition to 2020 (MOH Vietnam, 2018) and Thailand's 5-Year National Plan of Action for Nutrition 2019-2023 (MOPH Thailand, 2019). The

key components of the NPANs were analysed and discussed. This includes formulation of the NPANs, stakeholder involvement, goal and objectives of different NPANs, nutritional issues addressed by the NPANs, strategies, programmes and activities identified for implementation, institutional framework for implementation, monitoring and evaluation approaches, and budget allocation. The challenges in implementing previous NPANs are also discussed.

RESULTS & DISCUSSION

Background of development of NPANs

Most of the NPANs in the six countries were first published in late 1990s or early 2000s, responding to the call of the first ICN on concerted effort to reduce starvation and all forms of malnutrition. The Philippines and Thailand formulated their first NPAN as early as 1970s. All countries had recognised the persistent undernutrition and parallel rise of the rates of obesity and other diet-related chronic diseases as the key drivers for nutrition action plan implementation. The NPANs in these countries have been developed by nutrition and health authorities of the respective countries, usually with extensive consultations and inputs from food and nutrition experts in the country, technical working groups, relevant stakeholders as well as international organisations such as Food and Agricultural Organization (FAO), WHO and the World Bank. Most of the plans were designed based on scientific evidence reviews, the experiences and lessons learnt from the past implementations, as well as detailed analyses of the nutrition situation in the respective country. These documents serve similar role of acting as framework for action and blueprint/reference documents by different stakeholders to address nutrition challenges in the country. Table 1 summarises the background of the NPANs in the six SEA countries and the stakeholders involved in the implementation.

Stakeholders involvement in the implementation of the action plans

The importance of multidisciplinary approach has been acknowledged by all the NPANs in which collective responsibility and involvement of all stakeholders in the development and implementation of the action plans are stressed and promoted.

The stakeholders pulled together by most of the countries are primarily the governmental organisations (Table 1). Other typical stakeholders include non-government organisations (NGOs), universities, professional bodies, social-political organisations and associations, and international organisations. All countries in this review, except Malaysia, are Scaling Up Nutrition (SUN) Movement member countries. Myanmar provides elaboration of the specific roles of each stakeholder identified.

Most NPANs also acknowledge the importance of involving media and private sector, particularly food-related industries. Food industries in Malaysia have been encouraged to play a major role in producing healthier food and beverage products at affordable prices through reformulation and innovation. In Vietnam, private sector is encouraged to increase production of specialised nutrition products to be used specifically among poor and disadvantaged groups.

Goal and objectives of different NPANs

The six NPANs reviewed present different goals with majority give emphasis to hunger eradication, prevention/ reduction of all forms of malnutrition, promotion of food and nutrition security and achievement of nutritional well-

Table 1. Overview of six NPANs included in the review

Country	*First NPAN*	*Current NPAN*	*Lead organisation in NPAN formulation*	*Time frame for review/update*	*Stakeholders/agencies/partners involved or identified in the action plans*
Indonesia	National Food and Nutrition Action Plan (*Rencana Aksi Nasional Pangan dan Gizi, RANPG*) 2001-2005	National Food and Nutrition Action Plan (*Rencana Aksi Nasional Pangan dan Gizi, RANPG*) 2015-2019	Ministry of National Development Planning & National Planning Agency (BAPPENAS)	Every 5 years	Government ministries and agencies, Investment Coordinating Board (BKPM), Bank Indonesia, local government, private sectors, civil society organisations, universities, professional organisations, community organisations, UN organisations, donors and media
Malaysia	National Plan of Action for Nutrition of Malaysia I (NPANM I) 1996-2000	National Plan of Action for Nutrition of Malaysia III (NPANM III) 2016- 2025	Ministry of Health, under the purview of the National Coordinating Committee of Food and Nutrition (NCCFN)	Every 10 years	Government ministries and agencies, professional bodies, academicians (universities), NGOs, private hospitals, mass media (telecommunication company), bank association, Federation of Malaysia Manufacturers, other food companies including small medium enterprises, fast food industries, hypermarket chains and supermarkets, food & beverages industries and international organisations [WHO, United Nations Children's Fund (UNICEF), ASEAN Secretariat]
Myanmar	National Plan of Action for Food and Nutrition (NPAFN) 1994	Multi-sectoral National Plan of Action on Nutrition (MS-NPAN) 2018/19 – 2022/23	National Nutrition Centre, Department of Public Health, Ministry of Health and Sports	Every 5 years	Development Assistance Coordinating Unit, National Nutrition Centre, government ministries, departments and agencies, state/regional government authorities, development partners (such as United Nations, SUN United Nations Network for Nutrition), civil society organisations including NGOs, the private sector and communities

(to be continued)

Table 1. Overview of six NPANs included in the review [Cont'd]

Country	*First NPAN*	*Current NPAN*	*Lead organisation in NPAN formulation*	*Time frame for review/update*	*Stakeholders/agencies/partners involved or identified in the action plans*
Philippines	Philippine Nutrition Plan 1974-1977	The Philippine Plan of Action for Nutrition (PPAN) 2017-2022	National Nutrition Council (NNC)	Every 5 years	National government agencies particularly the members of the NNC, the NNC Secretariat, local government units, NGOs, academic institutions, and development partners such as UNICEF, WHO, United Nations World Food Program Philippines. Others include Nutrition International (formerly Micronutrient Initiative), the Philippine Coalition of Advocates for Nutrition Security (PhilCAN), Civil Service Commision, media organisations, Employees' Unions, and the food industry
Thailand	National Plan of Action for Food and Nutrition (1977-1981)	The 5-year National Plan of Action for Nutrition 2019-2023	Ministry of Public Health (MOPH)	Every 5 years	Government ministries, related national organisations, Food and Drug Administration, journalist club, food industry group, educational institutions
Vietnam	National Plan of Action for Nutrition for 1995 – 2000	National Plan of Action for Nutrition to 2020	Ministry of Health	Every 5 years	Government ministries and agencies, the National Institute of Nutrition, the Maternal Child Health department and Preventive Medicine Department of MOH, the Hospital of Endocrinology, Central Specialized Hospitals, Institutes of Hygiene and Epidemiology/Pasteur Institutes, Ho Chi Minh Institute of Public Health, training facilities, social-political organisations and associations, People's Committees of provinces and centrally-run cities, Provincial Health Departments, District Health Centers, Commune Health Centers, international governmental and non-governmental organisations (such as UNICEF, WHO, FAO), media

being. Slightly different from other NPANs, Thailand's action plan is developed in line with the food education strategy in the country's 2nd Strategic Framework for Food Management in Thailand 2018-2037, giving emphasis to creating desirable behaviour in healthy food consumption. Most NPANs have similar objectives with emphasis on improving nutritional status of the population, preventing and/or reducing undernutrition and diet-related NCDs, and improving food and/or nutrition security. It is noteworthy that the goal and objectives outlined in these countries' NPAN are consistent with internationally agreed recommendations such as the Rome Declaration and the Framework for Action on Nutrition, and will contribute to the Sustainable Development Goals (SDGs) 2030 of the UN, particularly SDG 2 (end hunger, achieve food security and improved nutrition and promote sustainable agriculture), SDG 3 (good health and well-being), as well as the results of the World Health Assembly for 2025.

Nutrition issues to be addressed in action plans

As most countries in the region face similar situation of double burden of malnutrition, it is not surprising that the different NPANs show similarities in the nutrition situation and issues identified to be addressed (Table 2).

Some of the common priority nutritional issues identified include low exclusive breastfeeding rate; high prevalence of stunting, underweight and wasting amongst children under 5 years of age; increased prevalence of obesity and nutrition-related NCDs; micronutrient deficiencies; low vegetables and fruits intake; and low physical activity levels among the population.

Specific nutritional issues that are considered important to be addressed by respective countries are also identified, for example the problem of high salt, high fat foods consumptions, and protein consumption that are not meeting requirement in Indonesia; prevalence of low birth weight and teenage pregnancy in Myanmar; hunger in Philippines; and lower physical status and stature of the population in Vietnam.

Framework for NPANs

All NPANs in this study, except Vietnam, had developed a framework for the respective nutrition action plan. All of these frameworks developed are presented in pictorial format (Figures 1-5). These frameworks show one commonality wherein all of them summarise the goal, priorities and strategies identified for the action plan.

Strategies, food and nutrition programmes and activities

In alleviating the nutrition issues of the country, the NPANs in this review has prioritised the nutritionally vulnerable groups i.e. infants and young children, pregnant and lactating women.

Key strategies in NPANs

The overarching strategy of Malaysia is their foundation strategy which emphasises the responsibilities of all relevant agencies. Nutrition objectives, considerations and components are to be incorporated into national development policies and action plans in other relevant ministries and agencies, with the support of a wide range of enabling and facilitating strategies. In Myanmar, the action plan's key strategy is to strengthen multi-sectoral coordination in nutrition and deliver a package of essential nutrition-specific and nutrition-sensitive services/ interventions with the overall goal to reduce all forms of malnutrition among mothers, children and adolescent girls. The interventions in each state/region prioritise the most important factors

Table 2. Key nutrition situation/issues to be addressed by different NPANs

Nutrition situation/issues to be addressed	*Indonesia*	*Malaysia*	*Myanmar*	*Philippines*	*Thailand*	*Vietnam*
High prevalence of stunting among children <5 years old	+	+	+	+	+	+
High prevalence of wasting among children <5 years old	+	+	+	+		
High prevalence of underweight among children <5 years old	+	+	+			+
Increased prevalence of childhood overweight/obesity		+			+	+
Poor nutritional status of pregnant and lactating women			+	+		
Low rate of exclusive breastfeeding in the first 6 months of life	+	+		+	+	+
Low birth weight	+	+	+	+	+	+
Anaemia	+ (in women of childbearing age & pregnant mother)	+	+ (in child bearing age women & children <5 years old)	+ (among infants 6-11 months)	+ (in pregnant women, children aged 6 months to 3 years old & women of reproductive age)	+ (in pregnant women & children <5 years old)
Vitamin A deficiency			+	+ (among infants 6-11 months)		+
Iodine deficiency disorder (IDD)			+	+ (among pregnant & lactating women)	+ (in pregnant women, children)	+
Hunger			+	+		
Poor infant and young child feeding			+	+		
Low consumption of fruits and vegetables	+	+	+		+	+
Energy consumption not meeting requirement	+			+		+
Protein consumption not meeting requirement	+					
High consumption of salt and high fat foods	+				+	+ (high salt intake)
Increased prevalence of overweight/obesity among adults	+	+	+	+	+	+
High/Increased prevalence of non-communicable diseases		+	+		+	+
Improper nutrition knowledge and practices among mother and family members						+
Physical inactivity	+ (especially in urban area)	+ (among adolescents and adults)			+	+
Physical status & stature (height)					+	+

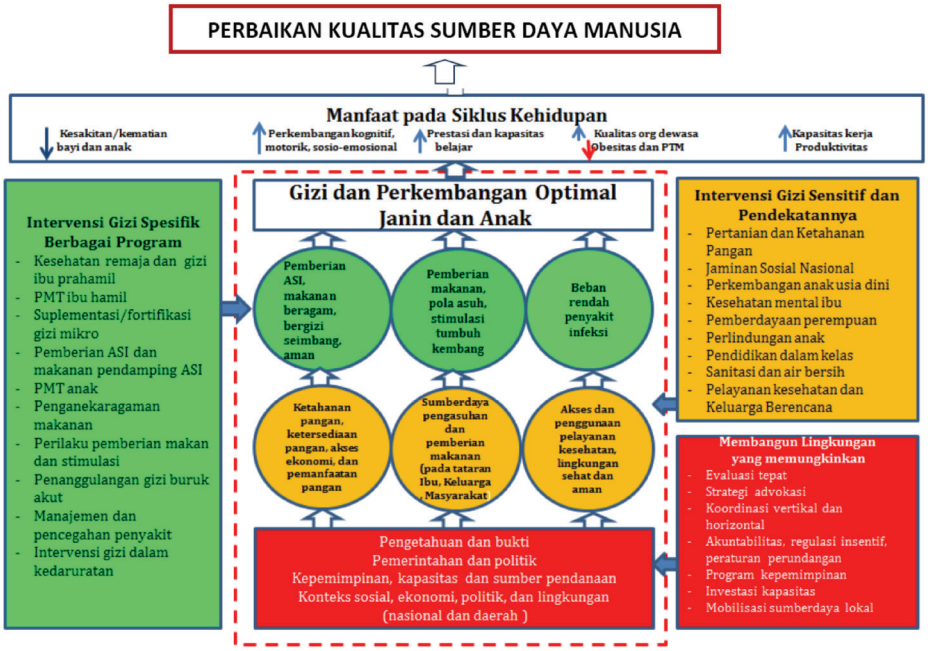

Figure 1. Framework of Indonesia National Food and Nutrition Action Plan (2015-2019)

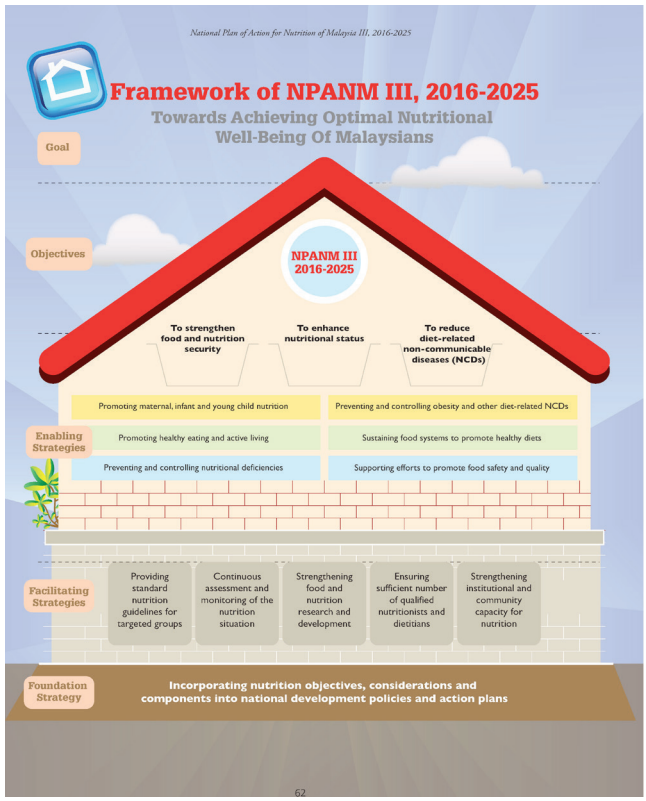

Figure 2. Framework of National Plan of Action for Nutrition III, Malaysia (2016-2025)

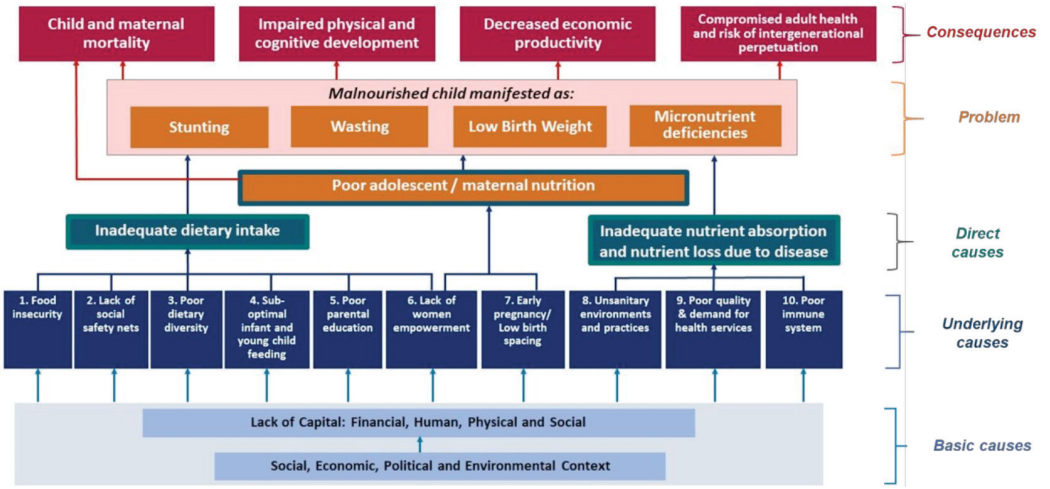

Figure 3. Conceptual Framework of the Multi-sectoral National Plan of Action on Nutrition, Myanmar

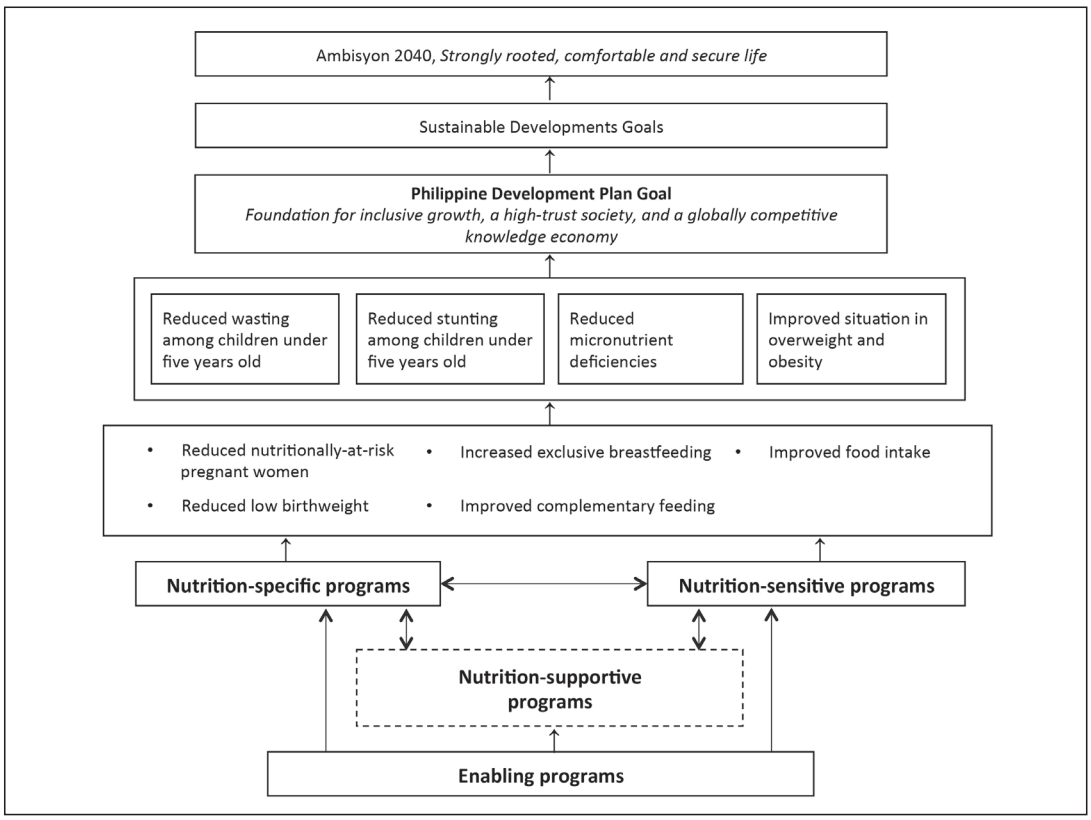

Figure 4. Framework of Philippines Plan of Action for Nutrition (2017-2022)

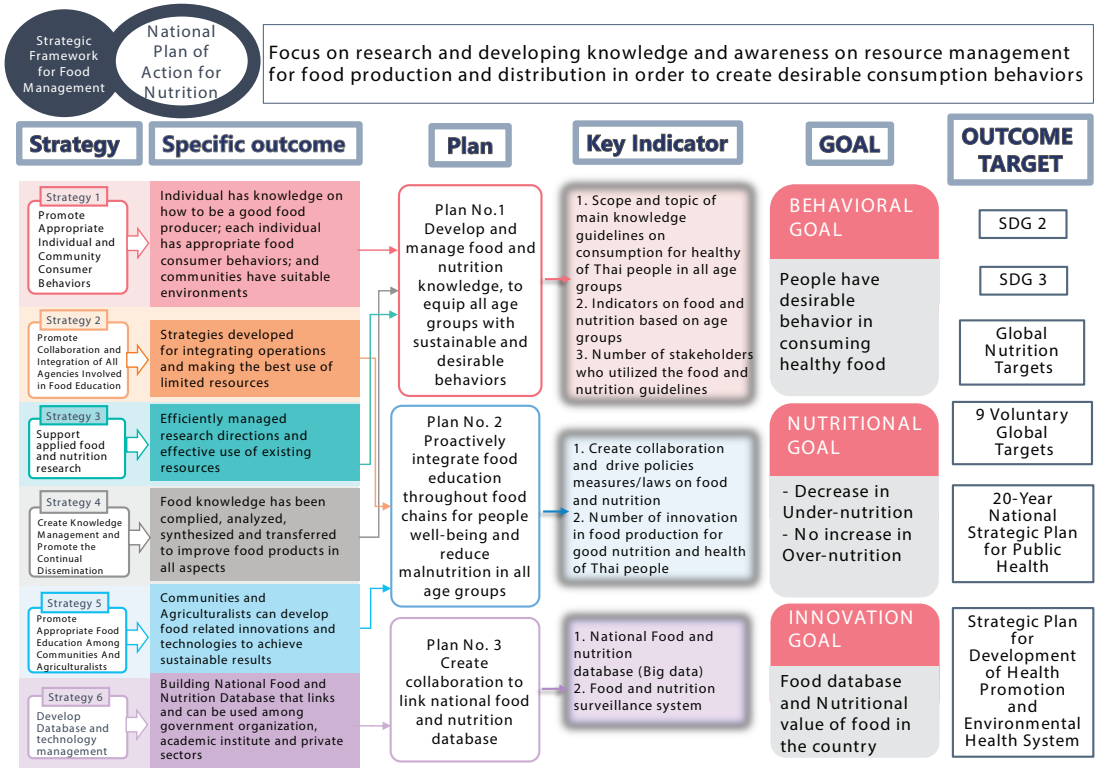

Figure 5. Framework of National Plan of Action for Nutrition, Thailand (2019-2023)

causing poor nutrition as well as interventions that are most responsive to effective operationalisation and scale-up to achieve high coverage and impact. Philippines' strategies focus on the First 1000 Days of Life, complementation of nutrition-specific and nutrition-sensitive programmes, intensified mobilisation of local government units, reaching geographically isolated and disadvantage areas, and complementation of actions of national and local government units.

Community nutrition improvement, increase in food accessibility, food safety enhancement and food and nutrition institutional strengthening are among the important pillars of strategies undertaken by Indonesia in its action plan. Thailand's NPAN strategies focus on the integration of food education throughout the food chains, through the process of promoting, developing and teaching to improve eating behavior thus achieving the goals of improved nutritional status. The three identified focus areas in Thailand's NPAN include develop and manage knowledge about food and nutrition to equip all groups of people with sustainable and proper behaviours; proactively integrate food education in all food chains; and create collaboration to link national food and nutrition database. Vietnam takes different approaches in its NPAN strategies in which the country focuses on legislative, advocacy and communication, technical, science, and international cooperation approaches.

Food and nutrition programmes & activities identified

Though the strategies proposed are different among countries, the programmes and activities identified by these NPANs are to some extent, similar (especially among the countries participating in SUN Movement). These can be generally divided into nutrition-specific and nutrition sensitive programmes/activities.

Multi-sectoral approach is utilised by most countries in the programme implementation, where several agencies are involved in one programme or activities with a lead agency identified for every activity. Most programmes identified are in response to the nutrition issues identified by respective country, are relevant to the priority gaps identified in the review, locally appropriate, and adopted after considering the past experiences in implementation capacity in order to achieve the intended nutrition impact. Table 3 provides an overview of common nutrition programmes and activities by these action plans.

Different from other countries, majority of the projects identified in Thailand's NPAN focus on development of knowledge, techniques, indicators and tools for behaviour modification and consumption changes; development of food education system (formal and non-formal) and national database on food and nutrition in which the nutrition data system will also be used for food and nutrition surveillance system.

a. Nutrition promotion during the first 1000 days of life

The importance of good nutrition during the first 1000 days of life is recognised by most NPANs in addressing the persistent undernutrition problems. Exclusive breastfeeding is being promoted by all countries and that Vietnam is taking the initiative to develop regulations on the operation of the breast milk bank. Other common activities undertaken to promote mother and children nutrition include education on complementary feeding; nutrition intervention for teenage girls, pregnant women and mothers; children nutritional status monitoring; supplementary provision of nutritional products for mothers/children at risk for poor nutrition, antenatal and post-natal care, baby friendly hospital initiative and control of the marketing of infant foods.

b. Addressing nutritional needs/ nutrients deficiencies

Dietary supplementation, micronutrient supplementation and food fortification are among the common activities outlined by these NPANs to safeguard the health and population's nutritional needs. Most countries implement dietary supplementation programmes for different target groups, particularly the vulnerable groups of infants, children and mothers. School feeding or school milk programme exist in all six countries (Table 3). Iron and folic acid supplementation and iodisation of salt are implemented by all six countries. Multiple micronutrients supplementation for high-risk groups is common in the NPANs of these countries. NPANs of these countries also respectively identified several staple foods such as rice, flour and oil for nutrients fortification (Table 3).

c. Food and nutrition security enhancement

Most NPANs underscore the need to increase/diversify local food production and utilisation. Several countries have price control system in place. Indonesia, Malaysia, Myanmar and Thailand integrate nutrition component/food-based nutrition education into the planning of food supply, agricultural and production. The community healthy food production project in Thailand

Table 3. Overview of some common nutrition programmes and activities identified in the NPANs

	Indonesia	*Malaysia*	*Myanmar*	*Philippines*	*Thailand*	*Vietnam*
Nutrition promotion for the First 1000 Days of Life	✓	✓	✓	✓	✓	✓
Pre-schoolers/school children/school feeding or school milk programme	✓	✓	✓ (provided in some areas)	✓	✓	✓
Micronutrient supplementation						
Iron and folic acid supplementation for women of reproductive age/pregnant women/ adolescent girls	✓	✓	✓	✓ (all women age 10-49 years old)	✓ (weekly dose of iron and folic supplementation for 20-49 years old women who want to have a child, daily dose for pregnant women)	✓
Multiple micronutrient supplementation	✓ (micronutrient powder supplementation)		✓ (pregnant women)	✓		✓ (children under 2 years old)
Vitamin A supplementation	✓ (lactating women & children aged 6-59 months)		✓ (children 6-59 months, post natal women, community-based distribution for remote area	✓ (lactating women & children aged 6-59 months)		✓ (children aged 6-36 months, <6 months old not receiving breastfeeding, children <5 years old with risk factors for vitamin A deficiency, women within one month of giving birth)
Zinc supplementation for diarrhoea prevention and control in children	✓		✓	✓		✓

(to be continued)

Table 3. Overview of some common nutrition programmes and activities identified in the NPANs [Cont'd]

	Indonesia	*Malaysia*	*Myanmar*	*Philippines*	*Thailand*	*Vietnam*
Promote the use of iodised salt	✓	✓	✓	✓ (iodised oil is provided for pregnant and lactating women in endemic areas)	✓ (iodised drinking water is provided for particular remote areas, where the accessibility of iodised salt is limited)	✓ (monitors the production and importation of iodised salt, and provide iodised salt especially for poor and disadvantaged regions, which have no access to iodised salt)
Food fortification programmes	✓ (iodised salt, wheat flour)	✓ (mandatory iron and folic acid fortification of wheat flour has been planned; universal salt iodisation)	✓ (universal salt iodisation, fortified rice, home-fortification with micronutrient powder)	✓ (fortification of flour, oil and sugar with Vitamin A and flour and rice with iron; salt iodisation; promotion of voluntary fortification of essential nutrients to manufacturers)	✓ (mandatory fortification of vitamin A in sweetened condensed milk; universal salt iodisation; fish sauce, seasoning products iodisation; triple fortification of instant noodles for iron, iodine and vitamin A)	✓ (vitamin A fortification for edible oil; iron and zinc in wheat flour and iodized salt fortification)
Food and nutrition security enhancement programmes/activities	✓ (superior seed production, food reserves strengthening, price control, integrated farming, food reserve strengthening, local food products market development)	✓ (affordable accessibility of fruits, vegetables and healthier foods, food wastage reduction, underutilised crops promotion)	✓ (women participation in agriculture, livestock and fisheries; quality seeds and fertilizers; agro-forestry, nutrition-sensitive land tenure and agriculture training)	✓	✓ (technology and innovation promotion for nutritious and safe foods production)	✓ (development of food security plans and guidelines for at risk areas, application of Vegetation-Aquaculture-Cage for Animal husbandry ecosystem for household nutrition security)

(to be continued)

Table 3. Overview of some common nutrition programmes and activities identified in the NPANs [Cont'd]

	Indonesia	*Malaysia*	*Myanmar*	*Philippines*	*Thailand*	*Vietnam*
Promotion of diversified local food production & utilisation	✓	✓	✓	✓	✓	✓
Overweight & obesity management and prevention of non-communicable diseases (NCDs)		✓ (Reduction in cooking oil subsidy; taxation on unhealthy foods and beverages; development of Standard guideline on weight management programme for overweight and obese individual at workplace)	✓	✓ (Overweight and Obesity Management and Prevention Programme for overweight and obese individuals across all age groups, policies and guidelines regulating marketing and selling of unhealthy food and beverages catering to all age groups)	✓ (Promote literacy on knowledge of food and nutrition to develop desirable behaviour of people of all age groups)	✓ (annual awareness campaigns, clinical nutrition activities; research and development of nutritional products for different target groups in controlling obesity and nutrition related NCDs)
Nutrition promotion/ education in schools	✓	✓	✓	✓	✓	✓

promote the development of technology and innovation for nutritious foods and encourage entrepreneurs and community chefs who have been trained in food production to produce nutritious and safe food products. Other activities identified are as indicated in Table 3.

d. Prevention of non-communicable diseases (NCDs)

NCDs prevention programmes exist in most countries, mainly focusing on promoting healthy eating and physical activities to prevent overweight and obesity through various approaches and settings (Table 3). Other approaches adopted in Malaysia include taxation of unhealthy foods and beverages.

e. Nutrition promotion & education in schools

The importance of schools in nutrition promotion is acknowledged by all NPANs. Healthy eating component is included in the Malaysia's preschool curriculum whereas in Thailand and Vietnam, nutrition education is provided for children from kindergarten through to university. Alongside nutrition education and school feeding, school is used as a platform for the delivery of nutrition-specific interventions to reach school aged children and adolescents who are difficult to access through the health system in Myanmar. In Philippines, nutrition education is delivered through the School Health and Nutrition Programme, integrating school gardening, supplementary feeding and nutrition education. Parent-teacher/ parent teacher associations approach is utilised by most countries (Malaysia, Myanmar and Philippines) to promote nutrition and healthy eating in schools, while some also train the food handlers in schools on healthy meal preparation (Malaysia and Vietnam). Thailand encourages food and nutrition teaching and develop curriculum for both formal and informal education system.

f. Other activities identified

Other activities identified by the various NPANs include strengthening institutional community capacity for nutrition by improving the number of qualified nutritionists/dietitians in the country; providing training for nutrition, dietetics, and food safety professionals; research and technology development in the areas of nutrition and food.

Performance indicators/outcomes and specific target for indicators

Target and performance indicators are used by all six countries in monitoring of action plans and programmes. Most of them identified similar indicators that can be categorised into three groups, namely indicators related to nutritional status, food security and micronutrient status (Table 4). Malaysia and Philippines have included the indicators that measure all six global nutrition targets.

Most NPANs do not discuss in detail the process of setting targets for the indicators. It is observed that several global targets and available country's baseline data were used and adopted as point of reference in setting the targets for the performance indicators. For several of the indicators, these countries are in agreement and are aiming collectively to reach the Global Nutrition Targets 2025 and SDGs 2030. All countries except Myanmar aim to achieve no increase from baseline for the childhood overweight rate in the country; increase exclusive breastfeeding rate up to least 50% (Indonesia), while Malaysia targets exclusive breastfeeding rate up to least 70%; 11-28% reduction in stunting and reduce childhood wasting to/no more than 5% (Malaysia, Myanmar,

Table 4. Indicators measured in different NPANs

Indicators	*Indonesia*	*Malaysia*	*Myanmar*	*Philippines*	*Thailand*	*Vietnam*
Nutritional status						
Prevalence of babies with low birth weight/to reduce the rate of low birth weight	+	+	+	+	+	+
Percentage of malnutrition (underweight) in toddlers/children <5 years old	+	+				
Prevalence of wasting in toddlers/children <5 years old	+	+	+	+	+	+
Prevalence of stunting in babies <2 years old/children <5 years old	+	+	+	+	+	+
Prevalence of overweight and obesity among children <5 years old		+		+	+	+
To reduce overweight among adolescent				+		
Prevalence of overweight and obesity among adults	+	+		+	+	+
Prevalence of overweight among elderly aged ≥ 60 years old		+				
Prevalence of obesity among elderly aged ≥ 60 years old		+				
Proportion of nutritionally-at-risk pregnant women				+		
Proportion of chronic energy deficiency among women of childbearing age						+
Height of children					+	+
Height of adult by gender increase by 1.0-1.5cm in comparison to the year 2010						+
Teenage pregnancy			+			
Micronutrient status						
Prevalence of anaemia in pregnant mother	+	+			+	+
Prevalence of anaemia among children <5 years old			+			+
Prevalence of anaemia among women of reproductive age		+	+	+	+	
Prevalence of iodine deficiency among children 6-12 years old				+		
Median urinary iodine concentration of mothers with children <5 years old						+
Median urinary iodine concentration of children 6-12 years old, pregnant & lactating women			+ (pregnant women)	+	+ (pregnant women)	
Percent with urinary iodine concentration <50mcg/L in children 6-12 years old & lactating women				+		
Prevalence of children under five with vitamin A deficiency/low serum vitamin A				+		+
Iodised salt household coverage salt/Prevalence of households using iodised salt qualified preventive (≥ 20ppm)			+		+ (20-40 ppm)	+
Food security						
Improvement of calorie consumption (kcal/capita/day)	+					
Percentage of household food insecurity/household with food poverty		+	+			
Households with acceptable food consumption score			+			
To increase the proportion of household with diets that meet the energy requirements				+		
Reduction of proportion of households with a per capita energy intake below 1800kcal			+			+
Food production (rice, corn, soybean, sugar, beef, fish, salt)	+					

(to be continued)

Table 4. Indicators measured in different NPANs [Cont'd]

Indicators	*Indonesia*	*Malaysia*	*Myanmar*	*Philippines*	*Thailand*	*Vietnam*
Dietary intake						
Percentage of infants at 6 months of age who receive solid, semi-solid or soft foods		+				
Percentage of children meeting the minimum acceptable diet		+	+	+		
Desirable dietary pattern score/Percentage of people having appropriate food consumption behaviour	+				+	
Average salt intake					+	+
Fish consumption	+					
Prevalence of adults meeting recommended intake (for cereal and cereal products; fruits; vegetables; meat, poultry and eggs; fish and fish products; legumes and nuts; milk and dairy products; water)		+	+		+ (proper consumption according to age group)	
Children consuming iron rich foods			+			
Nutrition practices and others						
Prevalence of exclusive breastfeeding in infants <6 months old	+	+	+	+	+	+
Prevalence of early initiation of breastfeeding (within one hour of birth)		+				
Prevalence of adults reading the Nutrition Information Panel (NIP)		+				
Nutrition officers at the provincial level have specialised training in nutrition						+
Nutrition officers at commune level and nutrition collaborators are trained and updated with nutrition knowledge						+
Have nutritionist/dietitians at the hospital (central, provincial and district level)						+
The proportion of hospitals implementing nutrition counselling and therapeutic treatment for some specific diseases and groups at hospitals of different levels						+
The number of provinces with nutrition surveillance unit capable of collecting adequate and qualified indicators on the implementation of the plan. Supervision of nutrition during emergencies in disaster-prone provinces						+
Non-communicable diseases						
Prevalence of hypercholesterolemia among adults > 18 years old		+				
Prevalence of diabetes among adults > 18 years old		+				
Prevalence of hypertension among adults > 18 years old		+				

Philippines, Thailand, Vietnam); and 10-30% reduction in prevalence of low birth weight.

Implementation, management, monitoring & evaluation

Implementation & management

NPANs of the six countries call for multi-sectoral and multi-stakeholder collaboration to ensure more effective implementation of intervention strategies. Decentralisation and multi-sectoral approach is emphasised by most countries, where the implementation is allocated to a range of different institutions. The implementation is largely led by and coordinated by the Ministry of Health (i.e. Malaysia, Myanmar, Thailand, Vietnam), National Nutrition Council (i.e. Philippines), National Planning Agency or BAPPENAS (Indonesia) or a high level coordinating committee. Some countries such as Indonesia, Myanmar and Philippines develop separate action plans for regional or local level. Specific advisory bodies have been established in most of these countries to provide overall technical assistance and support to all aspects of the action plan. Indonesia, Malaysia and Philippines also established technical working groups to support or facilitate the implementation of the action plan.

Monitoring & evaluation

All NPANs in this review underscore the importance of monitoring and evaluation activities. Most of them (Malaysia, Philippines, Indonesia, Vietnam) involve the generation of annual reports on implementation at all levels and progress report from various stakeholders involved. A system of indicators is used by all six countries in monitoring and evaluating the action plan. National health and nutrition surveys (Malaysia, Myanmar, Vietnam, and Philippines), data collection and indicators recorded at all levels (Indonesia, Thailand) form the important part of monitoring and evaluation process of these countries. The national nutrition surveys' findings help the respective countries in evaluating the impact of the strategies, reviewing the priorities and activities of the programme implemented, and plan for future action plan. Most countries also have in place mid-term review and long-term review for the NPANs.

Funding and budget for NPANs

The action plans of Indonesia, Myanmar, Philippines and Vietnam provide insights into the funding and budget allocation for NPAN implementation.

The primary funding sources for Indonesia, Philippines, Thailand and Vietnam are from the government budget. Other funding for these countries include special funding schemes allocated for certain regional areas and grant donations from corporate sector (Indonesia); funding and investment from development partners / international organisations (Philippines and Vietnam); contribution and mobilisation from the community and domestic organisations (Vietnam). In Vietnam, the largest proportion of the budget is allocated for improving the quantity and quality of people's meals and nutritional status of mothers and children.

Myanmar, Philippines and Vietnam conducted costing analysis for the action plan and estimated the budget required for the action plan activities. Philippines action plan's budget is an estimate of the costs of 38 projects and their ten programmes for the 6-year period whereas Myanmar's action plan provides details on the indicative total cost and funding required to implement and deliver the 5-year sector-level key results. Malaysia NPAN has not provided details of the funds for the implementation of the identified programmes and activities.

Common challenges in implementing NPANs

All six NPANs have outlined the key factors that influence the extent to which the planned activities can be implemented successfully. It is not surprising that these countries face some common challenges in implementing the plans.

The need for greater coordination among relevant stakeholders and active community participation are the major challenges facing most countries (Myanmar, Vietnam, Malaysia, Thailand, Indonesia). While the shared responsibility for implementation is emphasised, it appears that the Ministry of Health is often perceived as having sole responsibility on the action plan. Malaysia's NPANM III mentions the need to develop a road map that allows adequate coordination between national and sub-national levels, with involvement of other related stakeholders and community representatives to ensure commitment and active participation. In Indonesia, the lack of public-private partnership, multi-stakeholders coordination in the national and sub-national level have led to low programme coverage for nutrition specific intervention and fragmented nutrition policies and programmes. Vietnam's NPAN also highlights inadequate policy advocacy, attention from the government has caused inadequateness in cross-collaboration and that activities and resources are not being integrated effectively especially at localities. Thailand highlights that the collaboration among agencies and cooperation with private sector needs to be strengthened.

Financial commitment is also a critical factor in NPAN development and implementation (Philippines, Malaysia, Myanmar, Vietnam). In Vietnam, majority of the budget has been allocated to control malnutrition of children under five, and thus insufficient budget for other important nutrition issues. In Philippines, the budget formulation for the current plan has been largely concluded prior to the PPAN formulation exercise. In Malaysia, insufficient political commitment to tackling malnutrition has led to a financial shortfall, posed key challenges in implementing previous NPANM II. Proposal to have a "dedicated" budget (separate from Ministry of Health budget) from the Ministry of Finance to support NPANM activities which are largely prevention in nature, did not materialise.

Lack of human resources capacity or development is another common challenge identified. For example in Malaysia and Thailand, there is insufficient number of nutritionists in the health sector and community-based setting. Thailand highlights that the integration of nutrition professions and networking partners to drive work is a challenge. Vietnam recognises that there is a lack of necessary knowledge and means to propagandise and encourage its people to change their nutritional practices due to the limiting capacity of the nutrition network. Indonesia also highlights that commitment and capacity among sub-national level and the provision of technical support and guidance for districts/regional level needs to be improved.

Several of these countries also face difficulties in efficient monitoring and evaluation of the action plan. Philippines highlights inadequate system for managing the previous action plan and that the past PPANs, including the 2011-2016 plan, were not operational plans, not results-based and posed a challenge in evaluability of the plan. In Malaysia, improvement on timely collection of data for monitoring and evaluation purposes is needed as large national surveys are currently carried out only every few years. Thailand highlights the need for improvement

of tracking system and evaluations of the projects carried out, as well as the need of incorporating technology use in information management and effective nutritional surveillance.

Indonesia, Vietnam and Myanmar recognise low level of knowledge and awareness on the importance of nutrition among community and local authorities as one of the challenges in implementing their action plans. Thailand recognises that food and nutrition researches conducted in the country are still not meeting the nutritional gaps and needs of the nation. It has also been acknowledged that clearer policies and strategies on food and nutrition of related organisations are needed for promoting nutrition that covers all age groups.

DISCUSSIONS

Reviewing the NPANs in the six SEA countries, it is recognised that there are more commonalities than differences among these countries. The prioritisations of nutrition interventions outlined are based on respective country context and needs. These country action plans show similarities in several components including objectives, agencies and stakeholders involved, nutritional issues to be addressed, implementation, monitoring and evaluation mechanism as well as challenges in implementing previous NPANs/related documents.

There are, however, differences in a few aspects of the NPANs of these countries, such as the implementation strategies and targets set. Some countries have identified specific nutritional issues and indicators that are considered important to the country context. For example, Indonesia monitors several indicators on food production; Malaysia establishes a few diet-related NCDs indicators; Philippines has specific indicator on the prevalence of nutritionally at-risk pregnant women; Thailand indicators include number of innovations in food production for good nutrition and those related to national food and nutrition database development, whereas Vietnam includes indicators on improvement of population height. In the effort to achieve Global Nutrition Targets 2025, countries have set specific targets that are comparable to Global Nutrition Target especially for the indicators on prevalence of low birth weight (most countries establish target ranging from 22% to 33% reduction), childhood overweight (most countries aim to achieve no increase from baseline), and childhood wasting (most countries target a prevalence of no more than 5%).

Recommendation/way forward for challenges

The nutrition situation analysis in the NPANs indicates that most countries in this review have not fully achieved the various nutrition targets set. Several common challenges mentioned earlier (the need for greater coordination among stakeholders, capacity for implementation, monitoring and evaluation system improvement, and significant financial commitment to the NPAN by the government) must be tackled in order to effectively implement the NPAN and achieve the targets.

Clear commitment from various stakeholders is important for the multi-sectoral coordination mechanism to function effectively. In order to achieve this, various stakeholders in these countries will have to first recognise that the implementation is not the sole responsibility of the health sector and that the responsibility has to be shared across multisectors. However, the various stakeholders involved may have difficulty in visualising common goals as they may hold contradictory opinions and is competing with others for resource allocations to carry out its own mandate. Thus, harmonising their opinions, identifying their needs in earlier phase

of plan development to ensure that their objectives are not at stake and clearly define the roles and responsibilities for each of the stakeholders are important to ensure good collaboration between them. Activating a nutrition-based mandate across a multiplicity of ministries e.g. using improved nutrition outcomes as one of the performance indicators for relevant stakeholders/ministries could be considered as an approach to improve commitment. For example, Myanmar in its latest MS-NPAN has proposed sector-specific outcomes for different ministries. Besides, population should be actively involved and aware on decision making process, the geographic reach of the programmes should be expanded to reach remote populations, and the community awareness of nutrition problems, programmes and rights should also be improved (Lachat *et al.*, 2005; Gillespie, Bold & the Stories of Change Study Team, 2017; IFPRI, 2016; WHO, 2006).

The roles of different stakeholders have to be backed up by high quality technical expertise and a serious effort to build capacity. The ability to carry out stated objectives is needed at different levels. Thus it is important to ensure that well-trained personnel and decision makers are employed at different levels to coordinate, implement, monitor and evaluate the programmes and activities implemented. In this context, the establishment of a high quality national nutrition research and training institution in the country or region that are capable of providing nutrition and continuous professional development training are crucial. Philippines, Thailand and Vietnam have their respective institute of nutrition for research and training namely Institute of Nutrition, Mahidol University (INMU) in Thailand, Food and Nutrition Research Institute (FNRI) in the Philippines, and National Institute of Nutrition in Vietnam. The establishment of National Institute of Nutrition (NIN) is on the implementation agenda of Malaysia NPANM III. Nutrition research, science and technology capacities not only contributes to improving food and nutrition security, but also play crucial roles in providing an evidence base for decisions making and supporting policy making by the authorities/stakeholders. Besides, the adequacy of national technical expertise/capacity need to be assessed (Ismail *et al.*, 2005).

Having a common understanding of the form of capacities needed is crucial before trying to strengthen nutrition capacity especially in low-and middle-income countries (Ismail *et al.*, 2005). Shrimpton *et al.*, (2014) proposed a four-level (system, organisational, workforce, community) conceptual framework for capacity development to facilitate a more systematic approach to assessing the need for nutrition capacity development. It is believed that based on such assessment a comprehensive capacity development plan could be established for a country. Myanmar in its latest MS-NPAN adopts the methodology and tools recommended by the SUN UN Network Guidelines and Toolkit and exercised a capacity assessment as part of the action plan planning process to review the country's ability to coordinate, implement, and monitor the action plan at different levels.

The execution/implementation of the NPANs will be very much limited when there is lack of data and evidence that are actionable at national and sub-national levels. Thus, countries must work on establishing better monitoring and evaluation systems to ensure that timely, nationally representative data/information on outcomes of actions and trends of nutritional issues are available and accessible to evaluate and advise plan/programme development. National nutrition surveys or nutrition surveillance should be conducted in a

periodic manner covering all priority nutrition indicators. New surveillance systems in areas still not covered should also be developed. Effective evaluations include not only the assessments of whether a plan works but also the process evaluations that highlight impact pathways in order to better understand why, how, and where programme/ plan work, or do not work (Gillespie, Bold & the Stories of Change Study Team, 2017). Besides, monitoring and evaluation should also include the timely management, analysis interpretation, dissemination and communication of accurate nutrition data to and among relevant stakeholders. Countries in the SEA region should take heed of these important aspects and work towards acquiring quality food and nutrition data.

To better support financial commitment, countries may need to consider costing their nutrition plans and exercising budget analyses. Costing help to estimate the funding needed to implement nutrition activities and it serves as a first step in understanding overall resources required to support nutrition actions in a country (SPRING, 2018). With this, it helps policy makers to prioritise among the different implementation strategies in order that the funding can be allocated properly. Besides, it would be helpful to develop appropriate analyses and evidence through budget and expenditure analyses to demonstrate how much money can be lost to poor nutrition of the population if national resources are not invested appropriately in nutrition policy/programmes implementation. This could help to make a powerful case to target decision makers e.g. Ministry of Finance who have the power over budgets and spending for increased funding for nutrition.

CONCLUSION

The development of food and nutrition action plans by governments is vital in providing practical guidance to significantly reduce the burden of preventable diet-related NCDs and all other forms of malnutrition prevalent in the country. All six SEA countries in this review have recognised this importance and have respectively formulated their NPANs to provide a framework for coordinated implementation of nutrition intervention activities by the government and food and nutrition related stakeholders. It is imperative that there must be effective implementation, monitoring and evaluation of the plans so as to successfully address both extremes of the challenging nutrition situation in SEA countries. However, based on the various challenges highlighted by the countries in the implementation of these action plans, it is clear that a great deal remains to be done to be able to achieve the planned targets. The similarities in the nutritional issues, challenges for implementation, multi-sectoral implementation mechanism as well as the programmes/activities identified suggest that closer collaboration among countries on NPANs, periodic exchange of experiences among countries in the development and implementation of NPANs, and discussion on specific topics in NPAN will benefits the countries in the region.

Acknowledgement

This work was conducted by the Southeast Asia Public Health Nutrition Network. The authors acknowledge the financial support of BENEO-Institute, DuPont Nutrition & Biosciences and PepsiCo Services Asia Ltd to enable this work to be carried out.

Authors' contribution

All authors contributed to the preparation of the paper and approved the final draft of the manuscript.

Conflict of interest

The authors declare that they have no conflicts of interest.

References

BAPPENAS Indonesia (2015). *National Food and Nutrition Action Plan Indonesia* (*Rencana Aksi Nasional Pangan Dan Gizi Tahun*) 2015-2019. Ministry of National Development Planning/ National Development Planning Agency (*Kementerian Perencanaan Pembangunan Nasional/Badan Perencanaan Pembangunan Nasional*). From https://www.scribd.com/document/318524987/Dokumen-RAN-PG-2015-2019-edit12April-doc [Retrieved 12 February 2018]

Gillespie S, Bold M van den & the Stories of Change Study Team (2017). Stories of Change in nutrition: An overview. *Global Food Security* 13: 1–11. From https://doi.org/10.1016/j.gfs.2017.02.004 [Retrieved 1 July 2018]

IFPRI (2016). Taking action: Progress and challenges in implementing nutrition policies and programs. In Global Nutrition Report 2016: From Promise to Impact: Ending Malnutrition by 2030. Chapter 5. Pp. 44-59. Washington, D.C.

International Food Policy Research Institute (IFPRI). From http://dx.doi.org/10.2499/9780896295841_05 [Retrieved 30 June 2018]

Ismail S, Immink M & Nantel G (2005). Improving Nutrition Programmes An Assessment Tool for Action. Revised Edition. Food and Nutrition Division. Food and Agriculture Organization of the United Nations. Rome. From http://www.fao.org/docrep/009/a0244e/a0244e00.htm [Retrieved 30 June 2018]

Lachat C, Van Camp J, De Henauw S, Matthys C, Larondelle Y, Remaut-De Winter AM & Kolsteren P. (2005). A concise overview of national nutrition action plans in the European Union Member States. *Public Health Nutr. 8(3):266-74*. From https://doi.org/10.1079/PHN2004691 [Retrieved 1 May 2018]\

MOPH Thailand (2019). *The 5-Year National Plan of Action for Nutrition 2019-2023*. Bureau of Nutrition, Department of Health, Ministry of Health Thailand.

NCCFN Malaysia (2016). *National Plan of Action for Nutrition of Malaysia III 2016-2025*. National Coordinating Committee on Food and Nutrition, Ministry of Health Malaysia, Putrajaya.

MOH Vietnam (2018). *National Plan of Action for Nutrition to 2020*. Ministry of Health Vietnam, Hanoi, Vietnam.

NNC Myanmar (2018). Multi-Sectoral National Plan of Action on Nutrition (MS-NPAN) 2018/19-2022/23. National Nutrition Centre, Department of Public Health, Ministry of Health and Sports, the Republic of the Union of Myanmar. From https://www.mohs.gov.mm/page/7190 [Retrieved 29 July 2020]

NNC Philippines (2017). *Philippine Plan of Action for Nutrition 2017-2022 A Call to Urgent Action for Filipinos and Its Leadership Executive Summary*. National Nutrition Council, Department of Health, Manila, Philippines. From http://www.nnc.gov.ph/index.php/downloads/category/118-ppan.html [Retrieved 7 October 2018]

Shrimpton R, Hughes R, Recine E, Mason JB, Sanders D, Marks GC & Margetts B (2014). Nutrition capacity development: a practice framework. *Public Health Nutr.*17(3):682-8. From https://doi.org/10.1017/S1368980013001213 [Retrieved 1 July 2018]

Shrimpton & Rokx (2012). *The double burden of malnutrition: a review of global evidence (English)*. Health, Nutrition and Population (HNP) discussion paper. Washington D.C. World Bank. From http://documents.worldbank.org/curated/en/905651468339879888/The-double-burden-of-malnutrition-a-review-of-global-evidence [Retrieved 2 May 2018]

SPRING (2018). *Putting Budget Data to Work for Nutrition*. Arlington, VA: Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) project. From https://www.springnutrition.org/sites/default/files/ publications/briefs/budget_data_nutrition_brief.pdf [Retrieved 1 July 2018]

Tee ES, Hardinsyah R, Ismail MN, May KT, Florentino RF, Saipin C & Hop LT (2018). *National Plans of Action for Nutrition in Southeast Asian Countries – A Review*. Southeast Asia Public Health Nutrition Network. c/o Nutrition Society of Malaysia, Kuala Lumpur.

WHO (2000). *Development of the first food and nutrition action plan for the WHO European Region. Report on a WHO Consultation*. World Health Organization, Regional Office for Europe, Copenhagen. From http://apps.who.int/iris/bitstream/handle/10665/108297/E68895.pdf;jsessionid=01E301FE0BD39EB72FBBC17E96B168E5?sequence=1 [Retrieved 6 May 2018]

WHO (2006). *Comparative analysis of nutrition policies in the WHO European Region. A comparative analysis of nutrition policies and plans of action in WHO European*. World Health Organization, Regional Office for Europe, Copenhagen. From http://www.euro.who.int/__data/assets/pdf_file/0004/149782/instanbul_conf_20ebd02.pdf [Retrieved 22 April 2018)

WHO (2016). *Strategic Action Plan to reduce the double burden of malnutrition in the South-East Asia Region 2016-2025.* World Health Organization. Regional Office for South-East Asia, India. From http://apps.searo.who.int/PDS_DOCS/B5295.pdf [Retrieved 8 May 2018]

Acknowledgements

Appreciation is recorded to the following reviewers for their contributions towards the publication of Volume 26 (Numbers 1, 2, & 3), 2020 of the Malaysian Journal of Nutrition.

Dr. Abdul Muthalib, Rumah Sakit Dr Cipto Mangunkusumo, Indonesia

Dr. Adarsha Gowda, St Aloysius College, Autonomous, Mangalore India

Dr. Ahmad Munir C, Universiti Sains Malaysia

Dr. Akanksha Yadav, SGT University India

Dr. Ali H. A. Albelbeisi, European Gaza Hospital, Middle Area, Gaza Strip, Palestine

Dr. Alvin Chang Shang Ming, KK Women's and Children's Hospital, Singapore

Dr. Amin Ismail, Universiti Putra Malaysia

Dr. Amutha Ramadas, Monash University, Malaysia Campus

Dr. Anadi Nitithamyong, Food Science and Technology Association of Thailand

Prof. Dr. Angelina Rosario Bustos, Institute of Human Nutrition and Food, Philippines

Dr. Ani Margawati, Diponegoro University, Indonesia

Ms Anies Irawati, National Health Research and Development Agency, Ministry of Health of the Republic of Indonesia

Dr. Anna Vipta Mauludyani, Bogor Agricultural University, Indonesia

Dr. Anto Cordelia Tanislaus Antony Dhanapal, Universiti Tunku Abdul Rahman Malaysia

Mr. Anto J. Hadi, Institut Kesehatan-AKPER-AKBID Helvetia Malaysia

Dr. Apasara Arkarapanthu, Kasetsart University, Thailand

Dr Arif Sabta Aji, Alma Ata University, Yogyakarta, Indonesia

Dr. Aryati Ahmad, Universiti Sultan Zainal Abidin Malaysia

Dr. Atef. A Hassan, Animal Health Research Institute, Agriculture Research Center, Cairo, Egypt

Dr. Azad Shokri Kurdistan, University of Medical Science Iran

Dr. Azmawati Mohammed Nawi, Universiti Kebangsaan Malaysia

Dr. Azizah Mat Mat Hussin, Universiti Kuala Lumpur Malaysia

Dr. Barakatun Nisak Mohd Yusof, Universiti Putra Malaysia

Dr. Bhupinder Kaur, Quest International University Perak Malaysia

Dr. Catherine Castaneda, Adamson University, Philippines

Dr. Cecilia Acuin, International Rice Research Institute Philippines

Dr. Chuah Khun Aik, Abbott Nutrition Research and Development, Singapore

Prof. Dr. Chen Chee Keong, Universiti Sains Malaysia

Dr. Chin Yit Siew, Universiti Putra Malaysia

Dr. Chittipong Tipbunjong, Prince of Songkla University

Dr. Damayanthi Dassanayake, University of Peradeniya, Kandy, Sri Lanka

Dr. Demetria Bongga, University of the Philippines

Dr. Denise Koh, Universiti Kebangsaan Malaysia

Dr. Dewi Marhaeni Diah Herawati, Universitas Padjadjaran Indonesia

Mrs. Dini Ririn Andrias, Universitas Airlangga Indonesia

Dr. Divya Vanoh, Universiti Sains Malaysia

Prof. Dr. Ir. Dodik Briawan, Institut Pertanian Bogor, Indonesia

Mr. Dudung Angkasa, Universitas INDONUSA Esa Unggul Indonesia

Dr. Dwi Budiningsari, Universitas Gadjah Mada Indonesia

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