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Vitamin A knowledge and household consumption frequency of vitamin A – rich foods in Tangail, Bangladesh

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ABSTRACT

Introduction: Vitamin A deficiency is one of the most serious health problems in developing countries. This study aims to explore the comparative figure of vitamin A knowledge, household consumption frequency of vitamin A-rich foods, and association of socio-demographic factors with knowledge and consumption in four residential areas in Tangail district, Bangladesh. **Methods:** This study used a population-based cross-sectional design with 400 study participants selected using purposive sampling technique. Knowledge and consumption frequency were assessed by a structured questionnaire along with food frequency table. Data were analysed using descriptive statistics. **Results:** Only 33.5% participants had primary vitamin A knowledge, where most from urban (48.5%) and semi-urban (30.6%) areas had comparatively higher knowledge than those from rural (11.2%) and slum (9.7%) areas. Specific knowledge level was also poorer in rural and slum areas than urban and semi-urban areas. Most of the participants received knowledge through commercial advertisements (65.7%). Household consumption frequency of vitamin A-rich foods (plant and animal) was comparatively lower in rural and slum areas than in urban and semi-urban areas. Different socio-demographic factors (place of residence, education and household income) significantly influenced participant's vitamin A knowledge and household consumption of vitamin A-rich foods ($p<0.05$). **Conclusion:** In general, the study population lacked knowledge regarding the importance of vitamin A. Consumption frequency of vitamin A-rich foods was still poorer in slum and rural areas than in urban and semi-urban areas.

Keywords: Vitamin A knowledge, consumption frequency, plant sources, animal sources, socio-demographic factors

INTRODUCTION

Micronutrients such as vitamins and minerals play an important role in the promotion of health and prevention of diseases (Paul, 1998). Global estimates show that one third of the world's preschool-age population suffers from vitamin A deficiency disorders and the populations from South Asian developing countries are the most vulnerable groups

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(Akhtar *et al.,* 2013). Vitamin A deficiency affects about 19 million pregnant women and 190 million preschool-age children, mostly from Africa and South-East Asia (WHO, 2011). Vitamin A deficiency alone is responsible for almost 8% of deaths among children under the age of 5 years in South-East Asia (WHO, 2009).

Vitamin A is an essential component of the human diet. Human ingest two types of vitamin A: provitamin A from plants and preformed vitamin A from animal sources (Akram *et al.*, 2011). All pigmented vegetables and fruits (particularly orange and yellow), leafy green vegetables, and yellow corn supply provitamin A in the diet. Common dietary sources of carotenoids such as carrot, spinach, broccoli, lettuce, green peas, tomatoes, mango, and papaya have provitamin A activity (Southon & Faulks, 2003). Vitamin A (preformed) occurs mainly in animal products such as milk, liver, meat, butter, egg yolk, and in animal fat. The richest food source is liver, with other animal and fish sources providing substantial amounts of the preformed vitamin (Bates, 1995; Roos, Islam & Thilsted, 2003). The Recommended Dietary Allowance for adults 19 years and older is 900 mcg retinol activity equivalent for men (equivalent to 3,000 IU) and 700 mcg retinol activity equivalent for women (equivalent to 2,333 IU) (National Institutes of Health Office of Dietary Supplements, 2018). Vitamin A deficiency could result in impaired cellular differentiation, reduced resistance to infection, anaemia, and ultimately death, which is a serious health problem in developing nations (Arlappa, 2011; Jiang *et al.,* 2006). Different strategies like food diversification, fortification, and supplementation are helpful to cope with vitamin A deficiency (Tang *et al.,* 2005).

Many factors contribute towards vitamin A deficiencies, such as diets with low nutrient quality and diversity, low household purchasing power, inadequate knowledge of nutritional practices, and inequality (Ahmed, Prendiville & Narayan, 2016). According to the Household Income and Expenditure Survey Bangladesh (HIES) 2016 (BBS, 2019), the level of education and monthly income in rural areas were comparatively lower than urban areas. Similarly, consumption of vitamin A-rich foods such as vegetables, milk, egg etc. was comparatively lower in rural areas than urban areas, which provides substantial evidence regarding the influence of place of residence and other socio-demographic factors on food consumption. However, data on vitamin A knowledge and intake of vitamin A-rich foods among different places of residence in Tangail district, Bangladesh are scarcely reported. Thus, this study was conducted to evaluate the primary and specific knowledge about vitamin A among targeted participants of selected residential areas. This study also explored the household consumption frequency of vitamin A-rich foods (plant and animal sources) in different places of residence and identified various socio-demographic factors associated with the level of knowledge about vitamin A and consumption frequency of vitamin A-rich foods.

MATERIALS AND METHODS

This was a population-based cross-sectional study. A purposive sampling technique was adopted to select samples from each residential area of the Tangail district and the selected areas were marked as urban (Tangail city), semi-urban (Santosh), slum (Tangail sadar) and rural (Porabari, Charabari and Kabila-para) areas. Sample size was calculated by following the formula described by Charan & Biswas (2013) at 95% confidence interval.

$$n = \frac{(Zr^2 \times PQ)}{d^2} = 385$$

Here, n = Sample size, P = Estimate of the expected proportion (Expected rate 0.5), $Q = (1\text{-}P) = (1\text{-}0.5) = 0.5$, d = 5% level of confidence interval = 0.05, Z = 1.96; value of the normal variable, which is equal to 1.96 at 5% level of significance. Although the minimum sample size was calculated to be 385 households, a total of 400 samples were collected considering 5% non-response rate.

A structured and semi-structured questionnaire containing (i) socio-demographic and personal information; (ii) knowledge about vitamin A (only heard about vitamin A was considered as primary knowledge and knowledge about vitamin A deficiency problems was considered as specific knowledge); (iii) weekly household intake frequency of vitamin A-rich foods including both plant and animal sources (quantitative), was used in this study. Vitamin A knowledge, education, age and income were assessed on the chief household earning member (study respondent), whereas consumption of vitamin A-rich foods was assessed on the respondent's entire family. Respondent's family size was one of the inclusion criteria of this study and it was categorised as small (1-4 members) and large (5-8 members) family. Pretesting was conducted to test the survey instrument and data collection procedures before data collection began. The objective was to ensure that the questions being asked accurately reflected the information the researchers desired and that the respondents could and would answer these questions. At the same time, all the enumerators were trained on the questionnaire and methodology. A day long training programme was conducted by Department specialists on related fields. The programme included providing the enumerators with an overview of the background, objectives, method/skill of data collection, eliciting good data, time management, and relevance of the survey.

Data were collected by face-to-face interview with the participants. Collected data were coded and entered into the computer, and analysed using SPSS programme for Windows Version 17.0 (SPSS 17.0, Chicago, IL, USA). Descriptive statistics [cross tabulation, chi-square test (χ^2)] were used to describe both categorical and numerical variables. All the participants received an explanation before becoming a study participant and completed an informed consent form. Research approval was obtained from the Department of Food Technology and Nutritional Science, Mawlana Bhashani Science and Technology University, Tangail-1902, with the ethics approval number MBSTU/FTNS/ERB/2019 (02).

RESULTS

The socio-demographic characteristics of the study participants from different residential areas of Tangail are depicted in Table 1. Most of them were in the age range of 31-40 years (38.5%) and 41-50 years (34.3%). Most of the participants belonged to small families consisting of 1-4 members (54.3%). Majority of the small families were found in urban (31.8%) and semi-urban (26.3%) areas. In contrast, 45.8% of large families, which consisted of 5-8 members, were found in rural (32.8%) and slum (26.8%) areas. The education levels of the participants recorded were illiterate (33.0%), primary (26.3%), Secondary School Certificate (24.4%), Higher Secondary School Certificate (8.3%), Graduate and above (8.0%). Most of the graduate (68.8%) and illiterate (45.5%) participants were from the urban and slum areas, respectively. The majority of the respondent's household monthly income was <$118 (38.5%) and most of these

lower household incomes were recorded in rural (32.5%) and slum (50.0%) areas. In contrast, higher household incomes ($354-472 and above) were recorded in urban and semi-urban areas.

Knowledge about vitamin A

Among 400 participants, 33.5% (*n*=134) had primary knowledge about vitamin A and majority of them were found in urban (48.5%) and semi-urban (30.6%) areas, whereas 66.5% (*n*=266) had no knowledge about vitamin A and most of them were from rural (32%) and slum (32.7%) areas (Figure 1). Several factors influenced their level of knowledge. These included participant's residence ($p<0.01$; $x^2=81.29$) and educational qualification ($p<0.01$; $x^2=101.14$), which were found to be significantly correlated with level of knowledge about vitamin A.

Specific knowledge about vitamin A was also analysed (Figure 2). It revealed that most of the participants (51.5%) believed that vitamin A deficiency only causes night blindness. A poor number of participants (9.0%) believed that vitamin A deficiency may cause other health problems. In a comparative analysis, the overall specific knowledge level was found to be poorer in rural and slum areas than urban and semi-urban areas as most of the participants from rural and slum areas did not have any primary knowledge about vitamin A.

Sources of knowledge

The study participants received vitamin

Table 1. Demographic characteristics of study population

Characteristics	*Residence n (%)*					*p-value* (x^2)
	Urban	*Semi-urban*	*Rural*	*Slum*	*Total*	
Age group (years)						
21-30	4 (13.8)	4 (13.4)	7 (24.1)	14 (48.3)	29 (7.3)	0.03 (18.86)
31-40	32 (20.8)	39 (25.3)	43 (27.9)	40 (26.0)	154 (38.5)	
41-50	37 (27.0)	39 (28.5)	36 (26.3)	25 (18.2)	137 (34.3)	
51-60	27 (33.8)	18 (22.5)	14 (17.5)	21 (26.3)	80 (20.0)	
Family size						
1-4 (small)	69 (31.8)	57 (26.3)	40 (18.4)	51 (23.5)	217 (54.3)	<0.01 (17.68)
5-8 (large)	31 (16.9)	43 (23.5)	60 (32.8)	49 (26.8)	183 (45.8)	
Education						
Graduate and above	22 (68.8)	7 (21.9)	3 (9.4)	0 (0)	32 (8.0)	<0.01 (122.45)
HSC	13 (39.4)	11 (33.3)	7 (21.2)	2 (6.1)	33 (8.3)	
SSC	37 (37.8)	35 (35.7)	20 (20.4)	6 (6.1)	98 (24.4)	
Primary	11 (2.8)	30 (7.5)	32 (8.0)	32 (30.5)	105 (26.3)	
Illiterate	17 (12.9)	17 (12.9)	38 (28.8)	60 (45.5)	132 (33.0)	
Household monthly income (USD)						
<$118	8 (5.2)	19 (12.3)	50 (32.5)	77 (50.0)	154 (38.5)	<0.01 (217.36)
$118-236	16 (13.6)	47 (39.8)	35 (29.7)	20 (16.9)	118 (29.5)	
$236-354	30 (43.5)	23 (33.3)	13 (18.8)	3 (4.3)	69 (17.3)	
$354-472	19 (90.5)	1 (4.8)	1 (4.8)	0 (0)	21 (5.3)	
>$472	28 (73.6)	10 (26.3)	0 (0)	0 (0)	38 (9.5)	

Significant when $p<0.05$

USD=United States Dollar; HSC=Higher Secondary School Certificate; SSC= Secondary School Certificate

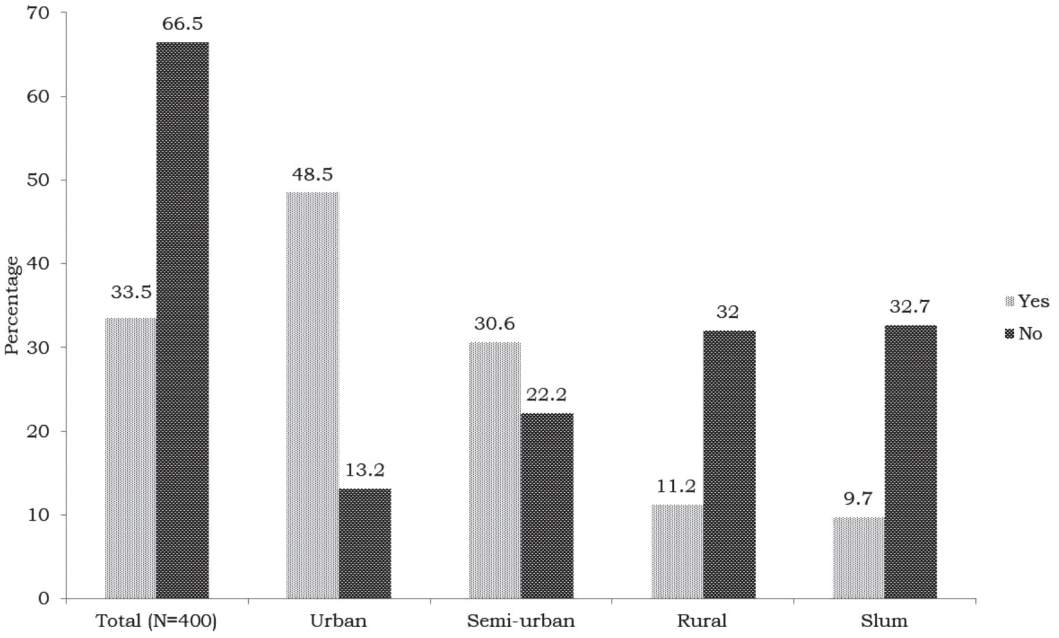

Figure 1. Distribution of primary knowledge about vitamin A

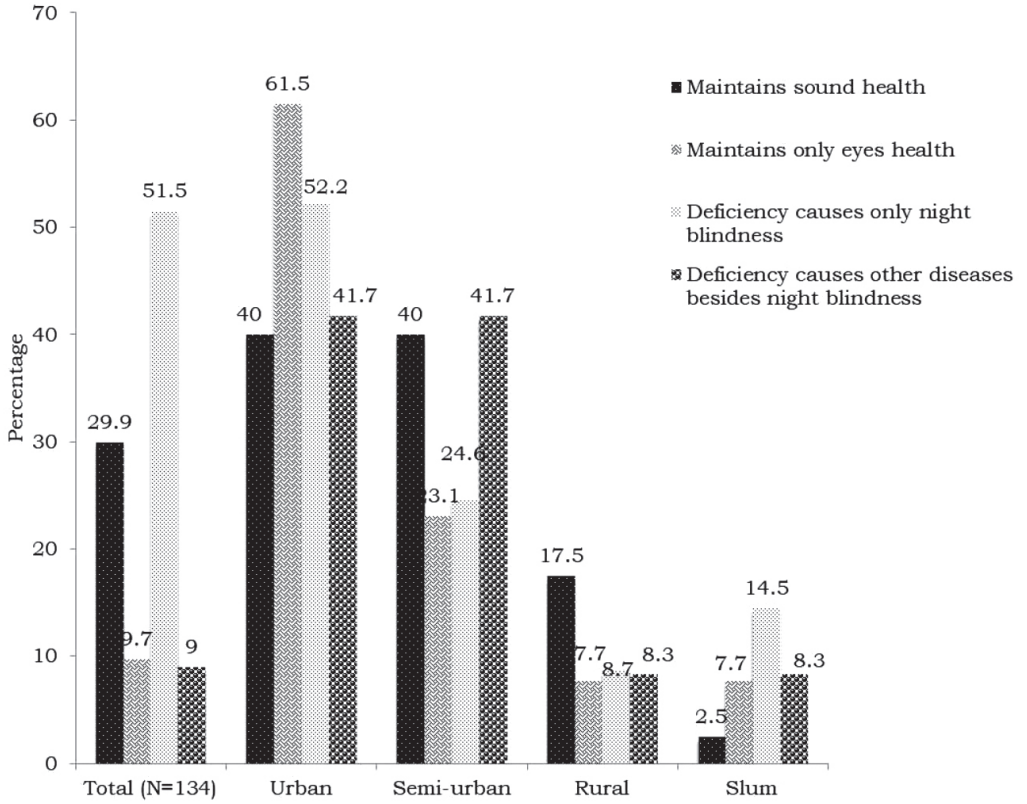

Figure 2. Distribution of specific knowledge about vitamin A

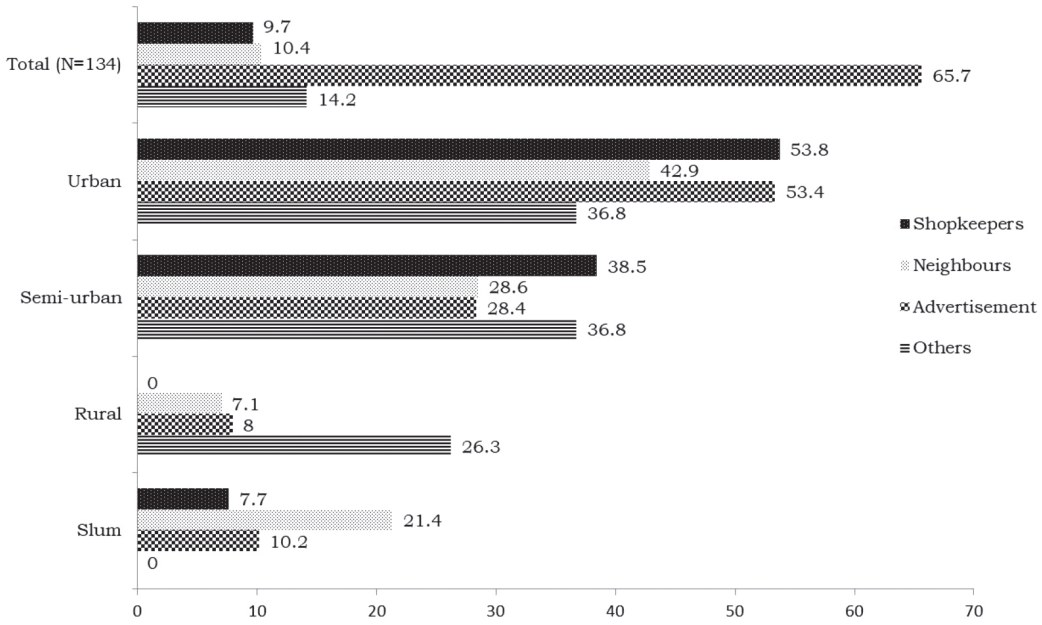

Figure 3. Sources of knowledge about vitamin A

A knowledge through various mediums and those are depicted in Figure 3. A total of 65.7% participants gained vitamin A knowledge through various advertisements on vitamin A (in print and electronic media) and most of them were from urban areas (53.4%). Advertisements were found to be less effective in rural (8.0%) and slum areas (10.2%), whereas dissemination of knowledge through other mediums such as shopkeepers (9.7%), neighbours (10.4%) and others (e.g. peers, relatives, friends, books and some other sources which the participants could not remember) (14.2%) were recorded as comparatively lower than advertisements.

Household consumption of vitamin A-rich foods

The results of the current study revealed that almost all the families from different study areas consumed green leafy vegetables on a regular basis with quantitative variations. Most of the families (48.3%) consumed nearly 2-3 kg green leafy vegetables per week (Table 2). Similar findings were found for spinach (35.3%), pumpkin (51.4%), and tomato (50.3%) consumption. In contrast, most of the families consumed carrot (39.3%), sweet potato (36.35%), and ripe papaya (37.8%) at <2 kg per week. A significant number of families from the urban, rural and slum areas did not consume sweet potato at all, whereas maximum consumption of sweet potato was found in semi-urban area. Lower consumption of carrot, spinach, pumpkin, tomato, and ripe papaya was observed in rural and slum areas as most families from these areas consumed <2 kg per week, with the least number of families consuming >3 kg per week.

Vitamin A fortified soybean oil consumption frequency was also analysed. A total of 38.1% families consumed vitamin A fortified soybean oil on a regular basis. Among these families, consumption rate was found to be higher in urban (53.5%) and semi-urban

Table 2. Household consumption frequency of vitamin A-rich foods

Sources	*Amount per week*	*Residence, n (%)*				*Total*	*p-value* (x^2)
		Urban	*Semi-urban*	*Rural*	*Slum*		
Plant sources							
Green leafy vegetables	< 2 kg/week	12 (19.4)	10 (16.1)	30 (48.4)	10 (16.1)	62 (15.5)	<0.01 (44.59)
	2-3 kg/week	44 (22.8)	55 (28.5)	54 (28.0)	40 (20.7)	193 (48.3)	
	> 3 kg/week	39 (29.1)	34 (25.4)	13 (9.7)	48 (35.8)	134 (33.5)	
	Never	5 (45.5)	1 (9.1)	3 (27.3)	2 (18.2)	11 (2.8)	
Carrot	< 2 kg/week	22 (14.0)	42 (26.8)	45 (28.7)	48 (30.6)	157 (39.3)	<0.01 (56.54)
	2-3 kg/week	24 (21.4)	33 (29.5)	22 (19.6)	33 (29.5)	112 (28.0)	
	> 3 kg/week	29 (55.8)	15 (28.8)	6 (11.5)	2 (3.8)	52 (13.0)	
	Never	25 (31.6)	10 (12.7)	27 (34.2)	17 (21.5)	79 (19.8)	
†Sweet potato	< 2 kg/week	37 (25.5)	49 (33.8)	29 (20.0)	30 (20.7)	145 (36.3)	<0.01 (25.10)
	2-3 kg/week	7 (20.0)	8 (22.9)	6 (17.1)	14 (40.0)	35 (8.8)	
	> 3 kg/week	11 (52.4)	3 (14.3)	4 (19.0)	3 (14.3)	21 (5.3)	
	Never	45 (22.6)	40 (20.1)	61 (30.7)	53 (26.6))	199 (49.8)	
†Spinach	< 2 kg/week	16 (16.8)	23 (24.2)	30 (31.6)	26 (27.4)	95 (23.8)	<0.01 (45.36)
	2-3 kg/week	28 (19. 9)	49 (34.8)	19 (13.5)	45 (31.9)	141 (35.3)	
	> 3 kg/week	19 (41.3)	12 (26.1)	8 (17.4)	7 (15.2)	46 (11.5)	
	Never	37 (31.4)	16 (13.6)	43 (36.4)	22 (18.6)	118 (29.5)	
Pumpkin	< 2 kg/week	27 (24.8)	31 (28.4)	29 (26.6)	22 (20.2)	109 (27.3)	0.12 (13.94)
	2-3 kg/week	45 (22.0)	53 (25.9)	49 (23.9)	58 (28.3)	205 (51.4)	
	> 3 kg/week	18 (36.0)	11 (22.0)	8 (16.0)	13 (26.0)	50 (12.5)	
	Never	10 (28.6)	4 (11.4)	14 (40.0)	7 (20.0)	35 (8.8)	
†Tomato	< 2 kg/week	12 (20.3)	14 (23.7)	15 (25.4)	18 (30.5)	59 (14.8)	<0.01 (35.97)
	2-3 kg/week	32 (15.9)	56 (27.9)	65 (32.3)	48 (23.9)	201 (50.3)	
	> 3 kg/week	45 (39.1)	25 (21.7)	14 (12.2)	31 (27.0)	115 (28.8)	
	Never	11 (44.0)	5 (20.0)	6 (24.0)	3 (12.0)	25 (6.3)	
Papaya	< 2 kg/week	23 (15.2)	39 (25.8)	48 (31.8)	41 (27.2)	151 (37.8)	<0.01 (69.30)
	2-3 kg/week	40 (28.6)	43 (30.7)	30 (21.4)	27 (19.3)	140 (35.0)	
	> 3 kg/week	30 (60.0)	11 (22.0)	5 (10.0)	4 (8.0)	50 (12.5)	
	Never	7 (11.9)	7 (11.9)	17 (28.8)	28 (47.5)	59 (14.8)	
Vitamin A fortified soybean oil	Yes	68 (53.5)	31 (24.4)	15 (11.8)	13 (10.2)	127 (31.8)	<0.01 (96.37)
	No	26 (10.4)	61 (24.5)	78 (31.3)	84 (33.7)	249 (62.3)	
	Occasionally	6 (25.0)	8 (33.3)	7 (29.2)	3 (12.5)	24 (6.0)	
Animal sources							
Liver	<1 kg/week	32 (24.2)	52 (39.4)	27 (20.5)	21 (15.9)	132 (33.0)	<0.01 (35.22)
	1-2 kg/week	15 (35.7)	12 (28.6)	8 (19.0)	7 (16.7)	42 (10.5)	
	>2 kg/week	1 (50.0)	0 (0.0)	0 (0.0)	1 (50.0)	2 (0.5)	
	Never	52 (23.2)	36 (16.1)	65 (29.0)	71 (31.7)	224 (56.0)	
Whole Milk	<1 L/week	22 (21.8)	12 (11.9)	22 (21.8)	45 (44.6)	101 (25.3)	<0.01 (77.85)
	1-2 L/week	32 (25.6)	41 (32.8)	35 (28.0)	17 (13.6)	125 (31.3)	
	>2 L/week	44 (35.8)	39 (31.7)	28 (22.8)	12 (9.8)	123 (30.8)	
	Never	2 (3.9)	8 (15.7)	15 (29.4)	26 (51.0)	51 (12.8)	
Whole Egg	<1 dozen/week	3 (4.3)	14 (20.0)	7 (10.0)	46 (65.7)	70 (17.5)	<0.01 (104.03)
	1 dozen/week	25 (19.2)	35 (26.9)	39 (30.0)	31 (23.8)	130 (32.5)	
	>1 dozen/week	71 (38.2)	49 (26.3)	47 (25.3)	19 (10.2)	186 (46.5)	
	Never	1 (7.1)	2 (14.3)	7 (50.0)	4 (28.6)	14 (3.5)	

†Consumption frequency on seasonal basis; significant when $p<0.05$

(24.4%) than rural (11.8%) and slum (10.2%) areas. A small percentage (6.0%) of families consumed vitamin A fortified soybean oil occasionally. Several factors were found to influence this different consumption rate at different study areas. Table 2 reveals the association of study participant's residence with their consumption rate of vitamin A-rich plant food items. In this study, participant's residence was found to be significantly correlated with their consumption rate of green leafy vegetables, carrot, sweet potato, spinach, tomato, ripe papaya, and vitamin A fortified soybean oil ($p<0.05$), whereas no significant influence was found for pumpkin consumption with residence ($p>0.05$).

Consumption frequency of vitamin A-rich animal sources were also analysed in Table 2. Most of the families (33.0%) consumed liver (beef and chicken) at <1 kg per week, whereas 56.0% families did not consume liver at all. Majority who did not consume liver belonged to the rural (29.0%) and slum (31.7%) areas. Whole milk consumption rate at 1-2 litres per week was found (31.8%) and recorded as highest among all families. Lower consumption rate was observed in the slum areas. Majority of slum families (44.6%) consumed <1 litre milk per week, whilst a minority of them (9.8%) consumed >2 litres milk per week. Whole egg is considered one of the important and cheaper sources of vitamin A and in this study, about 46.5% families mostly consumed >1 dozen eggs per week. Higher consumption rate was found in urban (38.2%) and semi-urban (26.3%) areas than rural (25.3%) and slum (10.2%) areas. In this study, the consumption rate of all vitamin A-rich animal food items was found to be strongly correlated with participant's residence ($p<0.05$).

Income and education are also considered as important determinants that can influence consumption rate of vitamin A-rich foods among respondent's household in various study areas. In this study, income was found to be significantly correlated with the consumption rate of various plant sources of vitamin A, such as green leafy vegetables ($p=0.02$; $x^2=24.02$), carrot ($p<0.01$; $x^2=61.90$), spinach ($p<0.01$; $x^2=42.45$), pumpkin ($p=0.03$; $x^2=22.65$), tomato ($p<0.01$; $x^2=29.44$), ripe papaya ($p<0.01$; $x^2=43.52$), and vitamin A fortified soybean oil ($p<0.01$; $x^2=107.23$). In contrast, there was no correlation found between the consumption of sweet potato and income ($p=0.23$; $x^2=15.15$). Similar strong correlations were found between income and consumption rates of animal sourced vitamin A, such as liver ($p<0.01$; $x^2=29.88$), whole milk ($p<0.01$; $x^2=91.17$), and whole egg ($p<0.01$; $x^2=73.04$).

Besides income, education also influences the consumption rate of plant and animal sources of vitamin A. In the current study, participant's education was found to be significantly correlated with the consumption of carrot ($p<0.01$; $x^2=32.10$), spinach ($p=0.01$; $x^2=25.20$), ripe papaya ($p<0.01$; $x^2=47.08$), vitamin A fortified soybean oil ($p<0.01$; $x^2=101.14$), liver ($p<0.01$; $x^2=32.06$), whole milk ($p<0.01$; $x^2=43.98$), and whole egg ($p<0.01$; $x^2=57.29$). No correlations were found between education and consumption of green leafy vegetables ($p=0.96$; $x^2=4.93$), sweet potato ($p=0.11$; $x^2=18.22$), pumpkin ($p=0.09$; $x^2=19.13$), and tomato ($p=0.10$; $x^2=18.48$).

DISCUSSION

In general, the results of the current study have revealed that majority of the participants seemed to have poor knowledge about vitamin A. People living in urban and semi-urban areas knew more about vitamin A compared

to slum and rural areas. Consistent with our results, the Bangladesh National Micronutrient Survey 2011-12 (IPHN, 2014) reported that at the national level, 73.7% of participants had knowledge about the source of vitamin. Importantly, the knowledge about vitamin A was found more in urban areas than rural and slum areas e.g., yellow/orange vegetables and fruits are rich sources of vitamin A was mentioned by 49.2% of urban participants, 39.5% of slum, and 35.9% of rural participants.

As vitamin A is essential for so many bodily functions, (e.g., embryonic development, organ formation during foetal development, normal immune functions, and eye development and vision), insufficient vitamin A in the diet has such a severe negative impact on human health and is considered a major worldwide health problem. Night blindness is one of the first signs of vitamin A deficiency. Xerophthalmia, keratomalacia, and complete blindness can also occur since vitamin A has a major role in photo transduction (Micronutrient Information Centre, 2019). According to the Bangladesh National Micronutrient Survey 2011-12 (IPHN, 2014), over 50.0% of respondents mentioned that eating vitamin A-rich foods is good for eyesight and over 80.0% of respondents mentioned that eating vitamin A-rich foods is good for health, while eating vitamin A-rich food prevents night blindness was mentioned by 20% of respondents. But this specific knowledge about vitamin A was found to be very poor among the population of our selected study areas. Our study revealed that most of the participants were unaware of the many other important functions of vitamin A, as well as about other vitamin A deficiency diseases. Large number of them believed that vitamin A deficiency only causes night blindness. A few of them knew that vitamin A is important for human health (though the specific reasons were not known to them) and its deficiency might cause many other diseases.

Mass media including radio, television (TV), newspapers, magazine, cinema, and press has always been used primarily as the most effective method for disseminating knowledge and prevention messages worldwide (Myhre & Flora, 2000). According to the National Media Survey (NMS, 2016), TV, print including newspaper, and radio coverages in Bangladesh are 82.9%, 23.8% and 16.7%, respectively. Rahman (2009) conducted a survey on the knowledge about AIDS in urban and rural areas in Bangladesh whereby he found that advertisements and programmes in TV were the major source of information to both these areas, followed by radio and friends or relatives. In this study, similar findings indicated that a large number of the study population learnt about vitamin A through various advertisements telecasted in TV, newspaper, radio, magazine, and other mass media as these mediums reach more easily from urban to remote areas of Bangladesh.

The top food sources of vitamin A include carrots, dairy products, liver, fish, milk, eggs, and fortified cereals (Solomons, 2006; Institute of Medicine, 2001). However, the consumption of animal food sources is expensive and is not economically feasible for most families. Naturally, plant sources are the primary and cheapest source of vitamin A. According to the report of Household Income and Expenditure Survey Bangladesh (HIES) 2016 (BBS, 2019), the overall consumption of vitamin A-rich foods per capita in Bangladesh is lower than recommendation. Among different sources of vitamin A, green leafy vegetables provide a convincing amount of vitamin A in regular diet. However, according to HIES 2016 (BBS, 2019), the overall consumption

of vegetables including both leafy and non-leafy vegetables in Bangladesh is lower (167.3g/capita/day) than the daily requirement. Precisely, it reported that vegetables consumption is lower in rural areas (164.8g/capita/day) than in urban areas (174.1g/capita/day). These results also revealed substantial evidence that the place of residence significantly influence food consumption. The current study also shared some similar findings where consumption rate was higher in urban and semi-urban areas than in rural and slum areas.

Foods fortified with vitamin A is a feasible and cost effective approach to reduce vitamin A deficiency. Bangladesh has also successfully piloted edible oil fortification with Vitamin A. In Bangladesh, soybean oil is used sparingly in cooking, hence total oil and fat intake on the national basis is low (26.8g/capita/day). In the same study, comparative analysis revealed that edible oils including vitamin A fortified soybean oil consumption is higher in urban (29.57g/capita/day) than in rural (25.70g/capita/day) area (BBS, 2019). Similar findings were also recorded in the current study where higher consumption rate of vitamin A fortified soybean oil was recorded in urban areas than other areas, with the lowest consumption found in slum and rural areas.

Consumption of different animal sources (liver, whole milk and egg) of vitamin A was also analysed. According to HIES 2016 (BBS, 2019), the consumption of animal sourced vitamin A such as egg (13.6g/capita/day) and milk (27.3g/capita/day) was lower than daily requirement. Precisely, it reported that egg consumption in urban areas (15.9g/capita/day) was recorded to be higher than in rural areas (12.7g/capita/day). Similarly, lower consumption of milk and milk products was recorded for rural areas (26.3g/capita/day) than urban areas (30.0g/capita/day). The current study also revealed some similar findings. The lower consumption rates in slum and rural families may be due to various socio-demographic factors as these factors account for around 10% of the variation in food consumption, while individual factors account for about 25% (Ball, Crawford & Mishra, 2006). Inequalities or disparities derived from socioeconomic factors are proposed to have an influence on the dietary and health habits of individuals and now these are considered a matter of great concern (Bartrina *et al.,* 2015; Forouzanfar *et al.,* 2016; James *et al.,* 1997). Our analysis also identified that place of residence, family income, and level of education as significant correlates of vitamin A-rich food consumption. Samaniego-Vaesken *et al.* (2018) conducted a research study and reported that place of residence and habitat size have a limited influence on food choices and consumption, regardless of age and gender among the Spanish ANIBES study population. In contrast, the current study indicated that participant's place of residence significantly influenced most of the vitamin A-rich food (both plant and animal sources) consumption ($p<0.05$).

Several studies have indicated that the level of education can influence dietary behaviour (Kearney *et al.,* 2000). Similar correlations were found in this study where consumption of many vitamin A-rich foods was significantly correlated with participant's level of education ($p<0.05$). However, nutrition knowledge and good dietary habits are not always strongly correlated. This is because knowledge about health does not always lead to direct action (De Almeida MDV *et al.,* 1997). Likewise, the current study also found many of the vitamin A-rich foods consumption (green leafy vegetables, sweet potato, pumpkin, and tomato) were not correlated with participant's level of

education. This may also be linked with household income, because people with higher education level usually have a higher income as well. Raine (2005) reported that insufficient income is the most significant barrier to healthful eating in adults. This study revealed that vitamin A-rich foods consumption was correlated with household monthly income ($p<0.05$).

In general, the results of the current study have revealed that knowledge about vitamin A was poorer in rural and slum areas than in urban and semi-urban areas. Similarly, household consumption of most vitamin A-rich foods were found to be lower in rural and slum than in urban and semi-urban families. Most of the rural and slum families consisted of large number of members (Table 1), but their consumption was not as high as urban and semi-urban families. Moreover, various socio-demographic factors influenced the study participant's knowledge level about vitamin A, as well as their household consumption frequency of vitamin A-rich foods in different residential areas.

CONCLUSION

Different population from different residential areas showed variations in terms of knowledge about vitamin A and also in their household consumption frequency of vitamin A-rich foods. This study revealed that many participants in the rural and slum areas were unaware of vitamin A and its importance. There may be several reasons, such as poverty, lack of basic health education and awareness campaign on proper nutrition in these areas, which may have aggravated the situation. They should be educated about basic health, nutrition, low cost and easily available vitamin A-rich food sources to help them understand the importance of vitamin A. Effective future policy initiatives are required to promote greater consumption of vitamin A-rich foods. Education and behavioural change programmes are also needed to promote the consumption of these foods. Special attention needs to be given in order to improve the consumption of vitamin A-rich animal sources especially in lower income families from the rural and slum areas. The findings of this survey will provide reference data to aid in future policy making and nutrition promotion programmes regarding vitamin A in this region. In addition, these data will also provide the basis for national level nutrition policy making and strategic action planning for the central region of Bangladesh.

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Authors' contributions

RB, principal investigator, designed, formulated and supervised the experiment, and finally reviewed the manuscript; MNR, developed questionnaire, preliminary reviewing and correction of manuscript; RI, MYJ & SAT, performed the data collection and analysis; MRH, developed questionnaire, analysed data and prepared manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

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Determinants of fathers' involvement in breastfeeding practices in Kuala Selangor

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ABSTRACT

Introduction: Fathers' knowledge, attitude, and involvement in breastfeeding practices are crucial factors to determine the success of breastfeeding outcomes such as decision-making on breastfeeding, successfulness of exclusive breastfeeding, and continuation of breastfeeding practices. This study aimed to identify the determinants of fathers' involvement in breastfeeding practices. **Methods:** This cross-sectional study involved 203 fathers attending Maternal and Child Health Clinics in Kuala Selangor. Self-administered questionnaires were used to obtain information regarding fathers' sociodemography, breastfeeding knowledge, attitudes, and involvement towards breastfeeding practices. **Results:** Mean age of the fathers was 32.1±5.9 years, ranging between 21 to 50 years. Findings showed that majority of the fathers were involved in breastfeeding practices (52.7%; *n*=107, 57.0±6.2), had fair knowledge in breastfeeding (62.6%; *n*=127, 13.77±3.2), and showed low attitude towards breastfeeding (68.0 %; *n*=138, 61.9±6.7). Multiple logistic regression analysis revealed factors with significant influence on fathers' involvement towards breastfeeding practices were: (1) fathers' breastfeeding knowledge, (2) fathers' attitudes towards breastfeeding practices, and (3) mode of infant delivery. **Conclusion:** These significant predictors may help healthcare professionals to establish effective strategies by advocating the role of fathers in the breastfeeding process such as by offering continuous support, active involvement, and effective participation.

Keywords: Breastfeeding support, paternal involvement, breastfeeding knowledge, breastfeeding attitude, involvement

INTRODUCTION

The World Health Organization (WHO) has highlighted the importance of exclusive breastfeeding among mothers for the first six months of their infant's life to achieve optimal health, growth, and development. The Academy of Nutrition and Dietetics has stated that breastfeeding with complementary foods from six months to at least twelve months of age is the ideal feeding pattern for infants (Lessen & Kavanagh, 2015). Breastfeeding provides many nutritional benefits, is convenient and inexpensive as compared to formula milk. According to the Fourth National Health and Morbidity Survey (IPH, 2016), 65.3% of

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infants under six months of age were breastfed within the first hour of delivery, 47.1% of infants under six months of age were breastfed exclusively, 39.4% of infants between 20 to 23 months of age continued on breastfeeding. Overall, the prevalence of breastfeeding practices in the latest survey is increasing as compared to the survey conducted in 2006, but it still places Malaysia with the lowest prevalence of exclusive breastfeeding practices as compared to other Southeast Asian countries. Moreover, the overall prevalence of exclusive breastfeeding has not met the target level of 70%, which is to be achieved by 2025 (WHO & UNICEF, 2014 & NCCFN, 2016).

The decision on breastfeeding is usually influenced by many factors. Factors influencing breastfeeding includes the provision of support from family members and healthcare providers (Draman *et al.*, 2017; Leahy-warren *et al.*, 2014), level of education (Laanterä, Pietilä, & Pölkki, 2010; Leahy-warren *et al.*, 2014), previously having breastfed or first-time mothers (Leahy-warren *et al.*, 2014), having a positive attitude towards breastfeeding and high breastfeeding self-efficacy (Lester, 2014; Abdul Hamid & Yahya, 2018), working mothers (Amin *et al.*, 2011), and mothers facing breastfeeding difficulties (Hobbs *et al.*, 2016).

A recent study has shown that fathers play an important role that contributes to the success of breastfeeding outcomes. Sherriff, Hall, & Panton (2014) revealed that fathers' breastfeeding knowledge, positive attitude towards breastfeeding, participation in decision-making in breastfeeding, provision of practical support, and emotional support were five key attributions of fathers' role in breastfeeding. Previous studies have shown increasing evidence that fathers may influence breastfeeding outcomes such as decision-making in breastfeeding (dos Santos *et al.*, 2016; Draman *et al.*, 2017; de Montigny *et al.*, 2018; Rempel, Rempel & Moore, 2017), early initiation of breastfeeding, the successfulness of exclusive breastfeeding (Draman *et al.*, 2017; Phua, Razak & Shukri, 2020), and continuation of breastfeeding (de Montigny *et al.*, 2018).

Mothers are pleased to have fathers' support, active involvement and effective participation in breastfeeding practices (dos Santos *et al.*, 2016). Mothers consider fathers play an important role in the breastfeeding period by offering emotional and physical support, which are critical components of breastfeeding success, especially when mothers encounter feeding difficulties. According to Binns *et al.* (2009), the provision of practical and emotional support from fathers is a key factor for successful breastfeeding, increasing the confidence of mothers and enabling them to maintain sufficient milk production. Besides, a study conducted by Draman *et al.* (2017) showed that fathers' decision and motivation for breastfeeding has a positive effect on exclusive breastfeeding practices among mothers.

To the best of our knowledge, the study on fathers' role in breastfeeding is very limited in Malaysia. To date, only three studies have been conducted to investigate father's influence towards breastfeeding. Phua and colleagues found that first time mothers with good paternal support had longer breastfeeding duration (Phua *et al.*, 2020), meanwhile another study discovered that there was no difference in breastfeeding knowledge and attitude among fathers in the exclusive and non-exclusive breastfeeding groups (Mohamad *et al.*, 2015). However, Draman and colleagues suggested that mutual decision on breastfeeding practices imposed a greater influence towards exclusive breastfeeding practices (Draman *et al.*, 2017).

Therefore, there is a need to identify the determinants of fathers' involvement in breastfeeding. Understanding the determinants of fathers' involvement in breastfeeding practices may assist health professionals and policy makers to provide significant strategies focusing on the promotion of breastfeeding, directly steering fathers as breastfeeding supporters, particularly in exclusive breastfeeding practices for the first six months of life. Therefore, this study aims to identify the determinants of fathers' involvement in breastfeeding practices among fathers attending Kuala Selangor and Bestari Jaya primary health care facilities in Selangor, Malaysia.

MATERIALS AND METHODS

Subjects and study design

This was a cross-sectional study involving fathers accompanying their wives whom were attending the Kuala Selangor and Bestari Jaya maternal and child primary healthcare facilities in Selangor, Malaysia. Sample size calculation was made by using G* Power Software. Total sample size calculated by the software required 170 fathers in this study, based on power 0.9, type 1 error 0.05 and effect size 0.22 by a previous study (Mitchell-Box *et al.*, 2013). A total of 203 fathers were recruited and selected by convenience sampling. The inclusion criteria were biological fathers of a full-term, healthy singleton baby aged two years and below, and have literacy in either the Malay or English language. Illiterate fathers, diagnosed with psychiatric disorders, and foreigners were excluded from the study.

Data collection

Data were collected from September 2019 to October 2019. Each father was given a set of self-administered questionnaires consisting of sixty-eight questions divided into five sections (A, B, C, D, and E). Section A included nine questions to obtain the participants' demographic information. These included the fathers' age, ethnicity, level of education, occupation, income, parity, and participation in antenatal and breastfeeding classes. Section B contained six questions to gather information about infants. Section C contained twenty-two questions used to elicit information on breastfeeding knowledge of the respondents. Section D included seventeen questions that covered fathers' attitudes towards breastfeeding. Lastly, section E contained fourteen questions used to elicit information on fathers' involvement during the breastfeeding period. Fathers were given sufficient time to complete the questionnaire. Once completed, the questionnaires were reviewed for completion by the researchers.

Breastfeeding knowledge scale

The scale was developed by Laanterä, Pietilä & Pölkki in 2010, and has good internal consistency reliability measured by Cronbach's alpha coefficient, which is 0.84. The scale was used to measure participants' knowledge regarding breastfeeding in the hospital and at home, breastfeeding management, lactation, and specific situations such as breast problems (Laanterä *et al.*, 2010). This scale consisted of 22 items in which a four-point Likert scale ranging from "strongly agree" to "strongly disagree" and two open-ended questions were used. All the statements were reclassified, whereby the "strongly agree" and "somewhat agree" responses were combined to form "agree", while the "somewhat disagree" and "strongly disagree" responses were combined to form "disagree". Likert scale statements and open-ended questions were measured by awarding one point for each correct answer and zero if the answer was incorrect or incomplete.

The question regarding breastfeeding benefits was assessed by awarding one point if at least one breastfeeding benefit was reported and the question on how to increase lactation was assessed by awarding one point if increasing breastfeeding frequency or pumping or breastfeeding at night was suggested. A maximum of 22 points could be obtained by the fathers in the breastfeeding knowledge test.

Iowa Infant Feeding Attitude Scale (IIFAS)

The IIFAS was used to measure the attitudes of fathers towards breastfeeding practices. It has an internal consistency reliability measured by Cronbach's alpha coefficient that ranges between 0.78 and 0.85 in most studies (de la Mora *et al.*, 2006). The IIFAS have been translated and validated in the Malay language and has been used among mothers in Malaysia (Shukri *et al.*, 2017). The IIFAS consisted of 17 questions, eight questions were favourable towards breastfeeding, while nine questions favourable towards formula feeding. Fathers were asked to indicate the extent to which they agree with each statement, on a five-point Likert scale ranging from "strongly disagree" to "strongly agree." Items that were asterisked were reversedly scored (1=5, 2=4, 4=2, 5=1) (de la Mora *et al.*, 2006). Total attitude score could range from 17 to 85, with higher scores reflecting a more positive attitude towards breastfeeding. Previous researchers have grouped total score into the following five categories: (1) very positive towards breastfeeding (81-85), (2) positive towards breastfeeding (70–80), (3) neutral (49–69), (4) positive towards formula feeding (38–48), and (5) very positive towards formula feeding (17-37). However, in this study, a score of >65 was considered a positive attitude towards breastfeeding (Cox, Giglia & Binns, 2015).

Fathers' involvement in breastfeeding scale

The scale was developed by Abu-Abbas, Kassab & Shelash in 2016 to measure fathers' involvement in breastfeeding practices. It consisted of 14 items with a five-point Likert scale ranging from "strongly disagree" to "strongly agree", with a Cronbach's alpha of 0.73. This questionnaire has good internal consistency and reliability (Abu-Abbas, Kassab & Shelash, 2016). The total possible score for the questionnaire was 70 and scores of ≥58 suggested good involvement in breastfeeding practices, while scores <58 indicated poor involvement.

Data analysis

SPSS version 21.0 was used to analyse the data. Mean scores and standard deviation were calculated to measure fathers' knowledge, attitudes, and involvement in breastfeeding practices. Simple logistic regression analysis was used to determine the possible predictive variables affecting fathers' level of involvement in breastfeeding before conducting multiple logistic regression. To restrict the number of potential predictors in multiple logistic regression analysis, the results from simple logistic regression were examined and potential predictors were retained only if p-value was <0.25. Multiple logistic regression was used to identify the determinants of fathers' involvement in breastfeeding. Statistical significance was set at $p<0.05$. Data were presented in the form of tables and figures.

Ethical approval

Written informed consent was obtained from the participants to ensure privacy. The questionnaires were self-administered and data were collected anonymously. The study was approved by the UiTM Research Ethics Committee (REC/151/17) and Medical Research

Ethics Committee, Ministry of Health (NMRR-19-2649-49971).

RESULTS

Demographic variables

A total of 203 fathers were recruited in this study. Table 1 shows the characteristics of fathers. The age of the fathers in this study ranged between 21-50 years old with a mean age of 32.14±5.91 years old. Majority of the fathers (83.3%) were Malays. About 98.5% of the fathers indicated that they were living with their partners. Over half of the fathers did not pursue higher education (54.2%). Majority of the fathers (68.5%) had a monthly income of <RM3000. Only 37.4% of fathers were first-time fathers. Besides, majority of fathers were never involved in antenatal (88.7%) and breastfeeding classes (85.7%). Meanwhile, the age of the infants ranged between 2 days to 24 months. Most of the infants (72.9%)

Table 1. Characteristics of participants (*N*=203)

Variable	*M±SD*	*n*	*%*
Clinic			
KK Kuala Selangor		143	70.4
KK Bestari Jaya		60	29.6
Age			
<30 years old	32.1±5.9	83	40.9
≥30 years old		120	59.1
Ethnicity			
Malay		169	83.3
Others		34	16.7
Living			
With partner		200	98.5
Without partner		3	1.5
Education level			
Secondary school or lower		114	54.2
Higher than secondary school		89	45.8
Monthly income			
≤RM3000		139	68.5
≥RM3001		64	31.5
Number of children			
First child		76	37.4
Not first child		127	62.6
Involved in antenatal class			
Yes		23	11.3
No		180	88.7
Involved in breastfeeding class			
Yes		29	14.3
No		174	85.7

Table 2. Level of knowledge, attitude and involvement in breastfeeding among participants *(N*=203)

Variables	*Mean*	*SD*
Father's knowledge in breastfeeding	13.8	3.2
Father's attitude in infant feeding	61.9	6.7
Father's involvement in breastfeeding	57.0	6.2

were delivered through vaginal delivery, but 5.4% of them were through assisted vaginal delivery. Majority of the infants were ever breastfed (96.6%) and still being breastfeed (67.0%). Forty-six infants stopped exclusive breastfeeding within the first three months (22.7%).

Table 2 depicts the scores of breastfeeding knowledge, infant feeding attitudes, and involvement in breastfeeding among fathers.

Level of breastfeeding knowledge among fathers

The knowledge scores of the study population ranged from 5 – 20 points out of the possible 22, with a mean score of 13.8±3.2 and 62.6% of fathers correctly answered the breastfeeding knowledge questionnaire. About one quarter of the fathers knew that the consistency of breast milk and formula is equal (23.2%, *n*=47).

Majority of the fathers knew that it is recommended to breastfeed a healthy infant regularly (93.6%, *n*=190). More than half of the fathers expressed that infant gets milk from bottle similar to breastfeeding (58.6%, *n*=119). Only 34% fathers believed that most mothers with small breasts have insufficient lactation (*n*=69). Meanwhile, 44.8% knew that the nipples will be cracked if breastfeeding lasts over 10 minutes (*n*=91). Approximately half of the fathers believed that cracked nipples happened because the infant is allowed to latch too long in the first days of life (49.8%, *n*=101). A large number of fathers correctly answered that a dummy should not be used to prevent cracked nipples (68.5%, *n*=139) and donor milk is not used in the making of formula (83.3%, *n*=169). About 45.3% of the fathers believed that there is a need to give water to all infants, including exclusively breastfed infants, especially on hot days.

More than half of the fathers believed that it is recommended to follow a special time schedule while breastfeeding (69.5%, *n*=141). Only 29.6% fathers thought that breastfed infants need complementary foods from at least 4 months of age (*n*=60). A total of 42.9% fathers reported that it is recommended to cease breastfeeding if a breastfeeding mother has diarrhoea (*n*=87), while 90 fathers wrongly answered on the item "it is recommended to pump the breasts after alcohol consumption before the next breastfeeding" (44.3%). A large proportion of the fathers correctly answered on the item "breastfed or formula-fed infants have as many ear infections until they are 1 year old" (86.7%, *n*=176).

Level of fathers' attitudes in breastfeeding

Level of breastfeeding attitude among fathers was measured using IIFAS. The scores of fathers' attitudes in breastfeeding ranged from 43 to 77 points out of the possible 85, with a mean score of 61.9±6.7. A score of >65 was considered a positive attitude towards breastfeeding (Cox, Giglia, & Binns, 2015). More than half of the fathers (68%, *n*=138) were found to have

a lower breastfeeding attitude, whom had more positive attitudes towards formula feeding compared to fathers who had positive attitudes towards breastfeeding (32%, *n*=65).

The lowest mean score was 2.46 from the item "a mother who occasionally drinks should not breastfeed her baby", which reflected a negative attitude in breastfeeding. The highest mean score was 4.64 on the item "breast milk is the ideal food for babies", where majority of fathers managed to answer correctly. Almost half of the fathers agreed that the nutritional benefits of breast milk last only until the baby is weaned from breast milk (46.8%, *n*=95). Majority of fathers disagreed that formula feeding is more convenient than breastfeeding (50.7%, *n*=103). A large number of fathers managed to answer correctly on the item "breast milk is lacking in iron" (71.5%, *n*=145).

More than half of the fathers agreed that formula feeding is a better choice if a mother plans to work outside of home (53.7%, *n*=109). Majority disagreed that women should not breastfeed in public places such as restaurants (55.2%, *n*=112). Approximately half of the fathers thought that breastfed babies are more likely to be overfed than formula-fed babies (53.2%, *n*=108). Most of the fathers disagreed that formula milk is as healthy as breast milk for an infant (68%, *n*=138). Over half of the fathers wrongly answered on the item "a mother who occasionally drinks should not breastfeed her baby" (52.2%, *n*=106).

Level of father's involvement in breastfeeding

Meanwhile, the scores of fathers' involvement in breastfeeding ranged from 39 to 70 points, with a mean score of 57.0±6.2. The total possible score for the questionnaire was 70 and a score of ≥58 indicated good involvement in the breastfeeding process, while a score of <58 indicated poor involvement (Abu-Abbas *et al.*, 2016). A total of 107 (52.7%) fathers were found to have good involvement in breastfeeding and the rest represented poor involvement in breastfeeding (47.3%, *n*=96).

The mean score of the item "showed acceptance regarding formula feeding" was 2.76, which was the least among all involvement items, reflecting a negative involvement in breastfeeding. Meanwhile, the item "helped your wife with houseworks and taking care of other baby tasks like responding to the baby's cries, help in bathing the baby… etc." was 4.58, which was the highest score, reflecting a positive involvement in breastfeeding. Majority of the fathers agreed with their wife's desire to stop breastfeeding (40.4%, *n*=82). A total of 43.9% of fathers showed acceptance regarding formula feeding (*n*=89). A large number of fathers admitted not getting upset if other houseworks were not done during the breastfeeding period (69.9%, *n*=142).

Determinants of fathers' involvement in breastfeeding

Table 3 shows the results of Simple Logistic Regression (SLR) analysis. SLR was done to identify the possible predictors affecting fathers' involvement in breastfeeding practices before running the Multiple Logistic Regression (MLR) analysis. As shown in Table 3, there were significantly associated factors for fathers' involvement in breastfeeding practices: knowledge and attitude ($p<0.001$). Only ethnicity, education, occupation, income, baby's age, mode of delivery, knowledge and attitude scores were selected to be included in the MLR analysis as they had a *p*-value of <0.25.

Table 4 shows the results of MLR analysis to identify the determinants of fathers' involvement in breastfeeding

Table 3. Factors associated with fathers' involvement in breastfeeding practices using simple logistic regression

Variables	*Good involvement (n=96)*		*Poor involvement (n=107)*		*Crude OR (95% CI)*	*p-value*
	n	*%*	*n*	*%*		
Ethnicity						
Malay	83	86.5	86	80.4	1.56 (0.77, 3.32)	0.249*
Others	13	13.5	21	19.6	1.00	
Education						
Higher than secondary schools	49	51.0	40	37.4	1.75 (1.00, 3.06)	0.051*
Secondary school and lower	47	49.0	67	62.6	1.00	
Occupation						
Private/public sectors	73	76.0	68	63.6	1.82 (0.99, 3.36)	0.055*
Self-employed, not working	23	24.0	39	36.4	1.00	
Income						
≥ RM3001	36	37.5	28	26.2	1.69 (0.93, 3.08)	0.084*
≤ RM 3000	60	62.5	79	73.8	1.00	
Parity						
Primiparous	37	38.5	39	36.4	1.09 (0.62, 1.93)	0.758
Multiparous	59	61.5	68	63.6	1.00	
Attendance to antenatal class						
Yes	12	12.5	11	10.3	1.25 (0.52, 2.97)	0.619
No	84	87.5	96	89.7	1.00	
Attendance to breastfeeding class						
Yes	15	15.6	14	13.1	1.23 (0.56, 2.70)	0.606
No	81	84.4	93	86.9	1.00	
Baby's age						
≤ 6 Months	45	46.9	60	56.1	0.69 (0.40, 1.20)	0.191*
≥ 7 Months	51	53.1	47	43.9	1.00	
Mode of delivery						
Normal	76	79.2	72	67.3	1.85 (0.98, 3.49)	0.059*
Caesarean	20	20.8	35	32.7	1.00	
Fathers' age, *n*=203					1.00 (0.95, 1.04)	0.844
Breastfeeding Knowledge Score, *n*=203					1.29 (1.17, 1.44)	<0.001*
IIFAS Score (Attitude), *n*=203					1.17 (1.11, 1.23)	<0.001*

*Criterion for inclusion as a predictor for multiple logistic regression has been met (p<0.25)

Table 4. Factors associated with fathers' involvement in breastfeeding practices using multiple logistic regression analysis

Variables	*n*	*Crude OR (95% CI)*	*p-value*	*Adjusted OR[a] (95% CI)*	*p-value*
Mode of Delivery					
Normal	148	1.85 (0.98, 3.49)	0.059	2.12 (1.03, 4.36)	0.040*
Caesarean	55	1.00		1.00	
Knowledge	203	1.29 (1.17, 1.44)	<0.001*	1.17 (1.04, 1.31)	0.008**
Attitude	203	1.17 (1.11, 1.23)	<0.001*	1.14 (1.07, 1.20)	<0.001*

[a] A forward LR and backward LR multiple logistics regression model was applied
*p<0.05, **p<0.01

practices. Crude and adjusted odds ratios of variables associated with fathers' involvement in breastfeeding are shown in Table 3. Fathers who had a baby born through vaginal delivery were 2.1 times more likely to have good involvement in breastfeeding practices than fathers who had a baby delivered through C-section (crude OR: 1.845, 95% CI: 0.98 – 3.49, adjusted OR: 2.12, 95% CI of adjusted OR: 1.03 – 4.36). Besides, fathers with a higher score in breastfeeding knowledge were more likely to have good involvement in breastfeeding practices than fathers with a lower score (crude OR: 1.29, 95% CI of crude OR: 1.17, 1.44), and the adjusted odds ratio was 1.17 (95% CI of adjusted OR: 1.04 – 1.31). As expected, fathers with a higher score in attitude towards breastfeeding were more likely to have good involvement in breastfeeding practices than fathers with a lower score (crude OR: 1.17, 95% CI of crude OR: 1.11, 1.23), and the adjusted odds ratio was 1.14 (95% CI of adjusted OR: 1.07–1.20).

Ethnicity, education level, working status, monthly income, age of infant were not significant predictors influencing fathers' involvement in breastfeeding. The following demographic variables were also not significant factors affecting fathers' involvement in breastfeeding practices: total number of children, involvement in antenatal class, involvement in breastfeeding class, age of the infant, infant ever being breastfed, and duration exclusive breastfeed.

DISCUSSION

Determinants of fathers' involvement in breastfeeding

The present study found that fathers whose baby was delivered vaginally were 2.1 times more likely to have good involvement in breastfeeding practices than fathers whose baby was delivered through C-section. These findings may be related to the early cessation of breastfeeding by mothers who undergo caesarean delivery. In one prospective cohort study in Calgary, Alberta involving 3021 mothers found that more mothers who delivered by planned C-section had no intention to breastfeed or did not initiate breastfeeding when compared to women with vaginal births (Hobbs *et al.*, 2016). Therefore, they were more likely to cease breastfeeding before 12 weeks postpartum compared to those who delivered vaginally. Also, according to one meta-analysis study conducted by Zhao *et al.*, (2017) in China, in the early postpartum period, the odds of exclusive breastfeeding after a caesarean section was 47% lower than after vaginal delivery. These findings from previous studies showed that breastfeeding practices were affected adversely by

caesarean delivery. Given that mothers who had caesarean delivery will be more likely to have adverse breastfeeding outcomes, therefore it is suggested for fathers to continuously support their spouses to initiate breastfeeding and continue to breastfeed. Moreover, it is important to advocate future fathers on the importance of breastfeeding and how they could play their roles as a supportive partner especially during postpartum period.

From the present study, it was shown that fathers with a higher score in breastfeeding knowledge were more likely to have good involvement in breastfeeding practices than fathers with a lower score. In one cross-sectional study conducted by Abhinaya, Arunprasath & Padmasani (2016) in India among 93 fathers, they found that fathers with good knowledge had a positive attitude towards breastfeeding. In that study, fathers' breastfeeding knowledge was positively influenced by healthcare exposure and education (Abhinaya *et al.*, 2016). Leng *et al.* (2019) found that fathers' breastfeeding knowledge was the second predictor that influenced fathers' involvement in breastfeeding. A father who has good breastfeeding knowledge can improve breastfeeding continuity (Maycock *et al.*, 2015; Sherriff *et al.*, 2014). According to one community-based intervention study in Vietnam conducted by Bich & Cuong (2016), fathers' knowledge regarding breastfeeding was shown as a firm foundation for fathers' attitudes and involvement in breastfeeding. Fathers who have limited breastfeeding knowledge reported that they would like to gain more information regarding breastfeeding (de Montigny *et al.*, 2018; Ng, Shorey & He, 2019).

Besides that, fathers with a higher score in attitude towards breastfeeding were more likely to have good involvement in breastfeeding practices than fathers with a lower score. Fathers' attitudes towards breastfeeding are associated with fathers' involvement in the breastfeeding process (Lester, 2014; Rempel *et al.*, 2017), as they influence the initiation and success of breastfeeding (Ng *et al.*, 2019). In one correlational study conducted by Leng *et al.* (2019) in Singapore, the perceived acceptance of fathers by family members and friends, fathers' knowledge about breastfeeding, perceived behaviour control, marital satisfaction, and perceived improvements of knowledge and attitudes during two weeks postpartum were significant factors affecting fathers' involvement in breastfeeding practices. According to one integrative review study conducted by (Ng *et al.* (2019), factors that may influence fathers' involvement in breastfeeding included fathers' knowledge regarding breastfeeding, fathers' attitudes towards breastfeeding, fathers' perceptions of subjective norms surrounding their involvement in breastfeeding, fathers' perceived behavioural control of their involvement, committed relationship, socio-demographic characteristics, and fathers' attendance at antenatal classes. These findings showed that both fathers' knowledge and attitudes in breastfeeding can influence fathers' involvement during the breastfeeding period. Higher levels of paternal support and encouragement are linked with greater maternal confidence to breastfeed, as fathers are the main source of social support for mothers who are breastfeeding (Al-Namir, Brady & Gallagher, 2017). According to Al-Namir *et al.* (2017), excluding fathers from breastfeeding education, support and training can result in lower quality of life and father self-efficacy.

As this was a cross-sectional analysis, recall bias could have been introduced, especially among fathers who have an older infant. In addition, fathers were recruited using convenience

sampling. Thus, it may have contributed to study bias, especially since fathers who accompany their partners may have been more likely to actively participate in breastfeeding.

CONCLUSION

Multiple logistic regression analysis revealed three significant factors that influenced fathers' involvement in breastfeeding: fathers' breastfeeding knowledge, fathers' attitudes towards breastfeeding practices, and birth mode. These significant predictors may provide an insight to healthcare professionals to establish effective solutions and strategies for successful breastfeeding interventions and programmes involving fathers. Healthcare professionals and policy makers should implement strategies to engage fathers in the antenatal and breastfeeding classes to improve their overall knowledge and attitudes in breastfeeding in order to promote positive involvement of fathers in breastfeeding practices. Findings from this study may assist in the development of quantitative studies on a larger scale and with limited study bias. Future studies should also consider the effectiveness of fathers' involvement in breastfeeding and antenatal classes with breastfeeding outcomes.

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Authors' contributions

NIMN conducted the study, led the data collection at selected primary healthcare facilities, data analysis and prepared the draft of the manuscript; SBAH is the principal investigator, conceptualised the study design, advised on data analysis and interpretation, and critically reviewed the final manuscript.

Conflict of interest

The authors have no conflict of interest to declare.

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REVIEW

Malnutrition and its risk factors among children and adolescents with intellectual disability (ID) in Asian countries: A scoping review

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ABSTRACT

Introduction: Children with intellectual disability (ID) have higher probability of experiencing poor health status due to their limited ability to understand and assess information about nutrition and health. Malnutrition remains a significant health problem as it is prevalent among both typically developing and disabled children. This scoping review aims to discuss the prevalence of malnutrition among children and adolescents with ID in Asian countries. **Methods**: The review was based on the PRISMA-ScR method. A systematic electronic search was conducted using databases namely PUBMED, Science Direct, Scopus, and Google Scholar for articles published from 2006-2019, written in English and involved studies in Asian countries. **Results**: A total of 255,100 article's titles were identified and only 17 articles that met the inclusion criteria were included for further analysis. The findings revealed that the range of prevalence for underweight was 5.7%-76.3% and 28.9%-45.0% for stunting. The prevalence estimated for overweight was 3.9%-46.6%, while obesity was 1.6%-26.6%. The body mass index values ranged from 17.4±4.3kg/m^2-23.0±6.3kg/m^2. There were several risk factors related to malnutrition such as co-morbidity factors, behavioural factors, and parental factors. **Conclusion**: This review demonstrated concern regarding the prevalence of malnutrition among children and adolescents with ID, which is high in certain Asian countries. It was varied and thus difficult to compare due to different reference standards and definitions used for malnutrition. Establishing nutrition and health-related intervention programmes can help to prevent further rise in the prevalence of malnutrition in this group.

Keyword: Intellectual disability, malnutrition, overweight, obesity, underweight

INTRODUCTION

Intellectual disability (ID) is referred as a condition characterised by impaired intelligence and social functioning which begins before adulthood and affects normal development (WHO, 2020). Based on the American Association on Intellectual and Developmental Disabilities (AAIDD), intellectual disability, which was previously known as mental retardation, is defined as "the presence of three coexisting features, namely significant sub-average intellectual functioning, deficits or

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impairments in adaptive skills, and onset before 18 years of age" (Shea, 2012). The United Nations Children's Fund (UNICEF) (2018) estimated that there are at least 93 million children with disabilities in the world, and this statistic could be higher due to unreported data. UNICEF further stated that 1 in 20 children aged 14 years or younger lives with moderate to severe disabilities. However, the data included all types of disabilities, not differentiated either by intellectual, physical or other disabilities. A meta-analysis found that the prevalence of ID among children and adolescents was 1.83% and the female-to-male ratio varied between 0.4 and 1.0 (Maulik *et al.*, 2011). Recently, McKenzie *et al.* (2016), who extended Maulik *et al.* (2011)'s work, reported that the prevalence of ID for all age groups was estimated to be 0.05%-1.55%.

Some ID children would have co-morbid conditions such as autism, attention deficit disorder (ADHD), Down syndrome, epilepsy, and anxiety (Eisenhower, Baker, & Blacher, 2005; Jauhari *et al.*, 2012; Krause *et al.*, 2016). They have a higher probability of experiencing poor health status as compared to those without ID due to their limited ability to comprehend and assess information about nutrition and health. Hence, poor health status would expose them to the risk of getting communicable or non-communicable diseases as a secondary health condition (Bellamy, 2016). Nutritional status is an important indicator to determine the overall health status and wellbeing of children and adolescents with ID as these groups are vulnerable to suffer from malnutrition (under or over-nutrition).

The World Health Organization (WHO) (2020) defines malnutrition as "deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients; referring to three groups of conditions which are undernutrition, macronutrient-related malnutrition, and overweight/obesity". Malnutrition in this review will focus on undernutrition (wasting, stunting, and underweight) and overnutrition (overweight and obesity). The Global Nutritional Report (2020) reported a declining prevalence in underweight from 39.5% in the year 2000 to 33.7% in the year 2016 among children and adolescents (aged 5-19 years) in Asian countries. Meanwhile, overweight and obesity among children and adolescents showed a rising trend from 2000-2016, with a prevalence of 7.0%-17.3% and 1.7%-6.5%, respectively. Even though the prevalence of underweight has decreased, it remains a problem because the decline is too slow, while overweight and obesity is rising rapidly.

Undernutrition among children and adolescents with ID may result due to a lack in nutritious food intakes following their dependency on feeding and food preparation. This situation might worsen when they lose weight due to other risk factors such as multiple health conditions, frequent infections, as well as limited access to quality health care. A systematic review reported that disabled children are three times more likely to be underweight and twice as likely to have wasting and stunting as compared to normal children (Hume-nixon & Kuper, 2018). On the other hand, several studies found that children with disabilities had higher prevalence of overweight and obesity compared to children without disability (Bandini *et al.*, 2015; Ogwu, 2012). A systematic review on overnutrition revealed that adolescents with ID have more risk of having overweight-obesity (1.54 times) and obesity (1.80 times) than typically developing adolescents (Maïano *et al.*, 2016). The possible risk factors contributing to the rising level of overweight and obesity among children and adolescents with ID are age, gender,

sedentary behaviour, higher intakes of energy-dense foods, co-morbidities, and genetic disorders (Krause *et al.*, 2016; Segal *et al.*, 2016). Disabled children who are obese will be vulnerable to remain obese during adulthood and are prone to get other health problems such as diabetes, hypertension, and cardiovascular disease (Raghi *et al.*, 2016; Rimmer *et al.*, 2010).

Thus, these evidences suggest that malnutrition remains one of the significant health problems among children and adolescents as it is not only prevalent among typically developing children, but also among disabled children. To our knowledge, no published review article has explored the existence of malnutrition among ID children and adolescents in Asian countries. Understanding the current situation and trends on malnutrition among Asian children and adolescents with ID will provide useful information to assist researchers and health professionals in identifying priority health programmes for the prevention and care of this vulnerable group. This scoping review aims to review the prevalence of malnutrition among children and adolescents with ID in Asian countries.

MATERIALS AND METHODS

Sources of information and search strategy

The present study is a scoping review that was designed based on the "Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR)" method (Tricco *et al.*, 2018). A systematic electronic search was conducted using four databases, namely PUBMED, Science Direct, Scopus, and Google Scholar to source for research papers published from 2006-2019 that were written in English. In addition, a hand search was carried out using the reference lists of relevant articles and previous literature reviews on related topics. The keywords that were used in the database machines comprised of malnutrition, nutritional status, underweight, obesity, overweight, body weight status, body mass index, children, adolescent, intellectual disability, and mental retardation. The search strategies included all possible combinations of key search terms which were: (a) (malnutrition) AND children OR adolescent AND (intellectual disability OR mental retardation), (b) (overweight OR obesity OR underweight) AND children OR adolescent AND (intellectual disability OR mental retardation) (c) body weight status AND children OR adolescent AND (intellectual disability OR mental retardation) and (d) body mass index AND children OR adolescent AND (intellectual disability OR mental retardation).

Inclusion criteria

Research articles that met these specific inclusion criteria were considered eligible for this review. Firstly, the study participants were presented with ID. Studies based on mixed samples of participants presented with multiple disabilities were also considered eligible if specific data regarding the prevalence of underweight, overweight, or obesity were available for children and/or adolescents with ID. Secondly, the age of the study participants had to be 19 years old and below, which consisted of children and/or adolescents. Studies on a single sample (children or adolescents) or mixed samples (children and adolescents) were considered eligible if specific data on malnutrition were available. Thirdly, this review only included original research articles of a cross-sectional study or survey that were written by the researchers who conducted the study. Lastly, only

studies within 48 countries in the Asian continent were included.

Study selection and data charting

The articles were selected based on the PRISMA-ScR method (Tricco *et al.*, 2018). The study selection was based on the objectives of the study which focused on malnutrition of children and adolescents with ID in Asian countries. The researchers eliminated irrelevant articles based on the inclusion and exclusion criteria, as well as those that did not answer the research questions. The researchers screened the eligibility of relevant articles separately, based on the titles and retrieved relevant abstracts. Abstracts that did not meet the scope of the study were excluded. Based on the eligible abstracts, copies of the full articles were retrieved from the databases by downloading the soft copies. The researchers checked and revised the full articles to determine whether they appeared to answer the research questions of the study to select the final full articles for review. The results of the article search were managed using the Mendeley software and the extracted data from the full articles were documented in Microsoft Word. Data charting was done independently by a researcher and verified by the other two researchers. General and specific information from the selected studies were extracted based on the inclusion criteria and charted in a table which included author(s), years of publication, country, sample characteristics (sample size, age, ID and co-morbidities), anthropometric measures/ indices, reference standard/ classification criteria, and findings that were relevant to the objectives of the review.

Collating, summarising, and reporting the results

The characteristics and findings of the selected articles are presented in Table 1. The results of the extracted data on the prevalence of malnutrition were analysed using descriptive statistics (percentage) to provide summary characteristics according to the scopes of malnutrition research. Several limitations of the studies were observed to determine the research gap and usefulness for future research in malnutrition.

RESULTS

Based on Figure 1, a total of 255,100 titles were identified through database searching. Next, 94 abstracts were included for the initial screening process, after which duplicates were removed and 40 were excluded due to several reasons (i.e., population, age group, and study design). The duplicated articles were managed by recording, keeping track, sorting the list, and checking them using the Mendeley software. Then, 34 full-text articles were assessed for eligibility; 13 articles were excluded due to non-Asian countries and four because they were articles that were reanalysed using data from the same study. Finally, only 17 articles met the inclusion criteria and were included in the review for analysis (Table 1). This

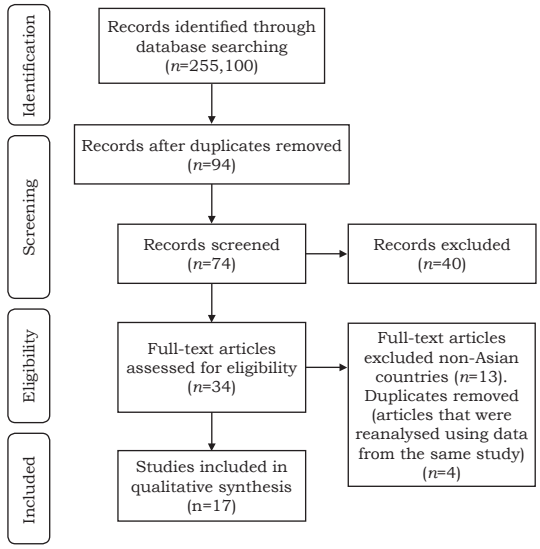

Figure 1. Flow chart of PRISMA-ScR method

Table1. Prevalence of malnutrition among children and adolescents with ID in Asian countries

Author	*Country*	*Sample size and age range of participants*	*Participant's characteristics*	*Anthropometric measures/ indices*	*Reference standard/ classification criteria*	*Prevalence of malnutrition (%)*	*Body mass index, (kg/m²)*
Sulton and Jajat (2019)	Indonesia	30 children aged 8-12 years old	Mild ID	BMI	International Obesity Task Force (IOTF) reference	Normal: 33.3 Overweight: 40.0 Obese: 26.6	21.9±2.5
Pise *et al.* (2019)	India	225 children aged 11-15 years old	Mild to severe ID	BMI	–	Underweight: 70.5 Normal: 23.2 Overweight: 6.3	17.4±4.3
Kavitha *et al.* (2019)	India	100 children aged 3-10 years	Profound, mild, moderate and severe ID	BMI	CDC 2000 Growth chart	Underweight: 64.0 Normal: 36.0	–
Wang *et al.* (2018)	Hong Kong	524 children with mean age: 12.2 years	Mild and moderate ID *ID with comorbidity (autism, ADHD, epilepsy, DS)	BMI	International Obesity Task Force (IOTF) reference	Underweight: 13.4 Normal: 55.3 Overweight: 22.1 Obese: 9.2	–
Sayin and Ilik (2017)	Turkey	220 (112 ID children and 108 TDC) 7-12 aged children	ID	BMI	International Obesity Task Force (IOTF) reference	Underweight: 8.0 Normal: 50.0 Overweight: 26.0 Obese: 16.0	–
Raina *et al.* (2016)	India	91 children aged 1-10 years old	Mental retardation	Height-for-age & weight-for-age	Waterlow's classification	Normal: 27.5 Wasted: 7.7 Stunted: 45.0	–
Pan *et al.* (2016)	Taiwan	1936 children and adolescents aged 7–18 years	Mild, moderate, severe, and profound ID *six comorbidities of ID (ID only, ID with physical disability, ID caused by genetic disorders, multiple disabilities without physical disabilities, autism spectrum disorders, and others with rare diseases)	BMI	Growth charts for Taiwanese children and adolescents	Underweight: 20.4 Normal: 44.4 Overweight: 11.6 Obese: 23.6	21.7±5.9

(to be continued)

Table 1. Prevalence of malnutrition among children and adolescents with ID in Asian countries [Cont'd]

Author	*Country*	*Sample size and age range of participants*	*Participant's characteristics*	*Anthropometric measures/ indices*	*Reference standard/ classification criteria*	*Prevalence of malnutrition (%)*	*Body mass index, (kg/ m^2)*
Sari *et al.* (2016)	Turkey	76 adolescents aged 14-18 years	Mild or moderate ID	BMI	BMI percentile values according to the curves used for Turkish children	Underweight: 18.4 Normal: 46.2 Overweight: 9.2 Obese: 26.3	23.0±6.3
Tamin *et al.* (2014)	Indonesia	1181 students aged 10-16 years.	ID	BMI	Obesity: BMI ≥ the 95th percentile for the respective age and sex	Non-obese: 85.8 Obesity: 14.2	
Nassa and Bhatia (2014)	India	30 days scholars and 30 hostellers aged 13-18 years	ID	BMI	CDC 2000 Growth chart	Underweight: 15.0 Normal: 78.3 Overweight: 5.0 Obese: 1.6	–
Nogay (2013)	Turkey	77 children aged 10-18 years	Mild, medium, severe mental retardation	Weight for age, Height for age, BMI for age	–	Weight for age Underweight: 14.3 Overweight: 3.9 Height for age Stunted: 28.9 Tall: 1.3 BMI for age Underweight: 9.1 Obesity: 15.6	–
Sanjay and Nadgir (2013)	India	205 children aged 5-15 years	Mental retardation with and without disability	BMI	CDC 2000 Growth chart	Underweight: 76.3 Normal: 16.3 Overweight: 4.7 Obese: 2.7	–
Sari and Bahceci (2012)	Turkey	70 children aged 7-18 years	Mild or moderate ID	BMI	BMI percentile values according to the curves used for Turkish children	Underweight: 5.7 Normal: 70.0 Overweight: 17.1 Obese: 7.1	–

(to be continued)

Table1. Prevalence of malnutrition among children and adolescents with ID in Asian countries [Cont'd]

Author	*Country*	*Sample size and age range of participants*	*Participant's characteristics*	*Anthropometric measures/ indices*	*Reference standard/ classification criteria*	*Prevalence of malnutrition (%)*	*Body mass index, (kg/ m^2)*
Choi *et al.* (2012)	South Korea	2404 children aged 7-18 years	ID who did not have specific genetic syndromes or physical disabilities *ID are defined as children with autism, mental retardation and/or developmental disability.	BMI	Korean age- and sex-specific percentiles for BMI (KCDC,2007)	Underweight: 14.3 Normal: 61.6 Overweight: 12.2 Obese: 11.8	–
Lin *et al.* (2010)	Taiwan	937 children and adolescents aged 6-18 years	ID	BMI	-	Underweight: 29.9 Normal: 34.3 Overweight: 13.0 Obese: 22.8	–
Ha *et al.* (2010)	South Korea	206 children and adolescents aged 8-19 years	ID *excluded chronic diseases, genetic syndromes, co-occurring conditions such as autism, diabetes, congenital heart disease, and cerebral palsy	BMI	Korean age- and sex-specific percentiles for BMI (KCDC,2007)	Underweight: 11.7 Normal: 41.7 Overweight: 46.6	21.6±5.7
Frey and Chow (2006)	Hong Kong	444 youth aged 6–18 years	Mild ID	BMI	International Obesity Task Force (IOTF) reference	Overweight/ obese: 20	18.9±4.2

Note: ID, intellectual disability: BMI, Body mass index; IOTF, International Obesity Task Force; CDC, Centres for Disease Control and Prevention; ADHD, Attention deficit hyperactivity disorder; DS, Down syndrome; TDC, Typical developing children; KCDC, Korea Centers for Disease Control and Prevention

review uses the term "study" to refer to these selected articles.

Geographic coverage, participants and study design

The studies included in this review had a mixture of both samples of children and adolescents aged below 19 years, with an age range of between 1-19 years old. Four studies included samples of children under 12 years (Kavitha, Singh, & Chandraiah, 2019; Raina *et al.*, 2016; Sayin & Ilik, 2017; Sulton & Jajat, 2019), while the rest combined children and adolescents. The sample size of the participants ranged from 30-2,404 children and adolescents. Eight studies included participants with various levels of ID (mild, moderate, and severe), four studies included participants with ID and co-morbidities or other disabilities (autism, attention deficit hyperactivity disorder, epilepsy, Down Syndrome, and developmental disabilities), while five studies only mentioned participants with ID (Table 1). The level of ID was determined by using Wechsler IQ scores of below 70 (mild= 55<ID<69, moderate= 40<ID<54, severe= 25<IQ<39, and profound= IQ≤24) or obtained from school records (Kavitha *et al.*, 2019; Pan *et al.*, 2016; Sulton & Jajat, 2019). The study participants were recruited from various community settings such as special education schools, households, and rehabilitation centres. These 17 studies were conducted in South Asia (Kavitha *et al.*, 2019; Nassa & Bhatia, 2014; Pise, Pradhan, & Gharote, 2019; Raina *et al.*, 2016; Sanjay & Nadgir, 2013), Southeast Asia (Sulton & Jajat, 2019; Tamin *et al.*, 2014), East Asia (Choi *et al.*, 2012; Frey & Chow, 2006; Ha, Vann & Choi, 2010; Lin *et al.*, 2010; Pan *et al.*, 2016; Wang *et al.*, 2018), and Southwestern Asia (Nogay, 2013; Sari *et al.*, 2016; Sari & Bahceci, 2012; Sayin & Ilik, 2017). No study was found for Central Asia and North Asia. The design of these selected studies was cross-sectional.

Measurements and reference standards

Majority of the studies (n=15) employed body mass index (BMI) to assess underweight, overweight and obesity, while only two studies used height-for-age and weight-for-age to determine stunting and wasting (Nogay, 2013; Raina *et al.*, 2016). Height and weight in majority of the studies were measured directly by the research team or obtained through school health records or measurements taken by clinicians (e.g., nurses and dietitians). These studies used a variety of reference standards, which included the International Obesity Task Force (IOTF) reference (Pan *et al.*, 2016; Pise *et al.*, 2019; Sayin & Ilik, 2017; Sulton & Jajat, 2019; Wang *et al.*, 2018), Centers for Disease Control (CDC) 2000 growth charts (Kavitha *et al.*, 2019; Nassa & Bhatia, 2014; Sanjay & Nadgir, 2013) Taiwanese growth chart (Pan *et al.*, 2016), Korea Centers for Disease Control and Prevention (KCDC) reference (Choi *et al.*, 2012; Ha *et al.*, 2010), Turkish BMI percentile (Sari *et al.*, 2016; Sari & Bahceci, 2012), and Waterlow's classification (Raina *et al.*, 2016). Only four studies did not report the reference standards that they had used.

Prevalence of malnutrition

Based on Table 1, prevalences of underweight, overweight and obesity were reported in fifteen of the studies. Two studies published on stunting and wasting (Nogay, 2013; Raina *et al.*, 2016), while a study reported on non-obese and obese subjects (Tamin *et al.*, 2014). Fifteen studies examined nutritional status focusing on stunting, wasting, underweight, overweight and obesity as primary outcomes, while the rest of the studies addressed them as

secondary outcomes (Lin *et al.*, 2010; Sayin & Ilik, 2017). Meanwhile, ten studies determined nutritional status/ malnutrition and its associated factors. The prevalence of malnutrition varied widely and could not be compared as these studies used different reference standards. The findings revealed that the range for overall prevalence of underweight was 5.7%-76.3%. Meanwhile, the prevalence estimated for overweight was 3.9%-46.6% and obesity was 1.6%-26.6%. However, four studies found none of their subjects/ respondents were obese (Ha *et al.*, 2010; Kavitha *et al.*, 2019; Pise *et al.*, 2019; Raina *et al.*, 2016). Two studies reported that the prevalence of stunting was 45.0% in Indian children (Raina *et al.*, 2016) and 28.9% among children and adolescents in Turkey (Nogay, 2013). Meanwhile, only a study by Raina *et al.* (2016) reported on wasting (7.7%). Six studies reported that the value of BMI ranged from 17.4±4.3 kg/m^2-23.0±6.3 kg/m^2 (Frey & Chow, 2006; Ha *et al.*, 2010; Pan *et al.*, 2016; Pise *et al.*, 2019; Sari & Bahceci, 2012; Sulton & Jajat, 2019).

DISCUSSION

This scoping review identified seventeen studies published between 2006 and 2019 addressing research on malnutrition focusing on underweight, overweight and obesity among children and adolescents with ID in Asian countries (Table 1). Although substantial information were available on childhood underweight, overweight and obesity in the general population, less is known among this vulnerable group.

This review paper found that the prevalences of underweight, overweight and obesity among children and adolescents with ID varied across the studies. It was difficult to compare the prevalences as the studies used different reference standards and definitions for malnutrition. The findings suggested that the highest prevalence of undernutrition was estimated in South Asia. Most of the studies in South Asia were conducted in India and they showed a high prevalence of wasting, stunting, and underweight as compared to the other studies in different Asian countries. Sanjay & Nadgir (2013) reported the highest prevalence of underweight at 76.3%, followed by 70.5% (Pise *et al.*, 2019), and 64.0% (Kavitha *et al.*, 2019), while Raina *et al.* (2016) estimated 45.0% for stunting and 7.7% for wasting. According to the Global Hunger Index (GHI) (2019), the high rates of child undernutrition, which include rates of child stunting and wasting, were due to South Asia's higher GHI scores. The GHI Severity Scale indicated that South Asia and Africa's South of the Sahara have serious levels of hunger as both continents have the highest regional 2019 GHI scores in the world. Several studies in South Asian countries suggested that lower socio-economic status (SES), poor dietary intakes, and food insecurity become potential determinants related to undernutrition among children (Chowdhury *et al.*, 2018; Kim *et al.*, 2017). However, these findings could not be generalised to all countries in South Asia, as the selected studies were only conducted in India. Meanwhile, the findings in Southwest Asia estimated the lowest prevalence of underweight at 8.0% (Sayin & Ilik, 2017) and 5.7% (Sari *et al.*, 2016); yet these findings only came from one country, which was Turkey. Although most studies did not identify the socio-economic stratification, an overall greater prevalence of underweight was reported among rural and low SES children and adolescents.

Besides, the findings estimated that the highest prevalence of overweight was 46.6% in South Korea, with no

prevalence of obesity (Ha *et al.*, 2010). Interestingly, the researchers suggested that the prevalence of overweight among ID children in their study was almost five times higher than the prevalence of overweight among children in the general population in South Korea. Ha *et al.* (2010) referred to KCDC (2007) for BMI classification and the sample was only restricted to children with ID, excluding those with chronic diseases and/or genetic syndromes, co-occurring conditions such as autism, diabetes, congenital heart disease, and cerebral palsy. Meanwhile, the highest prevalence of obesity was observed in studies from Indonesia and Turkey, which were 26.6% (Sulton & Jajat, 2019) and 26.3% (Sari & Bahceci, 2012), respectively. However, both studies only involved a small sample size of children and adolescents with mild ID, thus did not demographically reflect the overall population in Asia. Future research may need to use larger sample sizes of children and adolescents with ID of all levels in Asia.

The prevalences of underweight, overweight and obesity were inconsistent and varied according to the classification of BMI used. We observed that the prevalence of underweight using the CDC 2000 growth chart classification ranged from 15.0%-76.3%, which was higher than studies that used the IOTF classification (8.0%-13.4%), KCDC classification (11.7%-14.3%), and Turkish children growth chart (5.7%-18.4%). However, the range of overweight and obesity prevalence using the CDC 2000 growth chart classification was lower than the other classifications (1.6%-2.7%). The IOTF showed a slightly higher prevalence of obesity ranging from 9.2%-26.6%. Since many countries have their own population-specific threshold for determining BMI, a direct comparison between reference standards was invalid due to different cut-off points used in each classification. The differences between BMI classifications would affect the accuracy and precision of the tool to assess malnutrition. However, BMI is one of the most feasible methods to evaluate body composition in individuals with ID as it shows good agreement with dual-energy X-ray absorptiometry (DXA) results (Casey, 2013). Even though BMI is simple, quick and provides straightforward results, we still need to be cautious as it measures fat-free mass and body fat as one value (Nuttall, 2015).

Besides the prevalence of malnutrition, this review also observed ten studies that investigated the factors contributing to malnutrition among children and adolescents with ID in Asia. The risk factors included co-morbidity factors, behavioural factors, and parental factors. Co-morbid factors such as high blood pressure, anaemia, genetic disorder, physical disability, and level of ID were found to be significantly related with malnutrition. Sari & Bahceci (2012) found the presence of high blood pressure (20.1%) among ID adolescents in Turkey and it was associated with BMI. This finding was consistent among ID adolescents in Taiwan as they reported that the prevalence of hypertension (11.7%) was significantly higher than the general population of the same age, and it was associated with BMI (Lin *et al.*, 2010). Overweight and obesity with a combination of factors such as genetics, unhealthy diet and lifestyles were major risks for hypertension, diabetes and other morbidities (Jiang *et al.*, 2016; Raghi *et al.*, 2016). Besides that, Pan *et al.* (2016) reported that ID children with genetic disorders (Down syndrome) and physical disability appeared to have higher risks of being overweight and obese. Several researches suggested that Down syndrome, which has different characteristics than normal people such as short stature, thyroid problems, and

a lower metabolic rate contributes to overweight (Bertapelli *et al.*, 2016; Selvi *et al.*, 2017). Meanwhile, two studies in India revealed that those who were highly intellectually disabled were malnourished (Nassa & Bhatia, 2014; Raina *et al.*, 2016). These co-morbid conditions may increase functional limitations, which further threatens their ability to live independently.

The other risk factor identified was behavioural factors. Wang *et al.* (2018) studied on behavioural factors and reported shorter sleep duration, longer sedentary activities, higher intakes of energy-dense foods, and consumption of meats, fish, and eggs were risk factors for overweight and obesity among ID children in Hong Kong. Children who spent more time on sedentary activities and being physically inactive had reduced energy expenditure as they may be doing activities such as snacking while watching television. Children with ID face many barriers to participate in physical activity due to a lack of resources, opportunities, and psychological support (Ha *et al.*, 2010). Furthermore, higher energy intake and unhealthy eating habits call for parental attempts to help these children to modify their unhealthy lifestyles. However, this review only found one study which explored on behavioural factors. Thus, more future research needs to be conducted, especially among ID children and adolescents in Asia.

Lastly, parental factors such as parenting practices, maternal body weight, and parent's perception were found to be risk factors of overweight and obesity (Ha *et al.*, 2010; Wang *et al.*, 2018). For example, Wang *et al.* (2018) stated that parental practice on pressure to eat more was negatively associated with overweight and obesity, and this was consistent with the findings among typically developing children (Gregory, Paxton, & Brozovic, 2010; Wehrly *et al.*, 2014). Parents pressuring children to eat more would cause less enjoyment of eating (Webber *et al.*, 2010), food avoidance (Powell, Farrow, & Meyer, 2011), negative feeding experience, and decreased consumption of certain foods which would affect a child's weight (Galloway *et al.*, 2006). Furthermore, children may have a higher likelihood of being overweight and obese if their mothers were overweight and obese because parents would influence children's eating habits. Thus, it is helpful to assess parental factors because family provides the strongest moral support and parental involvement in the intervention will help to prevent or overcome malnutrition.

This review has some limitations. This scoping review is different from systematic review because it does not assess the quality of the selected studies. There is a possibility that the prevalence of malnutrition might be under- or overestimated due to methodological constraints. The limited number of studies meeting the inclusion and exclusion criteria and the variation of sample sizes, participants criteria, different reference standards, and geographical areas caused difficulty in generalising the findings. Besides, some information on malnutrition might be missing due to unpublished studies that were not available online.

CONCLUSION

In conclusion, this review demonstrated concern regarding the prevalence of malnutrition among children and adolescents with ID in Asian countries. The prevalence of underweight was high, especially in low SES countries such as India. Besides, the prevalence of overweight and obesity was also high in certain countries such as Indonesia and

Korea as compared to other countries in Asia. This review also found several risk factors related to malnutrition such as co-morbidity factors, behavioural factors, and parental factors. Many potential risk factors of malnutrition such as genetic disorder, level of ID, sedentary behaviours, dietary intake, and parenting practices are understudied in this population and deserve further investigation. Early detection on the prevalence of malnutrition and its associated factors would help to address the problem thoroughly in order to prevent further rise in prevalence. Although malnutrition is an underlying health condition in some people, it can significantly impact patient's health outcomes and cost if they do not receive proper treatment. This review found evidence that children and adolescents with ID are vulnerable groups for malnutrition in Asian countries. Hence, future studies should further investigate the understudied potential risk factors of malnutrition in order to assist in developing comprehensive nutrition intervention programmes and inclusive public health systems to combat this problem in this vulnerable population.

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Authors' contributions:

SFM, involved in study conception and design, conducted data collection, analysis and interpretation, and prepared the draft of the manuscript; SKL & DV, involved in study conception and design, critical revision and reviewed the manuscript.

Conflict of interest

The authors report no conflicts of interest in this work.

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Effect of resistance training exercise combined with high protein diet on body weight and muscle mass in underweight adolescent males

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ABSTRACT

Introduction: Many underweight males take commercial protein supplements to increase their body weight and build muscle. Nonetheless, commercial protein supplements may cause adverse effects. This study aimed to determine the effects of resistance training exercise combined with a high protein diet on body weight and muscle mass in underweight adolescent males. **Methods:** A repeated measures design study was conducted on nine males aged 12-15 years with low body weight. Energy and protein requirements were calculated, and energy and protein consumptions were measured for each meal during the high protein diet without exercise (HP) period and the high protein diet with resistance exercise (HP-E) period. Subjects engaged in three resistance training sessions each week during HP-E period, for eight weeks. Dietary intake, body composition, blood biochemistry, physical fitness, and self-esteem were assessed. **Results:** In HP-E period, resistance training exercise combined with a high protein intake (2.14 g/kg/d) increased body weight and lean tissue mass (LTM) by 0.5 kg and 0.5 kg, respectively. Resistance training during HP-E period increased arm, leg, and trunk muscle strength by 20.2%, 7.2%, and 14.5%, respectively, more than high protein diet alone during HP period. High protein intake in HP-E period did not affect blood urea nitrogen (BUN) and creatinine levels (11.0 mg/dL and 0.70 mg/dL, respectively). **Conclusion:** Eight weeks of resistance training combined with a high protein diet increased body weight and LTM without adverse effects. In particular, resistance exercise predominantly increased muscle strength. Kidney function was not affected by high protein consumption throughout this study.

Keywords: High protein diet, resistance exercise, adolescent male, body weight, muscle strength

INTRODUCTION

Underweight in adolescents is one of the most common problems in many Asian countries. A previous study indicated that the prevalence of underweight among 16.5-17.5 years old Japanese adolescents of both sexes in 2001 was marginally increased compared with that

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in 1978–1981 (Inokuchi *et al.,* 2007). Among adolescents in Ho Chi Minh City, Vietnam, 13.1% were reported to be underweight (Tang *et al.,* 2007). The weight status of Thai adolescents was investigated and published in 2013 as part of the "Waisai-Health Program", which conducted a survey of the weight status of adolescent Thai students at Srinagarindra the Princess Mother School, Phayao (SW.PY.) Among 313 male and 376 female students who participated in this programme, 5.8% of males and 5.4% of females were underweight (Suttikomin *et al.,* 2018).

Sufficient protein consumption can increase body weight and muscle mass. So far, food protein quality, as assessed by digestibility, net protein utilisation, and biological value, has been better for animal-based protein sources such as meat, eggs, milk, and its constituents than for plant-based protein sources such as raw cereals and legumes (Berrazaga *et al.,* 2018). The protein digestibility corrected amino acid score (PDCAAS) is a composite indicator of protein quality used to assess the ability of dietary protein to meet the body's amino acid requirements. A given dietary protein cannot fully meet the body's essential amino acid requirements when its PDCAAS is less than 100%. Apart from some soy protein isolates, plant-based protein sources that have been tested to date are characterised by PDCAASs that are less than 100% and therefore, lower than those of animal proteins (Berrazaga *et al.,* 2018). Likewise, consumption of soy protein has resulted in a lower synthetic rate of muscle protein when compared to consumption of animal protein such as whey, milk, or beef (Vliet, Burd & Loon, 2015).

Alternatively, resistance training exercise can also lead to an increase in body weight and muscle mass. This is an effective strategy not only for increasing muscle mass and body weight, but also for improving strength and endurance, which consequently promotes overall health. Importantly, the role of amino acid availability in regulating muscle protein synthesis (MPS) in response to amino acids, protein ingestion, and exercise has been reported. It has been shown that the quantity of protein intake is significantly correlated with an increase in body weight and muscle mass. Additionally, a correlation between aerobic fitness and body weight has been documented (Bray *et al.,* 2012). A study on the effects of a ten-week resistance or aerobic exercise training on body weight and lean body mass demonstrated that body weight and lean body mass of persons in the resistance training group were slightly increased, while total body fat mass was significantly decreased when compared to the control group (Donges, Duffield & Drinkwater, 2010).

Data from the "Waisai-Health Program" indicated that adolescent males tend to have more underweight problems than adolescent females (Suttikomin *et al.,* 2018). The pilot study of this research found that all male students wanted to improve their body weight status, which can result in a healthier body and mind. However, many of them regularly took commercial whey protein to increase their body weight and build muscle, even though the purity and safety of whey proteins are not guaranteed. Therefore, this study aimed to optimise the levels of protein intake from natural sources such as meat, fish, eggs, and dairy products, and incorporate a resistance exercise programme for underweight adolescent males to improve their body weight and muscle mass.

MATERIALS AND METHODS

Study design and subjects

This repeated measures design study was conducted among underweight male

students at the Princess Chulabhorn Science High School Chiang Rai (PCSHSCR), which is a boarding school, based on pre-specified inclusion and exclusion criteria. The inclusion criteria were underweight and underfat males aged between 12 and 15 years with a body mass index (BMI)-for-age below the <5th percentile (De Onis, Onyango & Borghi, 2007) and body fat-for-age below the 2nd percentile (McCarthy *et al.,* 2006). The exclusion criteria were those with chronic diseases, e.g. liver disease, kidney disease, heart disease, thyroid disease, thalassaemia, and the presence of injuries in the past six months before intervention. Out of 34 volunteers, only nine adolescents met the inclusion criteria for BMI and body fat percentage. Therefore, only nine low body weight and low body fat adolescent males were selected for this study. According to a priori calculation, nine participants in each intervention period were sufficient to generate a power of 0.8 at an alpha level of 0.05 for dependent measures, based on previous studies (Hammami *et al.,* 2016). This study was divided into three periods, with eight weeks for each period: baseline (BL) period, high protein diet without exercise (HP) period, and high protein diet with resistance exercise (HP-E) period.

Dietary intake

All subjects maintained their usual dietary intake during the BL period; they were allowed to eat *ad libitum* and 24-hour dietary intake was recorded everyday by themselves throughout the study period.

In the HP and HP-E periods, in order to increase the body weight of underweight males to normal body weights and provide adequate energy for their energy expenditures, their total energy requirements were derived from the Harris–Benedict equation × activity factor (1.200 in HP for sedentary living and 1.375 in HP-E for moderate activity). Hence, the amount of protein intake was 1.6-1.7 g/kg/d, as recommended by the International Olympic Committee (IOC). The use of 24-hour dietary records were monitored by the researchers throughout the HP and HP-E periods. The energy and protein content of each meal was calculated and subsequent meals were prepared by the school cafeteria for the subjects, under the supervision of the researchers. Compliance of subjects with the daily prescribed food intake was 100%.

Basal metabolic rate (BMR) was estimated so that underreporting of energy intake (EI) could be evaluated. A cut-off value of 0.9 was used to define underreporting of EI in terms of EI:BMR ratio (Kye *et al.,* 2014). When EI:BMR was <0.9, subjects were classified as under-reporters. Only one subject in the BL period was an under-reporter.

Exercise

In the HP-E period, subjects engaged in three resistance training sessions each week with upper body (push-ups, dips, bridges, and planks) and lower body (squats and lunges) exercises on Monday, Wednesday, and Friday at school. Each exercise session lasted approximately 45-60 minutes (excluding ten-minute warm-up and cool-down periods). All sessions were supervised by the researchers. The format and relative intensity of the training protocols for push-ups, dips, squats, and lunges composed of two sets of eight repetitions in week one, three sets of eight repetitions in weeks 2-3, and three sets of 12 repetitions in weeks 4-8. The format and relative intensity of the training protocols for bridge and plank exercises involved maintaining the correct position for the maximum possible time.

Body composition assessment
Body composition was assessed weekly on early Monday morning before breakfast. Height was measured by using a calibrated stadiometer (Seca model 216, USA). Body weight (kg), body fat (% of body weight), fat mass (kg), fat-free mass (FFM, kg), predicted muscle mass or bone-free lean tissue mass (LTM, kg), and total body water (%) were assessed using a Tanita BC-418MA segmental body composition analyser (Tanita Co. Ltd., Japan). Hand grips were used to allow the BC-418 model to assess segmental body composition. Muscle circumferences, including those for the abdomen, arm, buttock, calf, forearm, hip, mid-thigh, and waist circumferences were assessed according to the American College of Sports Medicine (ACSM) guidelines for exercise testing and prescription.

Biochemical assessment
Biochemical measurements were conducted at the BL, HP, and HP-E periods and included measurements of haemoglobin, fasting blood sugar (FBS), total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C), triglyceride, serum uric acid, blood urea nitrogen (BUN), and creatinine. These parameters were analysed using an automated blood BS-400 Chemistry Analyzer (Mindray Bio-Medical Electronics Co., Ltd. Shenzhen, China).

Dietary assessment
Energy and nutrient intakes were recorded for 24 hours, and dietary intake was calculated using the INMUCAL-Nutrients version 3 software provided by the Institute of Nutrition, Mahidol University. Estimated branch chain amino acid (BCAA) intake was calculated based on the amino acid content in foods according to the USDA National Nutrient Database for Standard Reference: USDA ARS (Agricultural Research Service, U.S. Department of Agriculture) (Table 1).

Strength tests
There were three procedures for the strength tests: muscle power was measured using a broad jump, and muscle endurance was measured using push-ups and sit-ups. To evaluate muscle power and endurance of the subjects, ratings of interpretation (poor, fair, average, good, and excellent) were used to classify them according to the standard of physical fitness for Thai adolescents aged 7-18 years (Samahito, 2012).

Self-esteem
Self-esteem was assessed using the Thai Five-Scale Test of Self-Esteem for Children (FSC). The FSC consisted of five areas and 36 items: seven academic items, five body image items, nine family items, seven social items, and eight global items (Putthisri & Silpakit, 1998).

Ethical approval and permission
This study, including the protocol and consent forms for students and their parents, was approved by the Ethics Committee at the Faculty of Medicine, Ramathibodi Hospital, University of Mahidol. Written informed consent was obtained from students and their legal guardians.

Ethical clearance
The study was approved by the Ethical Clearance Committee on Human Rights Related to Research Involving Human Subjects, Faculty of Medicine, Ramathibodi Hospital, Mahidol University (ID11-58-23).

Statistical analysis
Statistical analysis was performed using SPSS statistics version 15.0. General data, economic and social data, and nutritional status (anthropometric,

biochemical, and dietary data) were presented as mean (±standard deviation, SD) or percentage. The differences in body composition, biochemical data, dietary data, physical fitness scores, and self-esteem scores were determined by repeated measures ANOVA. *P*-values <0.05 were considered as statistically significant.

RESULTS

Total energy intake during the BL period had a range of 1135-1493 kcal/day and was 72.6-88.8% of the energy requirement (Table 1). In the HP period, the average total energy intake was 107.4% of the energy requirement. The last period was the HP-E period, and the average total energy intake was close to the energy requirement (94.9%). However, energy intake in the HP-E period was not significantly different from that in the HP period.

In the BL period, protein intake of all subjects ranged from 1.7-2.1 g/kg/d, which was higher than the Thai RDA (1.2 g/kg/d) (Bureau of Nutrition, 2020). In addition, 70.3-84.4% of the total protein intake was derived from animal protein. The mean estimated total BCAA intake (isoleucine, leucine, and valine) was 13.78 g/d (18.3% of total protein). In the HP period, mean protein intake was 2.34±0.14 g/kg/d, ranging from 2.23-2.45 g/kg/d, which was higher than the International Olympic Committee (IOC) and American College of Sports Medicine (ACSM) recommendations for strength and endurance athletes. The average protein intake in the HP-E period was 2.14±0.15 g/kg/d, which was lower than that in the HP period (2.34 g/kg/d). The average protein and animal protein intake in the HP and HP-E periods were significantly different from that in the BL period. However, no significant difference in animal protein intake or percentage of BCAA intake was observed between the HP and HP-E periods (Table 1).

Tables 2 shows the body composition of subjects in each period. In the HP and HP-E periods, LTM and muscle

Table 1. Energy intake, energy distribution, and protein and total BCAA intakes of subjects during BL, HP and HP-E periods (mean±*SD*)

Parameters	*BL period (n=9)*	*HP period (n=9)*	*HP-E period (n=9)*
Energy requirement, kcal	1591±67	1655±74[a]	1913±90[ab]
Energy intake, kcal	1310±113	1778±128[a]	1806±98[a]
% of energy requirement	82.2±4.9	107.4±6.7[a]	94.9±5.6[ab]
Energy distribution, % of total energy			
Carbohydrate	49.9±2.6	45.9±2.0[a]	49.5±1.5[b]
Protein	23.4±1.5	22.7±1.2	20.5±0.6[ab]
Fat	26.5±1.5	31.3±1.2[a]	29.8±1.2[ab]
Protein, g/d	75.2±5.5	99.6±5.5[a]	92.3±6.3[ab]
g/kg/d	1.8±0.1	2.3±0.1[a]	2.1±0.1[ab]
Animal protein, g/d	58.8±5.3	83.5±4.9[a]	73.4±5.9[a]
% of total protein	78.2±4.0	83.8±1.3	79.4±0.9[b]
Vegetable protein, g/d	14.7±3.5	15.1±1.3	17.6±0.6[b]
% of total protein	19.5±4.2	15.2±1.1	19.1±0.9[b]
Total branched-chain amino acids, g/d	13.7±1.0	18.5±0.8[a]	17.2±1.2[ab]
% protein	18.3±0.1	18.6±0.2[a]	18.6±0.1[a]

[a] Significant difference from the BL period: $p<0.05$, [b] Significant difference from the HP period: $p<0.05$.

Table 2. Height, body weight, BMI, body fat, lean tissue mass, muscle circumference, strength test results, and self-esteem scores among subjects during the different study periods (mean±*SD*)

Parameters	*BL period (n=9)*	*HP period (n=9)*	*HP-E period (n=9)*
Height, cm	161.2±5.1	164.0±4.8[a]	165.0±4.8[ab]
Weight, kg	40.1±2.3	43.0±2.7[a]	43.5±2.9[a]
BMI (kg/m^2)	15.4±0.2	15.9±0.2[a]	15.9±0.3[a]
Body fat, %	4.7±1.0	6.0±0.8[a]	5.8±0.9[a]
LTM, kg	36.2±2.1	38.3±2.4[a]	38.8±2.6[a]
Right arm, kg	1.6±0.1	1.7±0.1[a]	1.7±0.1[a]
Left arm, kg	1.6±0.1	1.7±0.1	1.7±0.1[a]
Right leg, kg	6.7±0.6	7.0±0.8	7.1±0.8[ab]
Left leg, kg	6.7±0.6	6.9±0.8	7.0±0.8
Trunk, kg	19.3±1.6	20.8±1.4[a]	21.0±1.3[a]
Circumference, cm			
Upper arm	19.1±0.6	19.9±0.9[a]	20.2±1.1[a]
Forearm	19.7±0.7	20.1±1.3	20.3±1.3[a]
Buttock	78.6±3.1	79.2±3.5	79.3±3.4[a]
Mid-thigh	38.2±1.4	38.7±1.7	38.9±1.7[a]
Calf	29.9±1.3	30.2±1.5	30.5±1.5[a]
Waist	60.1±2.6	61.2±2.6[a]	61.2±2.6[a]
Abdomen	62.0±2.5	63.2±2.4[a]	63.3±2.5[a]
Hip	67.2±3.3	68.2±3.3[a]	68.2±3.3[a]
Strength tests			
Push-ups (30 sec)	14.6±3.3[2]	16.3±5.2[a2]	19.6±5.0[ab2]
Sit-ups (60 sec)	34.6±8.0[3]	38.4±6.2[a4]	44.0±4.9[ab4]
Broad jump (cm)	182.4±25.2[4]	191.2±25.0[a4]	205.0±21.6[ab4]
Self-esteem score			
Academics	9.4±1.6	9.7±1.0	10.0±1.8
Body image	6.5±2.1	6.6±1.7	7.6±1.7[ab]
Family	14.7±1.9	14.5±2.4	15.1±2.5
Global	10.8±1.6	11.3±2.3	12.2±2.1
Social	10.1±2.0	9.8±2.3	10.3±3.7

[a] Significant difference from the BL period: $p<0.05$
[b] Significant difference from the HP period: $p<0.05$
BMI: body mass index, LTM: lean tissue mass
The meaning of the symbol for Strength tests: [1]poor, [2]fair, [3]average, [4]good, and [5]excellent

circumferences (upper arm, waist, abdomen, and hip) were significantly higher than those in the BL period. Muscle strength (measured by push-ups and sit-ups) and muscle power (measured by broad jump) were significantly improved in both HP and HP-E periods compared to BL period. The highest muscle strength and power levels were observed in the HP-E period ($p<0.05$) (Table 2). In addition, mean self-esteem score for body image in the HP-E period was statistically, significantly higher than in the HP period. However, no significant differences were observed in the self-esteem scores for academics, family, global, and social among the BL, HP, and HP-E periods (Table 2).

Table 3. Body weight, lean tissue mass, and muscle circumference change - normal growth rate, % per 8 weeks

Parameters	*HP period (n=9)*	*HP-E period (n=9)*
Normal weight status, *n*	4	4
Body weight change – normal growth rate	1.06	0.88
LTM change – normal growth rate	0.56	0.56
Trunk LTM change – normal growth rate	1.70	1.44
Upper arm (MC change – normal growth rate)	0.15	0.23
Calf (MC change – normal growth rate)	0.28	0.44
Waist (MC change – normal growth rate)	0.52	0.41
Abdomen (MC change – normal growth rate)	0.26	0.17
Hip (MC change – normal growth rate)	0.33	0.23

LTM: lean tissue mass, MC: muscle circumference

After the HP and HP-E periods, subjects had weight gain at a normal growth rate of 1.06% and 0.88% per 8 weeks, respectively, and four out of nine underweight subjects had a normal weight status in the HP and HP-E periods (Table 3).

Table 4 shows the biochemical parameters including haemoglobin, FBS, TC, HDL-C, LDL-C, triglyceride (TG), serum uric acid, BUN, and creatinine in each period. All subjects' biochemical parameters were within the normal range during the BL, HP, and HP-E periods. In the HP and HP-E periods, HDL-C and HDL-C/TC ratio were significantly higher than those in the BL period. In the HP-E period, HDL-C and HDL-C/TC ratio, and TG were significantly different from those in the HP period.

DISCUSSION

Underweight young men looking to increase muscle and body mass may rely on commercial whey proteins where their purity and safety may not be guaranteed. Aside from that, whey protein may cause

Table 4. Blood biochemical parameters of subjects during the different study periods (mean±*SD*)

Parameters	*BL period (n=9)*	*HP period (n=9)*	*HP-E period (n=9)*
Haemoglobin, g/dL	14.4±1.7	14.2±1.4	14.3±1.1
FBS, mg/dL	86.6±5.7	85.5±5.0	83.1±4.0
TC, mg/dL	154.7±28.1	161.0±25.7	149.5±28.7
HDL-C, mg/dL	57.4±13.9	62.5±14.7[a]	49.5±13.4[ab]
LDL-C, mg/dL	86.4±21.9	87.8±19.8	87.1±22.4
LDL-C/HDL-C ratio	1.51±11.8	1.40±12.6[a]	1.76±14.71[ab]
TG, mg/dL	55.3±16.0	53.2±13.1	64.8±10.5[b]
Serum uric acid, mg/dL	5.8±0.8	5.7±0.5	5.4±0.7
BUN, mg/dL	11.5±2.5	11.2±3.0	11.0±2.2
Creatinine, mg/dL	0.69±0.09	0.72±0.09	0.70±0.08

[a]Significant difference from the BL period: $p<0.05$
[b]Significant difference from the HP period: $p<0.05$
FBS: fasting blood sugar, TC: total cholesterol, HDL-C: high density lipoprotein cholesterol, LDL-C: low density lipoprotein cholesterol

some adverse effects such as delivering a marked acid load to the kidneys, increasing the risk for stone formation, decreasing estimated calcium balance, and possibly increasing the risk for bone loss (Reddy *et al.,* 2002). Thus, caution should be exercised when using whey protein as a protein supplement. High protein diets combined with resistance training exercise may be a safer option for improving body weight and muscle mass.

In the BL period, total energy intake was 72.6-88.8% of the energy requirement, which may have caused all subjects to be underweight. Protein quality was assessed by protein, animal protein, and BCAA intakes. The mean protein intake of all subjects was 1.87 g/kg/d, which was higher than the Thai RDA (1.2 g/kg/d) (Bureau of Nutrition, 2020) and consistent with a study on adolescents in Baham, Cameroon (Kenmogne-Domguia, Ponka & Fokou, 2016). The study in Baham showed that protein intake of all subjects was significantly higher than their needs, while energy intake was significantly lower than their needs (p<0.05). The high prevalences of stunted growth and wasting in males are related to the relatively low energy intake, which could divert amino acids for energy production.

In the HP period, subjects received energy and protein intakes of 1778 kcal/d (107.4% of energy requirement) and 2.30 g/kg/d, respectively; the extra energy and protein intakes came from their own snacks, which subjects were allowed to eat *ad libitum* in addition to their main meals. Pereira *et al.* (2013) suggested that children have been gradually putting on weight due to a small but persistent daily positive energy gap, from 70 to 160 kcal above that is necessary for the growth process. This was consistent with the total energy intake in the HP period, which was higher than the energy requirement by 123 kcal. High protein intake in the HP period, which was more than that in the BL period by approximately 25.1%, increased body weight and LTM by 1.06% and 0.56%, respectively, when compared with the normal growth rate in the BL period (Table 3).

In the HP-E period, subjects had a total energy intake higher than that in the HP period because of their energy expenses for resistance exercise. The importance of maintaining energy balance is to preserve healthy body weight while increasing LTM. Negative energy balance generally results in muscle mass loss, the extent of which corresponds to the degree and duration of the deficit incurred (Murphy *et al.,* 2018). In the HP-E period, protein intake was not different from that in the HP period, 2.14 g/kg/d, which was 144.38% higher than that recommended by the Thai RDA (Table 1). In the HP-E period, resistance training exercise combined with a high protein intake (2.14 g/kg/d) increased body weight and LTM by 0.5 kg and 0.5 kg, respectively. The important role of amino acid availability in regulating muscle protein synthesis (MPS) in response to amino acids, protein ingestion, and exercise has been reported (Glass, 2010). In addition, exercise enhanced the ability of skeletal muscle to respond to amino acid provision. The most likely contributing mechanism is an exercise-induced increase in blood flow to the muscle that increases the delivery of amino acids to the muscle, thus increasing the provision of substrate for MPS (Glass, 2010).

In addition, resistance training for eight weeks in the HP-E period increased arm, leg, and trunk muscle strength by 20.2%, 7.2%, and 14.5%, respectively, more than a high protein diet alone during the HP period. Faigenbaum *et al.* (2007) studied the effect of a nine-week

resistance training on 22 middle school students aged 13.9 years. Their study indicated that subjects significantly improved arm muscle strength (bench press) by 15.0% and leg muscle strength (vertical jump) by 5.0%, which were close to the results of our study. In the HP-E period, calf and mid-thigh circumferences increased by 0.12% and 0.06% per week, respectively, from the HP period. Our findings are consistent with those of Piazza *et al.* (2014), who studied the effect of resistance training in young athletes aged 11.9±1.0 years and found that after six weeks of resistance training, calf and mid-thigh circumferences increased by 0.11% and 1.30% per week, respectively, from baseline.

After subjects had resistance training in the HP-E period, muscle strength and muscle power significantly improved when compared to HP period. However, no significant difference in LTM was observed between the HP and HP-E periods (Table 2). Our findings are consistent with the findings of Ormsbee *et al.* (2011) that resistance training enhanced muscle protein synthesis and increased muscle strength and hypertrophy. Protein and amino acid supplements have been shown to augment physiological improvements associated with resistance training, such as increasing body composition, muscular strength, and hypertrophy, while suppressing exercise-induced proteolysis. However, increasing strength and power after resistance training in both pre-adolescents and adolescents are usually attributed to increased neuromuscular activation and coordination, rather than muscle hypertrophy (Harries, Lubans & Callister, 2012). A review of physiological adaptations following resistance training in youth athletes revealed adaptive processes in the neural system (Legerlotz *et al.,* 2016). It is well documented that both neural and morphological factors contribute to increased muscle strength, as well as improved contraction characteristics in healthy adults, particularly in the early stage of training onset (Carroll *et al.,* 2011). Regarding the effects of training in children, there seems to be general agreement that such neural adaptation appears to be the predominant mechanism responsible for exercise-induced strength, rather than muscle morphological changes (Behm *et al.,* 2008).

In the HP and HP-E periods, subjects received a high protein diet. To assess safety, we evaluated biochemical parameters, including BUN and creatinine. There have been no reports of protein-induced diminutions in renal function despite subject populations that are generally at risk for kidney disease (Martin, Armstrong & Rodriguez, 2005). Antonio *et al.* (2015) studied the effect of eight weeks of resistance training exercise combined with high protein intake from whey or beef protein powder in 17 healthy males and females, with an average age of 24.8 years. Subjects in the normal protein group and high protein group consumed 2.3 g/kg/d and 3.4 g/kg/d of dietary protein, respectively, during the intervention period. They found that BUN and creatinine levels were not significantly different between the normal protein group and the high protein diet group. Our study found that a high protein intake of 2.3 g/kg/d and 2.1 g/kg/d in the HP and HP-E periods, respectively, did not affect BUN and creatinine levels, which were within normal limits throughout the study.

LDL-C concentration has been the prime index of cardiovascular disease risk and the main target for therapy. However, a previous study suggested that TC/HDL-C and LDL/HDL cholesterol ratios are risk indicators with greater

predictive value than isolated parameters used independently, particularly the former (Millán *et al.,* 2009). TC/HDL-C ratio should be less than 4.5 and 4.0 in men and women, respectively. LDL/HDL cholesterol ratio should be less than 3.0 and 2.5 in men and women, respectively (Gotto AM *et al.,* 2003). A recommended ratio is not available for adolescents yet. However, if we applied this ratio to the subjects, we found that all subjects had TC/HDL-C and LDL/HDL cholesterol ratios of lesser than 4.5 and 3.0, respectively, throughout the study. This study found significant increase in TG in the HP-E period. Consistent to Patel *et al.* (2015)'s study, they found that TG increased 13.6 mg/dl after eight weeks of resistance training intervention. The increased TG could be resulted from a greater need for fuel delivery, including a greater reliance on oxidative fuels such as fat, during resistance training, although this requires confirmation (Patel *et al.,* 2015). However, TG levels of all subjects in our study remained within normal levels.

The present study of eight weeks resistance training on lipid profile in underweight adolescent males showed that resistance training may increase TG, decrease HDL-C, and tended to decrease TC and LDL-C, but there were no statistically significant differences. Our findings were similar with the results of lipid profile in overweight males on eight weeks resistance training, which found that resistance training tended to increase TG, decrease TC, LDL-C, and HDL-C, but there were no statistically significant differences (Patel *et al.,* 2015).

In the HP-E period, mean self-esteem score for body image was significantly higher than in the HP period. The self-esteem score for body image was in parallel with improvements in body weight and muscle mass change, which is consistent with the finding of Velez, Golem & Arent's (2010). They found that 12 weeks of resistance training exercise in adolescents yielded an increase in self-esteem scores for body image from pre-test to post-test, whereas no change was observed in the control group.

STRENGTHS AND LIMITATIONS

The strengths of the study were that the energy and protein intakes during each meal were calculated by the researchers and related to the subjects' activities, and that the food was prepared by the school cafeteria. Besides that, participants' compliance with dietary intake was 100% throughout the study. The weakness of this study was the short-term period of the study, which may have led to the non-significant difference of LTM change in the HP-E period when compared to the HP period. Therefore, the study duration should be at least 16 weeks for future studies.

CONCLUSION

Eight weeks of resistance training with upper-body and lower-body exercises combined with a high protein diet (2.14 g/kg/d) increased body weight and LTM by 0.5 kg and 0.5 kg, respectively. In addition, resistance exercise predominantly increased muscle strength and power, rather than muscle hypertrophy. The high protein intake did not affect kidney function throughout the study.

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Authors' contributions

WS, principal investigator, conceptualised and designed the study, prepared the draft of the manuscript and reviewed the manuscript; PL, conducted the study, data analysis and interpretation, assisted in drafting of the manuscript, reviewed the manuscript; SP and NT, assisted in drafting of the manuscript, reviewed the manuscript.

Conflicts of interest

None

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The acceptability of weekly iron-folic acid supplementation and its influencing factors among adolescent school girls in Yogyakarta city: a mix-methods study

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ABSTRACT

Introduction: Indonesia has initiated the weekly iron-folic acid supplementation programme (WIFS) among adolescent school girls since 2016. However, its acceptability needs to be investigated. This study aimed to assess the acceptability of WIFS and its influencing factors. **Methods**: A mixed-methods study was conducted in six schools in Yogyakarta from January-April 2018. Totally, 211 participants aged 12-18 years were involved in the cross-sectional survey, followed by four focus group discussions (FGDs) and in-depth interviews (IDIs). Body mass index-for-age, haemoglobin, serum ferritin, habitual intake, and acceptability (defined as self-reported iron folic acid tablet consumption) were assessed. **Results**: This study reported that 22.3% and 12.4% of the participants were categorised as iron deficient and anaemic, respectively. Almost 90% of participants had received the tablet, but only 62.0% of them reported consuming it. Logistic regression test indicated that the participants were more likely to take the tablet if it tasted good [OR (95%CI): 4.66 (1.90-11.43)]. Meanwhile, motivation for tablet consumption declined when respondents perceived the odour of tablet was unpleasant, reported forgetfulness, lacked peer support, and experienced side effects, with OR (95%CI) of 0.23 (0.07-0.77), 0.35 (0.13-0.95), 0.30 (0.08-0.58), and 0.04 (0.04-0.39), respectively. The results from FGD and IDIs strengthened the findings that the experience of nausea, organoleptic properties of iron-folic acid tablet, forgetfulness, and mother's support play important roles in students' acceptability. **Conclusion**: This study found moderate acceptability towards the WIFS programme. The inhibiting and reinforcing factors of WIFS acceptability in this study could be considered as inputs for programme improvements in the future.

Keywords: Adolescent girls, Indonesia, programme acceptability, school-based programmes, weekly iron-folic acid supplementation

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INTRODUCTION

Iron deficiency anaemia (IDA) is the third most important cause for the lost in disability-adjusted life years (DALYs) in adolescents worldwide at 3%, behind alcohol and unsafe sex (Gore *et al.*, 2011). There was a significant increase in the prevalence of anaemia in the population aged 15-24 years from 18.4% in 2013 to 32% in 2018, while data in 2013 showed that anaemia in adolescent girls aged 5-14 years was 26.4% (Kemenkes RI, 2013; Kemenkes RI, 2018) and about 40% in Yogyakarta City (Sudargo, Juffrie & Widiarsanti, 2012). Menstrual blood loss and increasing iron requirements during rapid growth make adolescent girls more vulnerable to be anaemic compared to males (WHO, 2016). Good health and nutritional status of this population will later determine their adult health and their children's health. It is well documented that anaemic women may have more risk to deliver a low birth weight and stunted baby (Koura *et al.*, 2012).

Based on this growing public health problem, the 65th World Health Assembly (WHA) is committed to cut the prevalence of anaemia among adolescent girls and reproductive women in half by 2025 (WHO, 2012). The Government of Indonesia is also committed to reaching this target reduction and has been giving weekly iron-folic acid supplementation (WIFS) through a blanket approach to adolescent school girls as part of the national anaemia control programme since 2016. All adolescent girls at school should receive and consume weekly iron-folic acid (IFA) tablet supplementation throughout the year (Kemenkes RI, 2016). This approach was recommended by the World Health Organization (WHO) for areas where endemic anaemia is > 20% (WHO, 2011). The weekly iron supplementation is known to be more suitable and effective in preventing anaemia among adolescents compared to daily supplementation (Angeles-Agdeppa *et al.*, 1997). However, some factors which influenced the success of this WIFS programme at school were documented such as inadequate IFA tablet supply, lack of awareness and support from school teachers and parents, and low acceptability of the programme (Darnton-Hill & Mkparu, 2015; Roche *et al.*, 2018).

The acceptability of a programme is one of the implementation outcome indicators which is considered particularly important for the success of health intervention, including the WIFS programme (Proctor *et al.*, 2011). The behaviour of adolescent school girls, especially in terms of their degree of uptake and adherence towards the weekly IFA tablet consumption, was defined as acceptability in this case (Sekhon, Cartwright & Francis, 2018). Even though the benefits of IFA tablet supplementation are very well understood and the availability of IFA tablet is more than enough, some uncertainties still exist after the adolescent school girls have received the tablet on whether they will consume it on a weekly basis or not. Some previous studies reported several factors may influence the acceptability of the WIFS programme, such as the support from peers, teachers and parents, the experience of gastrointestinal discomfort, and the organoleptic properties of IFA tablet (Dhikale *et al.*, 2015; Nuradhiani, Briawan & Dwiriani, 2017; Sajna & Jacob, 2017).

The Yogyakarta District Health Office first began implementing this WIFS programme among adolescent school girls with an IFA tablet distribution coverage reaching about 65.4% in 2016. Since this programme is newly implemented and there has been no documentation on the number of IFA

tablets consumed, a study is needed to explore the acceptability and its influencing factors. This study will provide good insights for health policy makers to achieve the main objective of the WIFS programme.

MATERIALS AND METHODS

Setting and study design

This study was conducted from January to April 2018 in two sub-districts in Yogyakarta city with a mixed-methods sequential explanatory approach. The study was conducted in the middle of the WIFS programme implementation in schools. At first, a cross-sectional survey was done to assess the prevalence of iron deficiency anaemia, quantify self-reported consumption of IFA tablets during the previous week, and determine the factors which may influence the acceptability of WIFS among adolescent school girls. Following the survey, qualitative method was subsequently applied to explore and enrich the findings from the cross-sectional survey on adolescent school girls' acceptability and school teachers' experiences towards the WIFS programme. The cross-sectional survey involved 211 participants who were randomly selected among first and second grade registered students from three junior and three senior high schools in Yogyakarta City. All students from the 3rd grade were not involved in the study since the national final exam preparation was held then by each school. The selected six schools were distributed in the Tegalrejo and Gondomanan sub-districts, which were purposely chosen based on the number of IFA supplementation distribution coverage. Tegalrejo and Gondomanan were considered as areas with the highest (100%) and lowest (13%) distribution coverage of the IFA supplementation programme for schools in 2016. The rationale of this area selection method was to identify whether higher proportion of IFA tablet distribution would have a correlation with higher compliance (number of IFA tablet consumed/number of IFA tablet distributed) and hence lesser anaemia prevalence.

Subjects and data collection

The inclusion criteria of subjects were adolescent school girls aged 12-18 years old and willing to participate in the study by completing the informed consent and assent forms. The study team excluded subjects who were menstruating at data and blood sample collection period. All consenting subjects were assessed for their nutritional and anaemia status, habitual food intake, and acceptability towards the on-going WIFS programme in their schools. Their weight and height were measured to determine body mass index (BMI)-for-age *z*-score, which was calculated by using the WHO AnthroPlus version 3.1 software. All respondents provided blood samples for assessing anaemia status based on the laboratory analysis of haemoglobin (Hb) and serum ferritin (SF). The assessments of Hb and SF were done in VitMin Lab, Willstaett, Germany and examined using the Hematoanalyzer KX-21 and ELISA method (Erhardt, 2020), respectively.

Furthermore, a pre-tested semi-quantitative food frequency questionnaire (SQ-FFQ) and a single 24-hour food recall were used to assess the adequacy of recommended intake, while variation in food group consumption was assessed through the Women's Dietary Diversity Score (WDDS) questionnaire (nine food groups) (Kennedy, Ballard & Dop, 2010). The dietary diversity score was categorised into three categories of food frequencies, namely: respondents who consumed ≤3 food groups, 4-5 food groups, and ≥6 food groups in a day and they were defined as low, medium, and

high dietary diversity, respectively. The estimation of nutrient composition from the SQ-FFQ was analysed using the Nutrisurvey software version 2007 with the Indonesian Food Composition Table (IFCT) database. The IFCT was taken from its existing source at http://www.nutrisurvey.de, which was regularly updated and added by the investigators for some packaged foods (i.e., milk, food supplement, biscuits, etc.). A recipe was formulated for mixed dishes that were not found in the available databases. The context of acceptability in this study was defined as how a student complied with consuming IFA tablets every week. This was described by self-reported consumption of the IFA tablets in the previous week. A structured questionnaire was used to measure IFA tablet knowledge, perceptual experience, organoleptic perceptions, and self-reported consumption of IFA tablets in the previous week with its influencing factors.

Qualitative data collection was done after the survey was completed, with four focus group discussions (FGDs) and four in-depth interviews (IDIs). The IDIs were done with a representative among the teachers who were in-charge of the healthy school programme (*Unit Kesehatan Sekolah/UKS)*. The current implementation of WIFS programme in each school (including programme planning, distribution, and reporting), support and programme challenges were collected during IDSs. FGDs were conducted in four out of six schools involved in this study. Two FGDs were done in the selected Junior and Senior High Schools in Gondomanan, and the other two in Tegalrejo, purposively. Each FGD consisted of seven to eight students who were intentionally selected based on the students' self-reported WIFS acceptability from the previous cross-sectional survey. Within each FGD group, students who reported consuming IFA tablets were mixed with students who did not take the tablets. The aim of this mixed group arrangement was to gather more valid information on the facilitating and inhibiting factors of WIFS acceptability among all FGD members. Moreover, the study team also collected information regarding knowledge on anaemia, how the participants received and consumed their IFA tablets, and parental support towards the WIFS programme among these FGD members.

This study was conducted according to the guidelines in the Declaration of Helsinki. All procedures involving human subjects/patients were approved by the Medical and Health Research Ethics Committee, Faculty of Medicine, Universitas Gadjah Mada (No. KE/FK/0902/EC/2017). Written informed consent was obtained from all subjects/participants before their participation in the study.

Data analysis

Descriptive and multivariate analyses were performed by SPSS (Version 20.0). The findings of this study were displayed thematically - with quantitative results, followed and supported by important findings from qualitative results. Tables 1, 3 and Figure 1 are presented based on the sub-district areas to distinguish the findings between areas with high and low distribution coverage of the IFA supplementation tablet programme in 2016. The adequacy of energy and nutrient intakes in Table 2 was calculated based on the adjusted Indonesian recommended dietary allowance (RDA) 2013. The adjusted RDA was determined by comparing the actual body weight of respondents to the reference body weight table and then multiplied it with the RDA of energy and each nutrient.

Statistical significance was tested using the Mann-Whitney test for non-normally distributed data, while chi-squared test was used to measure the

proportions for categorical variables. Furthermore, binary logistic regression test was used to determine the factors which affected acceptability (self-reported IFA tablet consumption) as the main outcome. The following variables were included in the logistic regression test: the residence of subject (sub-district), parent's (mother and father) last education, organoleptic experiences (taste, smell, and colour), perception of IFA tablet (for increasing blood volume, red colour, unfavourable smell, and nausea), factors considered as barriers towards compliance (reported forgetfulness, low peer and parental support, unfavourable appearance, experiencing side effect, and unknown benefit), dietary diversity score, anaemia and iron deficiency, and nutritional status. The backward logistic regression method was used in logistic regression analysis to obtain the presented final model.

Meanwhile, the verbatim transcripts from the FGDs and IDIs were coded based

Table 1. General characteristics and anaemia status of respondents

Variable	*All*	*Sub-district*		*p-value*
		Gondomanan	*Tegalrejo*	
Age, median (*IQR*)	15 (3)	15 (3)	14 (3)	0.13
Iron deficiency (ID)†, *n (%)*				
Yes (<15 ug/L)	47 (22.3)	26 (21.7)	21 (23.1)	0.80
No (≥15 ug/L)	164 (77.7)	94 (78.3)	70 (76.9)	
Haemoglobin (mg/dl), *n (%)*				
Anaemia (<12 mg/dl)	26 (12.4)	18 (15.0)	8 (8.9)	0.18
Normal (≥12 mg/dl)	184 (87.6)	102 (85.0)	82 (91.1)	
BMI-for-age z-score, n (*%)*				
Underweight (<-2 *SD*)	5 (2.4)	3 (2.5)	2 (2.2)	0.98
Normal (-2 *SD* to 1 *SD*)	143 (67.8)	81 (67.5)	62 (68.1)	
Overweight (>1 *SD* to 2 *SD*)	43 (20.4)	24 (20.0)	19 (20.9)	
Obese (>2 *SD*)	20 (9.5)	12 (10.0)	8 (8.8)	
Dietary diversity score, *n (%)*				
Low dietary diversity	30 (14.2)	18 (15.0)	12 (13.2)	0.77
Medium dietary diversity	110 (52.1)	64 (53.3)	46 (50.5)	
High Dietary Diversity	71 (33.6)	38 (31.7)	33 (36.3)	
Mother's last education, *n (%)*				
≤Junior high school	22 (10.4)	5 (4.2)	17 (18.7)	0.01*
Senior high school	86 (40.8)	56 (46.7)	30 (32.9)	
University	103 (48.8)	59 (49.2)	44 (48.4)	
Father's last education, *n (%)*				
≤Junior high school	16 (7.6)	5 (4.2)	11 (12.1)	0.17
Senior high school	96 (45.5)	58 (48.3)	38 (41.8)	
University	99 (46.9)	57 (48.5)	42 (46.1)	
Parent's income‡, *n (%)*				
≤Minimum income rate	73 (34.6)	40 (33.3)	33 (36.3)	0.66
>Minimum income rate	138 (65.4)	80 (66.7)	58 (63.7)	

†Iron deficiency (ID) was defined based on the serum ferritin parameter
‡According to minimum income rate (UMR) in Yogyakarta City, 2017
*There was no significant difference between Tegalrejo and Gondomanan except for mother's last education, $p<0.05$

on the generated evidence or existing concepts and themed accordingly. Each theme was explored and interpreted by the researchers through narrative analysis along with related quotes and stories from participants. Opencode (Version 4.3) application was used to code the verbatim transcripts.

RESULTS

A total of 211 participants with complete information were included in the analysis. About 22.3% and 12.4% of the participants were categorised as iron deficient and anaemic, respectively. The median age of the participants was 15 years old and most of the participants were categorised as having normal nutritional status based on BMI-for-age z-score. There were no significant differences in terms of the prevalence of anaemia and iron deficiency, nutritional status, dietary diversity status, and other general characteristics between adolescent school girls who resided in Gondomanan and Tegalrejo sub-districts, except in the proportion of the last attainment of mother's education (Table 1). The proportion of mothers who graduated from senior high school and university in Gondomanan was higher than in Tegalrejo.

In general, the proportion of students who knew about and had ever received the tablets was not as much as those who consumed it during the last week. The overall number of students who knew about the IFA tablet supplementation in schools were 196 (93.0%) and those who had ever received the tablets were 192 (91.0%). However, of the students who received the tablets, only 131 (62.0%) of them had consumed it within the last week. Compared to the self-reported consumption of IFA tablets among students in Tegalrejo (67.8%), this proportion was slightly higher than in Gondomanan (61.7%) (Figure 1). WIFS acceptability in Tegalrejo was better than Gondomanan, but not statistically different.

The District Health Office of Yogyakarta recommends that IFA tablet supplements are distributed to adolescent school girls weekly throughout the year and the students are

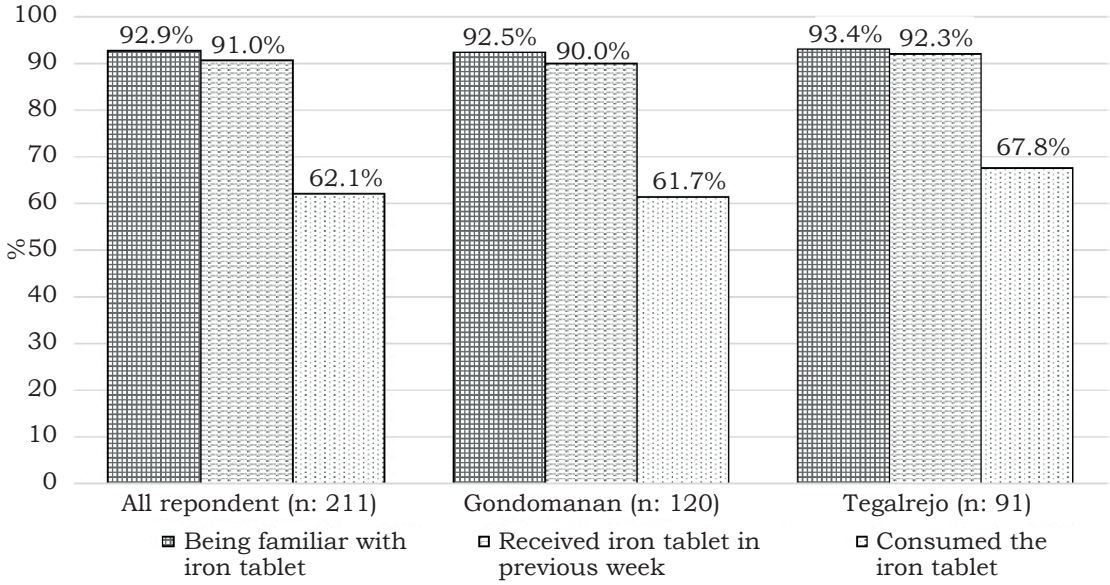

Figure 1. Cascade level of knowledge and practice in iron tablet supplementation

asked to consume the tablets together usually every Friday (Fixed-day WIFS Programme). However, our interviews with the students showed that only one out of six schools applied this method. The remaining schools distributed the IFA tablets on an unscheduled day or even distributed them accumulatively as 12 tablets for three months and without any effort to monitor the adherence.

"Every Friday the tablet was given to us. This method was good for us which means our school's teacher was aware of us. Therefore, we do not need to keep and consume the tablet in our home" (Junior High School student, 13 years old)

Although the Yogyakarta District Health Office has encouraged the teachers and school committee to participate in the monitoring of WIFS compliance, some constraints were reported. Insufficient time, personnel and high workload of teachers in each school were the main reasons for why the "fixed-day" WIFS programme was not applied in almost all schools.

Table 2 reports the proportion of subjects who fulfilled ≥80% of the Indonesian recommended dietary allowance (RDA) in this study. Most of subjects met the expected RDA for vitamin A (retinol) and folic acid, but not for the remaining energy and nutrients such as carbohydrate, fat, protein, vitamin C, Vitamin B12, and iron, which was even ranked as the least achieved. The distribution of WDDS food group consumption (nine groups) from a single 24-hour food recall supported the findings of inadequacy of these nutrients, which showed that the consumption of fruits and vegetables, as well as sources of animal protein (red meat) were the lowest proportion among other food groups at about 35.1% and 6.2%, respectively.

Table 3 describes some impressions from the participants about the IFA tablets to evaluate their knowledge and perceptions towards these tablets. More than 90% of participants who resided in Gondomanan and Tegalrejo wrongly assumed that the IFA tablets may elevate "blood volume". Blood volume was defined by students as the actual amount of blood circulating in the human system. Some students also thought that IFA tablets were characterised with the colour red (24.8%), fishy smell (14.8%), and may make them nauseated (5.6%). Besides that, the various reasons which explained why some students rejected to consume the IFA tablets were also captured in Table 3. The unfavourable organoleptic properties of IFA tablets (26.2%) and the lack of peer support (26.2%) were recognised as common factors for why some adolescent school

Table 2. The proportion of intake adequacy related to each nutrient among participants (*N*=211), based on the Indonesian recommended dietary allowance (RDA)†

Energy and Nutrients	*Median (IQR)*	*RDA*	*% (≥ 80% RDA)*
Energy (kcal)	1822 (1038)	2312	51.2
Carbohydrate (g)	275.7 (164.9)	317.0	60.2
Fat (g)	56.3 (35.2)	77.0	44.1
Protein (g)	56.9 (42.3)	68.0	54.5
Vitamin A as Retinol (mcg)	1094.4 (716.1)	656.0	91.0
Vitamin C (mg)	54.8 (66.6)	74.0	45.0
Iron (mg)	7.5 (7.8)	28.0	13.3
Folic Acid (mcg)	124.0 (116.1)	439.0	91.9
Vitamin B12 (mcg)	2.1 (2.5)	2.5	52.1

†According to adjusted Indonesian RDA 2013

girls did not take it as a supplement, while the other 18.0% of participants in the study reported that they forgot about storing and consuming the IFA tablets. Furthermore, the experience of side effects, lack of knowledge related to the benefits of IFA tablets, and the role of parent support were also some aspects which influenced the students' motivation towards consuming the IFA tablets.

The findings from Table 3 were confirmed by the results of FGDs and IDIs with students and teachers, for example in the following quotes from the participants:

".....there was a complaint from the student after they took the tablet. They felt nausea and the odour like fishy smell...but overall they have no problem with it other than that..." (Teacher in Senior High School)

"I left the tablet in the school and put it in the desk rack...then I forgot to consume it" (Student in Junior High School, 14 years old)

The role of the parents in supporting the nutrition programme to increase compliance of the WIFS programme is also essential. Some students and teachers highlighted this as follows.

"My parent did not recommend me to consume this tablet (IFA), because my mother said that I do not need it, just leave it. Since my doctor and mother do not recommend me to consume it so then I would not take it up ....." (Student in Senior High School, 16 years old).

"Yes... from our experience in 2017, one student gave the tablet back to us. She told me that she was prohibited by her parent who was a doctor" (Teacher in Junior High School).

Table 4 shows the determinants that influence WIFS acceptability among the subjects. Variables that did not contribute significantly as determinants of WIFS acceptability were removed from the final model, which are presented in Table 4, i.e., study area, mother's and father's last education, etc. The organoleptic

Table 3. The participants' first responses regarding iron tablet supplements and reasons for not taking the tablets

Variety of reasons	*All* *n (%)*	*Gondomanan* *n (%)*	*Tegalrejo* *n (%)*
Impression of iron tablet supplement, *N*=196			
May increase "blood volume"	180 (91.8)	101 (91.0)	79 (93.0)
Red colour appearance	48 (24.8)	27 (24.3)	21 (24.7)
The fishy smell	29 (14.8)	18 (16.2)	11 (13.0)
May make nauseated	11 (5.6)	4 (3.6)	7 (8.2)
Reasons for the participant to not consume the tablet, *N*=61			
The taste and appearance are not interesting	16 (26.2)	6 (17.6)	10 (37.0)
My friend does not consume it as well	16 (26.2)	6 (17.6)	10 (37.0)
Forget to store and take it	11 (18.0)	10 (29.4)	1 (3.7)
Being nauseated	2 (3.3)	1 (3.0)	1 (3.7)
Do not know the benefits	2 (3.3)	2 (5.9)	0 (0.0)
The parents do not encourage to take it	2 (3.3)	0 (0.0)	2 (7.4)

Table 4. Determinant factors of WIFS acceptability using multivariate logistic regression test (*N*=169)†

Factors	*Consumed iron tablet n (%)*	*Adj OR (95% CI)*	*p-value*
Taste experience			
Like	99 (86.8)	4.66 (1.90 – 11.43)	<0.01*
Dislike	32 (54.2)	Ref	
Nutritional status			
Underweight	5 (100.0)	7.99 (0.00 – 0.00)	0.44
Normal	112 (60.2)	0.24 (0.02 – 2.12)	
Obese	16 (80.0)	Ref	
The smell is not good (perception)			
Yes	13 (44.8)	0.23 (0.07 - 0.77)	0.02*
No	118 (70.7)	Ref	
Reported forgetfulness			
Yes	50 (82.0)	0.35 (0.13 – 0.95)	0.04*
No	58 (49.2)	Ref	
Not answered	23 (88.5)	-	
My friend does not consume it as well (peer support)			
Yes	16 (48.5)	0.30 (0.08 - 0.58)	0.03*
No	92 (63.0)	Ref	
Not answered	23 (88.5)	-	
Side effect (nausea)			
Yes	15 (88.2)	0.04 (0.04 - 0.39)	<0.01*
No	93 (57.4)	Ref	
Not answered	23 (88.5)	-	

†There were 27 out of 196 subjects excluded due to missing data
*Factors were significantly associated with WIFS acceptability, $p<0.05$

properties of the IFA tablets, particularly the taste, had a significant association with the willingness of respondents to consume the tablets. The respondents were more likely to take the tablet if it tasted good [OR (95%CI): 4.66 (1.90-11.43)]. Meanwhile, once the respondent has perceived that the odour of the tablet was not good, forgot to take and consume the tablet, had low peer support, and experienced side effects, the possibility of the respondent to take the iron tablets declined, with OR (95%CI) of 0.23 (0.07-0.77), 0.35 (0.13-0.95), 0.30 (0.08-0.58), and 0.04 (0.04-0.39), respectively. Respondents had more willingness to take the tablets if their close friends shared good experiences regarding IFA tablet consumption and conversely.

DISCUSSION

This study reported that about 22.3% and 12.4% of the participants were iron deficient and anaemic, respectively. There were no significant differences in the prevalences of anaemia, iron deficiency, and acceptability between the areas with high (Tegalrejo) and low (Gondomanan) IFA tablet distribution coverage. Nearly nine out of ten participants had received IFA tablet supplementation, however only 62% of them had taken the supplement based on self-reporting consumption interviews. This study found that the organoleptic properties and the perceptions of IFA tablets, reported forgetfulness, role of peer support, and experience of side

effects after consuming IFA tablets were determinant factors that significantly influenced WIFS acceptability among adolescent school girls.

The reinforcing factors

This study showed that peer and parental support was positively correlated with high adherence. Other studies described that improving motivation by parents and good sharing experiences from close friends were facilitating factors for the success of weekly IFA supplementation programme in schools (Dhikale *et al.*, 2015; Nuradhiani, Briawan & Dwiriani, 2017). Therefore, engaging parents of adolescent girls concerning the programme may help to improve the compliance level of the girls with WIFS (Dubik *et al.*, 2019).

Moreover, since the health issue includes eating behaviour of adults, which is also likely to be influenced by their peers (Salvy *et al.*, 2012), school-peer group also has a significant impact for increasing the acceptability among adolescent school girls in this study. Peer support was defined as the giving of assistance and encouragement by an assumed equal individual (Dennis, 2003). The theory of the Health Belief Model revealed that the adherence of self-managed treatment regimens, including iron tablet supplementation, might be improved through the mechanism of functional support based on sharing of information and experience, mutual counselling, and exchange among peer support groups (Nechitilo *et al.*, 2016).

The inhibiting factors

This study found that the organoleptic properties of IFA tablets, reported forgetfulness, and side effects were primary causes of low acceptability among adolescent school girls. The organoleptic aspects of the iron tablets, especially the flavour, was one of the determinant factors of acceptability among respondents. Some previous studies described various efforts to improve this issue, for example, the programme in India modified the colour appearance of the tablet from red to blue (Aguayo, Paintal & Singh, 2013), another in Mexico added favourable odour into IFA tablets such as vanilla or chocolate (Morales *et al.*, 2007), and one in Canada converted the IFA supplements from tablet to powder, even though the bio-availability of iron absorption requires further investigation and improvement (Hartman-Craven *et al.*, 2009).

India, who implemented a large-scale national IFA supplementation among adolescent girls, also documented that the most reported reason for low compliance was forgetfulness (Aguayo, Paintal & Singh, 2013). A similar study conducted in East Java, Indonesia described more details on the reason of low compliance among adolescent girls: being lazy, bored, losing the tablet, and lack of awareness (Susanti, Briawan & Martianto, 2016). The programme of fixed-day WIFS at schools is one of the best actions to avert the issue of reported forgetfulness. This fixed-day activity of doing IFA tablet consumption together at school has additional benefits, both to enable the monitoring of compliance and to prevent the common reason of forgetfulness among students for not consuming the tablets. Moreover, if the teachers are able to deliver anaemia and health education prior to initiating the programme, it may raise the adherence of students through improvement of their knowledge, perceptions, and behaviour (Bandyopadhyay *et al.*, 2017). Collaboration and commitment among the district health office, district education, and religious affair office are essentially needed to facilitate the schools or *madrasah* (Islamic schools) in providing the allocated time for this programme. The lessons learnt by Roche and colleagues who implemented

a multi-sectoral project of weekly iron supplementation for adolescent girls in West Java provides an ideal example (Roche *et al.*, 2018).

The other inhibiting factor which was faced as a challenge within this programme was the side effects experienced, especially gastrointestinal problems. Two studies revealed that the experiences of nausea, vomiting, black stool, and diarrhoea were frequently reported as causes of low acceptability towards iron supplementation programme (Dhikale *et al.*, 2015; Sajna & Jacob, 2017). Some efforts can be performed to avoid these reported side effects, such as eating a meal before consuming the IFA tablets, taking the IFA tablets in smaller doses by cutting the tablet into two and consuming it in the morning and afternoon/evening, and if the side effects cannot be avoided during IFA consumption day at school, the adolescent girls are suggested to consume the tablet at night (after dinner and before going to bed) (SABM, 2013).

One of the limitations of this study was the method of measuring acceptability, which only used self-reported consumption instead of using direct observation or log books for IFA tablet consumption. During the period when this study was conducted, the programme output of WIFS only measured the coverage of IFA tablet distribution, but not the actual compliance. Therefore, this study measured the acceptability of IFA tablet consumption through asking whether the participants consumed the IFA tablets in the previous week. The strength of this study was that it is the first published study in Indonesia aimed to assess the acceptability of WIFS programme among adolescent school girls using a mixed-methods design. The findings of this study can be used as an input for the improvement of WIFS programme in the future.

Recommendations for WIFS Programme improvement

Arranging a special session or specific day every week for consuming the IFA tablets together and inserting a fun breakfast session prior to the programme may solve some inhibiting factors which were found in this study. The fixed-day programme may prevent forgetfulness of taking the tablet since it will be done together within the school. Moreover, it may ease the process of programme monitoring and reporting. Meanwhile, the fun breakfast session, combined with some health and nutrition education sessions, could be conducted in advance to reduce gastrointestinal discomfort after consuming IFA tablets and increase the health awareness among students (Bandyopadhyay *et al.*, 2017; SABM, 2013).

In addition to that, creating a supportive environment is ultimately required to assure programme sustainability through increasing demand and support for the project among stakeholders in the school system, including school headmasters, school committee, teachers, parents, and the students themselves, who are especially essential to the success of the programme. The experiences of implementing behaviour change communication (BCC) strategy by Nutrition International and communication for development (C4D) strategy by United Nations Children's Fund (UNICEF) for health and nutrition adolescent programmes provide some excellent examples for promoting healthy role models (Roche *et al.*, 2018; UNICEF, 2007).

CONCLUSION

The technical and practical barriers of IFA supplementation programme, especially among adolescent school girls, based on the previous discussion are still

challenging. The acceptability, which was defined as self-reported consumption of IFA tablets in this study, was moderate. The prevalence of iron deficiency and anaemia were found to be 22.3% and 12.4%, respectively. Considering the prevalence of iron deficiency and anaemia in addition to the inadequacy of energy and some nutrients intake in this study, the blanket approach for IFA supplementation programme for adolescent school girls is still needed. However, the reinforcing factors which were found in this study, i.e. peer, parental and school support should be maintained and promoted, while the various inhibiting factors (barriers), i.e., reported forgetfulness, side effects, and organoleptic properties of IFA tablet should be carefully managed for future improvement of the WIFS programme.

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Authors' contributions

MRA, designed the protocol of the study, analysed the data, led the first article drafting; BJIK, designed the protocol of the study; NK, designed the protocol of the study, analysed the data; DY, led the data collection and compiled all verbatim transcripts; MF, led the data collection and compiled all verbatim transcripts; RF, led the data collection and compiled all verbatim transcripts. All authors had reviewed and agreed to the content of the manuscript.

Conflict of interest

The authors report no conflicts of interest in this work. This work was supported by a grant from the Medical Faculty of Universitas Gadjah Mada. The Medical Faculty of Universitas Gadjah Mada had no role in the design, analysis or writing of this article.

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Fruit and vegetable intake among overweight and obese school children: A cluster randomised control trial

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ABSTRACT

Introduction: Adequate daily intake of fruits and vegetables is crucial for the prevention of chronic diseases. This study aimed to determine the effects of My Body is Fit and Fabulous at School (MyBFF@school) with nutrition education intervention (NEI) on the stages of change for fruit and vegetable intake among overweight and obese secondary school children based on the trans-theoretical model (TTM). **Methods:** This was a cluster randomised controlled trial involving 15 out of 415 eligible government secondary schools in central Peninsular Malaysia, which were randomly assigned into intervention (six schools; 579 school children) and control (nine schools; 462 school children). The intervention group was given NEI for 24 weeks, while the control group followed the existing school programme by the Ministry of Education. **Results:** There was no significant difference between the intervention and control groups for the stages of change, with majority at the maintenance stage after six months (intervention: 34.9%; control: 39.0%). The within group analysis showed a significant reduction after six months for those at the action stage (action and maintenance stage) from 68.0% to 60.4% in the intervention group and from 71.4% to 65.6% in the control group. However, there was a significant increase among those with adequate fruit and vegetable intake in the intervention group and no significant increase in the control group. **Conclusion:** MyBFF@school with NEI based on TTM provided acceptable changes in fruit and vegetable intake among overweight and obese secondary school children.

Keywords: Trans-theoretical model, nutrition education intervention, childhood obesity, secondary school children, cluster randomised controlled trial

INTRODUCTION

Adequate fruit and vegetable consumption is crucial for the prevention of chronic diet related non-communicable diseases such as heart disease, stroke and some cancers (van't Veer & Kampman, 2007). The Malaysian Dietary Guidelines (MDG) 2010 recommends eating at least

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two servings and three servings of fruits and vegetables per day, respectively. Findings from the National Health and Morbidity Survey (NHMS) showed that there was a reduction from 48.4% in 2012 to 31.5% in 2017 of Malaysian adolescents who consumed at least two servings of fruits per day (IPH, 2013; IPH, 2017). Only 6.3% of adolescents consumed vegetables as recommended, although there was an increment to 7.8% in 2017 (IPH, 2013; IPH, 2017). Thus, it remains a great challenge for the country to ensure adequate intake of fruits and vegetables, particularly among adolescents.

Although there were studies reporting on the prevalence of adequate intake of fruits and vegetables among adolescents, there are however very few studies applying specific behavioural health models to assess the effects of fruit and vegetable intake using nutrition education intervention (NEI). Thus, one of the common behavioural models which is useful and used in fruit and vegetable consumption is the Trans-theoretical Model (TTM) (Vakili & Khadem-Rezaiyan, 2016; Davoodi *et al.*, 2017). The TTM consists of five stages of change, namely pre-contemplation, contemplation, preparation, action, and maintenance. Intervention programmes with TTM application is one of the effective ways to increase fruit and vegetable intake, encouraging those who are at pre-contemplation, contemplation, and preparation stages to change into an action/maintenance stage (Johnson *et al.*, 2008; Davoodi *et al.*, 2017).

Since behavioural change is a complex process which involves sequence of stages, assumption is usually made that the majority of them are not ready to change their behaviours. Thus, adolescents or school children might not consume fruits and vegetables because they are still at the pre-contemplation stage or are not aware of the importance of taking adequate fruits and vegetables. Despite that, there are also assumptions that individuals in the action and maintenance stages are more likely to have a higher intake of fruits and vegetables. Our study was conducted as little is known on the readiness of older adolescents or secondary school children to consume adequate fruits and vegetables. Since school children are spending most of their time in schools, school-based NEI could appear as one of the most effective strategies to educate and inculcate adequate intake of fruits and vegetables, particularly among overweight and obese secondary school children. It is important to understand the individual's behaviour and also to consider the stage of change of each individual target group before any nutrition education to increase their fruit and vegetable intake is undertaken. Therefore, this study was conducted with its aim to understand the effects of My Body is Fit and Fabulous at School (MyBFF@school) with NEI on the stages of change for fruit and vegetable intake based on TTM among overweight and obese secondary school children as compared to school children following the existing school nutrition and health programmes.

MATERIALS AND METHODS

The data collected were part of the MyBFF@school intervention study to combat obesity among Malaysian school children. The obesity intervention package for MyBFF@school comprised of nutrition education, physical activity, and psychology. One of the components in the NEI was the use of TTM to assess intake of fruits and vegetables. This study was a school-based cluster randomised controlled trial (Figure 1). Fifteen out of 416 eligible government secondary schools from the three states (Federal Territory of Kuala Lumpur,

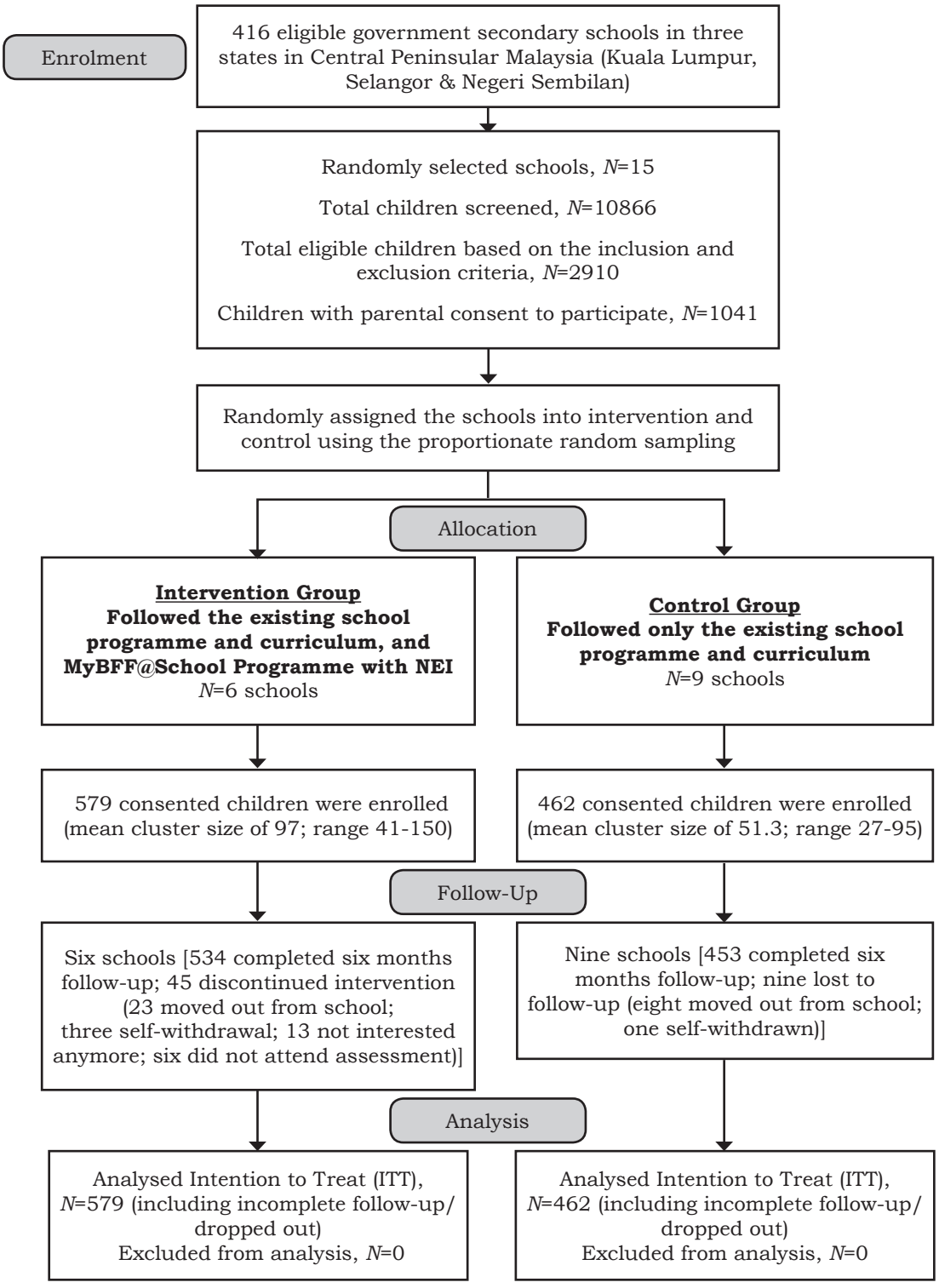

Figure 1. CONSORT diagram for nutrition component in MyBFF@school

Selangor, and Negeri Sembilan) in central Peninsular Malaysia were randomly assigned into intervention (six schools; 579 school children) and control (nine schools; 462 school children), taking into consideration the urban and rural classification used by the Ministry of Education Malaysia. The government schools were wholly run by the central government. Thus, the target population were school children aged 13, 14, and 16 years old for participation in the study. Those aged 15 and 17 years old were excluded since they were involved in the National Examination. The intervention group undergone the MyBFF@school programme with NEI, while the control group remained with the current school nutrition and health programmes. This study was approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia (NMRR NO: 13-439-16563) and was registered at ClinicalTrials.gov with Identifier: NCT04155255. Written informed consent was obtained from parents or guardian prior to the study.

Nutrition education intervention (NEI)

The NEI was specifically designed to tackle childhood obesity within the framework of the MyBFF@school programme. The Nutrition Education Module (NEM) consisted of five topics, which were divided into several sub-topics. These five topics were, Wake up call/time to act; My body weight/know my body weight; Eat well, be well; Make a better life; and MyBFF. Some of the sub-topics covered included challenges in body weight loss and management, body weight status and risk factors, the importance of breakfast, fruit and vegetable intake, healthy meal preparation, smart shopping, and tips for eating out. NEI was carried out by trained personnels using the NEM during co-curriculum activities time after school hours for 24 weeks. NEI sessions were held once every two weeks for 40-60 minutes per session at alternate weeks. The Malaysian Childhood Obesity Treatment Trial (MASCOTT) was used as a reference and guidance to develop the NEIs (Wafa *et al.*, 2011). All NEIs were carried out using interactive methods with practical sessions.

Trans-theoretical Model (TTM) for fruit and vegetable intake

A validated TTM questionnaire for fruit and vegetable intake behaviour was adapted from Povey *et al.* (Povey *et al.* 1999). This TTM questionnaire or algorithm was also later adapted in 2014 by Wong *et al.* (2014). In summary, the TTM stages of change applied in our study were as follows:

i) Pre-contemplation: The individual does not intend or seriously think about increasing fruit and vegetable intake in the next six months.
ii) Contemplation: The individual does not plan to continue trying to increase fruit and vegetable intake over the next six months.
iii) Preparation: The individual does not plan to continue trying and confident that he/she can change his/her diet to increase fruit and vegetable intake over the next six months.
iv) Action: The individual has already increased consumption of fruit and vegetable in his/her daily diet or he/she has been eating five servings of fruits and vegetables daily for the past one month or within one to five months.
v) Maintenance: The individual has already been consuming at least five servings of fruits and vegetables daily for at least six months.

All the five stages of change have been collapsed or further categorised

into pre-action (pre-contemplation, contemplation, and preparation) and action (action and maintenance).

Nutrition attitude on fruit and vegetable intake

The attitude of school children towards fruit and vegetable intake was assessed using a pre-tested questionnaire. A similar questionnaire was used for both pre- (baseline) and post- (after six months) assessments. This questionnaire was developed by the MyBFF@school nutrition intervention component team. There were only two questions that measured fruit and vegetable attitude, as part of the fifteen-item nutrition attitude questionnaire. The attitude on fruit and vegetable was measured on a five-point Likert scale, ranging from strongly disagree (1 point) to strongly agree (5 points). There are two types of attitudes - positive and negative. For positive attitudes, the order of the Likert scale was as follows: strongly agree (5 points), agree (4 points), neutral (3 points), disagree (2 points), and strongly disagree (1 point). As for negative attitude, the order of the Likert scale was reversed as follows: strongly agree (1 point), agree (2 points), neutral (3 points), disagree (4 points), and strongly disagree (5 points).

Intake of fruits and vegetables

Fruit and vegetable intake was measured using a guided quantitative food frequency questionnaire (FFQ) for the past one week. In a guided quantitative FFQ, school children were guided by the interviewer to facilitate the understanding of serving size. This FFQ was developed using a similar approach for the FFQ on fruit and vegetable intake adopted from the WHO STEPwise Approach for Surveillance of NCD (WHO, 2005), which was previously used in the NHMS 2011 and NHMS 2015 in Malaysia. Therefore, no reliability and validity tests were conducted. Standard household utensils and food album were used to facilitate the quantifying of fruit and vegetable intake, which was later transformed into standard serving size measurements.

Statistical analysis

All the study data were managed using REDCap electronic data capture tool, which is a web-based application designed to support data capture for research studies (Harris *et al.*, 2009). Data analyses were run using SPSS version 20 (SPSS Inc., Chicago, IL., USA). Descriptive statistics were used to present the baseline data. All analyses were based on the intention to treat analysis (ITT), taking into consideration dropped outs and incomplete data collection. Since loss to follow-up is often difficult to avoid in a randomised trial, the ITT principle was therefore used and it requires all participants in the trial to be included in the group regardless of any departure from the randomised treatment. In our study, the McNemar's test was used for within group analysis for categorical data to determine whether school children in the intervention and control groups who were at the pre-action stage (pre-contemplation, contemplation, and preparation) and action stage (action and maintenance) have changed after six months as compared to baseline. Chi-square test was applied for other categorical data. Independent t-test was used to compare the mean attitude on fruit and vegetable intake between groups, while paired t-test was used to analyse the mean intake of fruits and vegetables within the group at baseline and after six months. Results were considered statistically significant at $p<0.05$.

RESULTS

Characteristics of the respondents at baseline

The demographic characteristics of the respondents at baseline from the cluster of six intervention schools (*n*=579 school children) and nine control schools (*n*=462 school children) are shown in Table 1. Overall, majority of the respondents were Malays (79.0%), living in urban areas (64.1%), and girls (58.7%), with an equal percentage (41.2%) of the respondents aged 13 and 16 years, respectively.

The stages of change on fruit and vegetable intake

Overall, there was no significant difference on the stages of change on fruit and vegetable intake between the intervention and control groups, both at baseline and after six months, although there was a slight reduction among those at the maintenance stage for both intervention and control groups at 34.9% and 39.0%, respectively, as shown in Table 2(i). However, the within group analysis showed a significant difference after six months, in which a reduction from 68.0% to 60.4% was observed for those at the action stage (action and maintenance stage) in the intervention group and from 71.4% to 65.6% in the control group.

Intake of fruits and vegetables

There was an overall significant increase in the adequate intake of fruits and vegetables after six months from 17.8% to 28.0% (McNemar χ^2=17.99, p<0.01) in the intervention group and from 20.6% to 26.6% (McNemar χ^2=4.54, p<0.05) in the control group (Table 3). However, the adequate intake of at least five servings of fruits and vegetables among those in the pre-action stage and action stage of the intervention group was only significantly increased from 25.9% to 36.2% (McNemar χ^2=4.84, p<0.05) and from 14.0% to 24.1% (McNemar χ^2=12.86, p<0.01), respectively (Table 3).

Table 1. Demographic characteristics of the respondents at baseline

Characteristics of the respondents	*Intervention (N=579)*	*Control (N=462)*	*Total (N=1041)*
Sex, *n* (%)			
Boys	234 (40.4)	196 (42.4)	430 (41.3)
Girls	345 (59.6)	266 (57.6)	611 (58.7)
Location, *n* (%)			
Urban	330 (57.0)	337 (72.9)	667 (64.1)
Rural	249 (43.0)	125 (27.1)	374 (35.9)
Age groups, *n* (%)			
13 years	261 (45.1)	168 (36.4)	429 (41.2)
14 years	79 (13.6)	104 (22.5)	183 (17.6)
16 years	239 (41.3)	190 (41.1)	429 (41.2)
Ethnicity, *n* (%)			
Malay	486 (83.9)	337 (72.9)	823 (79.0)
Chinese	32 (5.5)	30 (6.5)	62 (6.0)
Indian	58 (10.0)	95 (20.6)	153 (14.7)
Others	3 (0.5)	0 (0.0)	3 (0.3)
BMI status, *n* (%)			
Overweight	252 (43.5)	226 (48.9)	478 (45.9)
Obese	250 (43.2)	189 (40.9)	439 (42.2)
Morbidly obese	77 (13.3)	47 (10.2)	124 (11.9)

Table 2. Stages of change on fruit and vegetable intake among overweight and obese secondary school children

i) Between intervention and control groups

Stages of change	*At baseline (N=1041)*				*After six months (N=1041)*			
	Intervention n (%)	*Control n (%)*	χ^2	*p-value*	*Intervention n (%)*	*Control n (%)*	χ^2	*p-value*
Pre-contemplation	25 (4.3)	14 (3.0)	7.58	0.11	48 (8.3)	33 (7.1)	3.10	0.54
Contemplation	7 (12.0)	14 (3.0)			19 (3.3)	13 (2.8)		
Preparation	153 (26.4)	104 (22.5)			162 (28.0)	113 (24.5)		
Action	169 (29.2)	147 (31.8)			148 (25.6)	123 (26.6)		
Maintenance	225 (38.9)	183 (39.6)			202 (34.9)	180 (39.0)		

Chi-square test

ii) Within intervention and control groups

Stages of change	*Intervention (n=579)*				*Control (n=462)*			
	At baseline n (%)	*After six months n (%)*	χ^2	*p-value*	*At baseline n (%)*	*After six months n (%)*	χ^2	*p-value*
Pre-action†	185 (32.0)	229 (39.6)	9.835	<0.01**	132 (28.6)	159 (34.4)	4.306	0.03
Action‡	394 (68.0)	350 (60.4)			330 (71.4)	303 (65.6)		

†Pre-action stage (pre-contemplation, contemplation, and preparation)

‡Action stage (action and maintenance)

McNemar's Test; *p<0.05, **p<0.01

Table 3. Intake of fruits and vegetables among overweight and obese secondary school children

Fruit-vegetable intake by stages of change	*Intervention (n=579)*				*Control (n=462)*			
	Baseline	*After six months*	χ^2	*p-value*	*Baseline*	*After six months*	χ^2	*p-value*
Overall‡								
Number of servings, mean±SD	3.03±1.65	3.15±2.01		0.26	3.19±1.79	3.41±2.16		0.09
Overall†, *n* (%)								
<5 servings	476 (82.2)	417 (72.0)	17.99	<0.01**	367 (79.4)	340 (73.6)	4.54	0.03*
≥5 servings	103 (17.8)	162 (28.0)			95 (20.6)	122 (26.4)		
Pre-Action[a] (n_i=185, n_c=132)								
Number of servings, mean±SD‡	3.32±1.80	3.48±2.14		0.43	3.41±1.90	3.82±2.47		0.14
Pre-Action[a]†,*n* (%)								
<5 servings	137 (74.1)	118 (63.8)	4.84	0.03*	96 (72.7)	88 (66.7)	0.94	0.33
≥5 servings	48 (25.9)	67 (36.2)			36 (27.3)	44 (33.3)		
Action[b] (n_i=394, n_c=330)								
Number of servings, mean±SD‡	2.90±1.56	3.00±1.52		0.42	3.10±1.74	3.24±2.01		0.33
Action[b]†, *n* (%)								
<5 servings	339 (86.0)	299 (75.9)	12.68	<0.01**	271 (82.1)	252 (76.4)	3.34	0.07
≥5 servings	55 (14.0)	95 (24.1)			59 (17.9)	78 (23.6)		

[a]Pre-action stage (pre-contemplation, contemplation, and preparation)
[b]Action stage (action and maintenance)
[i]Intervention group; [c]Control group
†McNemar's test; *p<0.05, **p<0.01
‡Paired t-test

Although there was an overall increment in the mean intake of fruits and vegetables after six months, the mean number of daily fruit and vegetable intake were lesser than five servings and was not significant in both intervention and control groups (Table 3). Both NEI and existing school health education were thus found to have a positive effect on the adequate intake of fruits and vegetables among school children in this study.

Attitude on fruit and vegetable intake by stages of change between groups

Attitudes were represented by 'I like to eat fruits' (positive) and 'I don't like to eat vegetables' (negative). As shown in Table 4, there was no significant difference on the attitude towards fruits for all stages of change, in both intervention and control groups at baseline. However, after six months, the only significant difference was noted for fruit intake at pre-contemplation. As for vegetable intake at baseline, although there was a significant difference between the intervention and control groups at preparation stage, there was however no significant difference after six months. In contrast, there was a significant difference in vegetable intake after six months at the maintenance stage.

Table 4. Attitude towards fruit and vegetable intake by stages of change

Attitude towards fruit and vegetable intake according to stages of change	*At baseline*			*After six months*		
	Intervention (n=579) mean±SD	*Control (n=462) mean±SD*	*p-value*	*Intervention (n=579) mean±SD*	*Control (n=462) mean±SD*	*p-value*
Pre-contemplation						
I like to eat fruits†	3.08±1.32	2.36±1.65	0.17	3.06±1.73	2.12±1.58	0.02*
I don't like to eat vegetables‡	2.72±1.02	3.07±1.21	0.34	2.42±1.03	2.30±0.81	0.60
Contemplation						
I like to eat fruits†	3.29±1.38	3.79±1.37	0.44	3.11±1.49	3.69±1.18	0.24
I don't like to eat vegetables‡	3.14±1.07	3.43±1.22	0.61	3.63±1.01	3.46±1.13	0.66
Preparation						
I like to eat fruits†	4.29±0.81	4.13±0.87	0.15	3.95±1.17	3.75±1.23	0.18
I don't like to eat vegetables‡	3.63±1.32	3.21±1.29	0.01*	3.41±1.32	3.44±1.26	0.83
Action						
I like to eat fruits†	4.37±0.83	4.35±0.85	0.84	4.03±1.09	4.15±0.93	0.31
I don't like to eat vegetables‡	3.38±1.33	3.56±1.32	0.23	3.34±1.20	3.50±1.28	0.32
Maintenance						
I like to eat fruits†	4.54±0.67	4.57±0.73	0.66	4.37±0.81	4.32±0.79	0.59
I don't like to eat vegetables‡	3.88±1.30	3.96±1.23	0.54	3.76±1.31	4.02±1.12	0.04*

†5-point Likert scale for positive attitude (5-strongly agree, 4-agree, 3-neutral, 2-disagree, 1-strongly disagree)

‡5-point Likert scale for negative attitude (1-strongly agree, 2-agree, 3-neutral, 4-disagree, 5-strongly disagree)

Independent t-test; *$p<0.05$

DISCUSSION

Our present study was undertaken to assess the effects of NEI on the stages of change in the daily consumption of fruits and vegetables among overweight and obese older school children. A within group analysis in our study showed that the school children who were at the pre-contemplation, contemplation, and preparation stages at baseline or prior to the programme constituted 32.0% of those in the intervention group and 28.6% in the control group. In contrast, 29.2% and 31.8% of the children in the intervention and control groups were at the action stage, respectively, which indicated that they had already been consuming at least five servings of fruits and vegetables for less than six months. The findings of our study also showed that at baseline, 38.9% and 39.6% of school children for both intervention and control groups were at the maintenance stage, respectively. This indicated that these groups of school children had already had at least five servings of fruits and vegetables per day for at least six months and were trying to avoid relapse. However, the findings of our study observed a slight reduction or some relapse among those at the maintenance stage after six months, with only 34.9% for the intervention group and 39.0% for the control group.

There was a significant difference after six months, whereby a reduction was observed from 68.0% to 60.4% in the intervention group and from 71.4% to 65.6% in the control group of those at the action stage (action and maintenance stage). However, there was a significant increase (McNemar's Test, $p<0.05$) in the percentage of those with adequate intake of at least five servings of fruits and vegetables daily in the intervention group - from 25.9% to 36.2% for those at the pre-action stage and from 14% to 24.1% for those at the action stage. It was reported that individuals who are at the action stage (action and maintenance stage) are more likely to follow a better diet than individuals in the pre-action stage, with a higher consumption of fruits and vegetables in older adults (Greene *et al.,* 2004). The findings of our study are however not consistent with the findings of this mentioned study and also a school-based obesity intervention designed to improve nutrition and physical activity habits among slightly younger American adolescents aged 12 years for the same duration. In this study, it was reported that most respondents were in the action stage after the intervention (Purswani *et al.,* 2017), thus such intervention is beneficial to increase fruit and vegetable consumption among school children. In our study, despite a slight reduction of those in the action stage in the intervention group, the percentage of those with adequate intake of fruits and vegetables was significantly increased in the intervention group.

Achieving or maintaining any positive behavioural change especially among overweight and obese school children is an arduous challenge. The respondents generally moved to different stages after the NEI. The application of TTM to study fruit and vegetable intake behaviour in our study required respondents to answer whether they were currently consuming at least five servings of fruits and vegetables daily for the past six months. In our study, school children who were at the maintenance stage in the intervention group had reduced from 38.9% to 34.9%, which indicated some relapse. Thus, relapse to previous behaviours may occur at any stage and various factors may contribute to this. Any intervention programme usually consists of several methods including some practical aspects, while others may focus only on theoretical approaches. Irrespective of the approach used, the

respondents should have high motivation and emotional strength in order to avoid possible temptations that could lead to a relapse between state of changes (Prochaska & Velicer, 1997; Purswani *et al*, 2017). A study by Gur *et al* (2019) among school children aged 9-15 years old in Istanbul however showed no relapse was observed during the follow-up period for the intake of fruits and vegetables. Since our study focused only on school-based intervention and not multi-component interventions at both home and school, it was rather challenging in designing the intervention that suited the level and stages of change of these school children. Apart from that, this relapse is possibly attributed by the lack of a school environment that supports the consumption of fruits and vegetables such as the availability or free access to fruits and vegetables in the school canteen, and also the lack of parental support to eat adequate fruits and vegetables at home. Despite these constraints, the application of TTM to facilitate the behavioural change for consumption of fruits and vegetables among overweight and obese school children in our study can be very beneficial. In our study, MyBFF@School with NEI had some positive effects in increasing the intake of fruits and vegetables among overweight and obese school children, both at the pre-action and action stages of change, after six months of participation in the programme.

The ability of nutrition education to help form positive attitudes towards healthy eating habits in children is recognised, although these attitudes are applied in practice less frequently (Stojan, Janez & Verena, 2012). Our study revealed that NEI had a different impact on the intake of fruits and vegetables among obese and overweight secondary school children according to their stages of change. At certain TTM stages, NEI formed a positive attitude towards eating fruits and vegetables, but there were also an increase in negative attitudes after NEI. In our study, NEI was shown to benefit secondary school children at pre-contemplation stage, which eventually formed positive attitudes towards fruits and vegetables after the intervention. Previous study noted that nutrition education did not always exert a positive influence on a person's nutrition behaviour, however, such intervention could affect their attitudes, intentions and other factors that may influence their behaviour indirectly (Conner & Armitage, 2002). A positive attitude towards healthy eating habits encourages school children to follow the daily recommendations as healthy habits, which subsequently leads to a healthy body and life (Harrington, 2016).

As for the strengths of the study, this study was designed as a randomised cluster controlled trial and has taken into consideration several parameters such as ethnicity and strata (urban versus rural). Therefore, it was representative of the Malaysian population and the findings of the study can be adopted or inferred to other schools in the country. However, our study's limitation was the challenge of ensuring full participation of school children in the intervention activities, especially among urban school children due to logistic problems, apart from the lack of involvement from parents.

CONCLUSION

MyBFF@school with NEI based on TTM had positive effects on the adequate intake of fruits and vegetables among obese and overweight secondary school children. The application of TTM helped us to understand the behaviours or attitudes of these children towards fruits and vegetables for the development

of a better and more effective obesity intervention programme. It is suggested that parents, teachers, and school administration work together to ensure a supportive environment, with the implementation of multi-component interventions to provide continuous access or availability to fruits and vegetables at home and school for school children.

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Authors' contributions

RS, principal investigator for nutrition component, conceptualised and designed the study, administered the data collection, conducted the data analysis, prepared the draft manuscript and reviewed the manuscript; NAAA, JR, NZ, WNAWM and ANI contributed to conception and design, interpretation and preparation of the draft manuscript; AY contributed to conceptualisation, formal analysis, methodology and writing of the review; MYJ, FMZ, ZI and AHM contributed to conception and design and providing critiques.

Competing interests

The authors declare that they have no competing interests.

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Energy and protein intakes are associated with stunting among preschool children in Central Jakarta, Indonesia: a case-control study

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ABSTRACT

Introduction: Stunting is a major nutritional problem in Indonesia. The prevalence of stunting in DKI Jakarta province was relatively high at 27.5% in 2013 and 17.7% in 2018. This study aims to describe nutrient intakes of children aged 25-30 months and to determine the proportional differences in nutrient intakes between stunting and normal children in Central Jakarta, Indonesia. **Methods:** A case-control study with a total sample of 121 children aged 25-30 months was conducted in Gambir and Sawah Besar sub-districts, Central Jakarta, where the prevalence of stunting was high. All children were exclusively breastfed for at least four months and had similar socio-economic levels. Data collected included height measurement, questionnaire-based interview, and 24-hour food recall. *T*-test and chi-square test were used to investigate the differences between two groups and logistic regression was used in multivariate analysis. **Results:** Factors associated with stunting were energy intake (*AOR*=6.0; 95% CI=1.0-35.0) and protein intake (*AOR*=4.0; 95% CI=1.1-15.5) after controlling for fat, carbohydrate, vitamin C, iron, and zinc intakes. The percentage of children with energy intake below the recommendation was much higher in stunted children (86.1%) compared to normal children (43.5%). Similarly, the percentage of children with protein intake below the recommendation was very much higher among stunted children (30.6%) compared to 8.2% in normal children. **Conclusion:** Children who lacked energy and protein intakes were at a higher risk of stunting than children who had sufficient intakes. Macronutrient intakes are important and should be consumed in sufficient quantities every day to prevent stunting.

Keywords: Stunting, energy intake, protein intake, preschool children, nutrient intake

INTRODUCTION

Stunting is a growth and development disorder that occurs in children aged 0-59 months, defined as length/height-for-age <-2 standard deviations (SD) according to the World Health Organization (WHO) growth standards (WHO, 2010). According to WHO, stunting is caused by malnutrition, recurrent infections, and inadequate psychosocial stimulation. The short-term impact of stunting is related to

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the reduction of cognitive and physical developments in childhood, while the long-term impact of stunting is related to reduced productivity and work capacity as adults, as well as increased risk of degenerative diseases in the elderly (Hoddinott *et al.*, 2013; Leroy & Frongillo, 2019).

In Indonesia, stunting is still a major nutritional problem in under-five children. In 2018, the prevalence of stunting in Indonesia was 30.8%, which meant that one in three toddlers in Indonesia was stunted (MOH RI, 2018). The prevalence of stunting in DKI Jakarta province, a capitol city of Indonesia, is also relatively high at 27.5% in 2013 and 17.7% in 2018 (MOH RI, 2018). The highest stunting prevalence in DKI Jakarta is occupied by the Central Jakarta area (29.2%), namely in Gambir and Sawah Besar sub-districts.

Direct factors that influence stunting are infection status and nutrient intake. Nutrient intake in infants, both macronutrient and micronutrient intakes, has a major role in growth (as measured by growth charts) and prevention of growth faltering (Elshazly & Haridy, 2018; Mzumara *et al.*, 2018). Energy deficits occurring in under-five children would cause growth retardation and loss of fat and muscle (Tessema *et al.*, 2018). Case-control studies on children in Iran and Bangladesh have shown a significant relationship between low carbohydrate intake and stunting (Esfarjani *et al.*, 2013; Iqbal *et al.*, 2019). Research has also shown the relationship between children's fat intake and stunting. Fat is a major component of many hormones, one of which is leptin, which has an effect on bone growth (Briend, Khara & Dolan, 2015; Mikhail *et al.*, 2013).

Studies show that stunting is influenced by low intake of protein. Protein is significantly related to a child's length or height (Arsenault & Brown, 2017; Ghosh, 2016; Michaelsen *et al.*, 2019). Chronic protein deficiency in under-five children causes growth to be impeded and becomes lower compared to growth standards. A survey on 75,548 children in 39 low- and middle-income countries showed that children who did not consume protein had a 1.4 times greater risk of stunting (Krasevec *et al.*, 2017).

It is known that some micronutrients (vitamins and minerals) play important roles in the growth and development of children and thus have a relationship with stunting (Iqbal *et al.*, 2019; Mikhail *et al.*, 2013). Many studies have shown the positive contribution of vitamins A and C to the growth of healthy children (Mora, Iwata & Andrian, 2008; Pasricha & Biggs, 2010). Among minerals, studies have shown an association of calcium, iron, and zinc deficiency with stunting (Esfarjani *et al.*, 2013; Iqbal *et al.*, 2019; Pasricha & Biggs, 2010).

This study aims to describe nutrient intakes of children aged 25-30 months and to determine the proportional differences in nutrient intakes between stunting and normal children aged 25-30 months in Gambir and Sawah Besar sub-districts, Central Jakarta, Indonesia. In the study area, to obtain a sufficient number of children younger than 24-month old with stunting was difficult, therefore, we extended the age range to 30 months old. The percentages of children 25 months old and those older than 25 months were 70.2% and 29.8%.

MATERIALS AND METHODS

This study was an observational study with a case-control design using quantitative approach. The study was conducted in Gambir and Sawah Besar sub-districts, Central Jakarta from October to December 2019. These sub-districts have the highest stunting

prevalences in Central Jakarta District. Respondents were 121 children aged 25-30 months old divided into two groups: 36 children in the case group and 85 children in the control group. To calculate the minimum sample size in this study, the two proportions formula was used. Based on previous research, it was found that the largest number of sample was 35 children. The case-control ratio used to determine the sample was 1:2, thus the number of cases was 35 children and number of controls was 70 children. However, when data collection was carried out, there were 36 children who came to the Integrated Health Service Post (*Posyandu)* for the case group and 85 children for the control group, hence all of them were included as research subjects.

Respondents resided in the Gambir sub-district (townships of Cideng, Petojo Utara, Petojo Selatan, and Duri Pulo) and in the Sawah Besar sub-district (townships of Karang Anyar, Mangga Dua Selatan, Kartini, and Pasar Baru). The case group consisted of children who were stunted at the start of the study based on anthropometric measurements conducted by enumerators, with stunting defined as height-for-age *z*-score <-2SD, while the control group had children who were not stunted at the time of the study. Matched co-variables were history of exclusive breastfeeding for at least four months and socio-economic level derived from *Posyandu* data in the same region.

The dependent variable in this study was stunting and the independent variables were macronutrient intakes (energy, protein, fat, and carbohydrate) and micronutrient intakes (vitamin A, vitamin C, calcium, iron, and zinc). Confounding variables in this study were the number of family members, father's education, mother's education, father's occupation, mother's occupation, family income, mother's nutritional knowledge, and infectious diseases.

Primary data collection was carried out by six enumerators with a background in public health nutrition education from the Faculty of Public Health, University of Indonesia. Enumerators were trained for two days with materials related to stunting, interview methods, and data collection mechanism in the field. Nutritional status data based on height-for-age and weight-for-age were obtained from anthropometric measurements. Measurement of height was carried out twice to get accurate results. The instrument used was a microtoise with duplo measurement. To get accurate results, calibration was carried out before taking measurements. Daily consumption and nutrient intakes were collected using the 24-hour food recall method in the beginning of the study, and food intake data were converted to nutrient intakes using Nutrisurvey (free license).

After data cleaning, univariate and bivariate analyses were conducted using chi-square and independent *t*-test. Variables with *p*-values <0.25 in the bivariate analysis were included in the multivariate analysis using logistic regression. Odds ratios (with 95% confidence intervals, CI) were calculated to determine the relationship between stunting and independent variables. Collinearity and interactions between the independent variables were examined and no collinear variables were found.

Before the interview, respondents were informed about the research and asked about his/her willingness to take part in the research. Respondents were also asked to fill in and sign an informed consent. This research has been approved by the Ethics Commission of the Research and Community Service Institute at Atma Jaya University (Reference number: 1154/III/LPPM-PM.10.05/09/2019).

RESULTS

Data from a total of 121 respondents aged 25-30 months were successfully collected. The results of the study showed that stunting was more common in boys (61.1%). Both stunted (72.2%) and non-stunted (69.4%) children had small family size. Father's education in stunted and non-stunted children were similar, which was high school. Most fathers of both groups had work (94.4% in the case group and 96.5% in the control group), while most mothers do not work (83.3% in the case group and 77.6% in the control group). Both stunted and non-stunted children tended to come from families with low incomes.

Based on the mother's education, there was a significant difference between stunted and non-stunted children, namely 52.8% of stunted children had

Table 1. Characteristics of children aged 25-30 months in case and control groups

Variables	*Case n=36*	*Control n=85*	*Total respondents n=121*	*p-value*
		n (%)		
Gender of children				
Male	22 (61.1)	37 (43.5)	59 (48.8)	0.12
Female	14 (38.9)	48 (56.5)	62 (51.2)	
Number of family members				
Large (>4 people)	10 (27.8)	26 (30.6)	36 (29.8)	0.93
Small (≤4 people)	26 (72.2)	59 (69.4)	85 (70.2)	
Father's education				
Low, ≤Junior High School	12 (33.3)	27 (31.8)	39 (32.2)	1.00
High, ≥Senior High School	24 (66.7)	58 (68.2)	82 (67.8)	
Mother's education				
Low, ≤Junior High School	19 (52.8)	24 (28.2)	43 (35.5)	0.02*
High, ≥Senior High School	17 (47.2)	61 (71.8)	78 (64.5)	
Father's occupation				
Does not work	2 (5.6)	3 (3.5)	5 (4.1)	0.63
Work	34 (94.4)	82 (96.5)	116 (95.9)	
Mother's occupation				
Does not work	30 (83.3)	66 (77.6)	96 (79.3)	0.65
Work	6 (16.7)	19 (22.4)	25 (20.7)	
Family income				
<Minimum salary level	26 (72.2)	47 (55.3)	73 (60.3)	0.12
≥Minimum salary level	10 (27.8)	38 (44.7)	48 (39.7)	
Mother's nutrition knowledge				
Low	14 (38.9)	27 (31.8)	41 (33.9)	0.58
High	22 (61.1)	58 (68.2)	80 (66.1)	
ARI history				
Yes	9 (25.0)	18 (21.2)	27 (22.3)	0.82
No	27 (75.0)	67 (78.8)	94 (77.7)	
Diarrhea history				
Yes	6 (16.7)	8 (9.4)	14 (11.6)	0.35
No	30 (83.3)	77 (90.6)	107 (88.4)	

*Statistically significant at *p*-value ≤0.05

Table 2. Proportions of macronutrient and micronutrient intakes among children with and without stunting

Variables	*Case n=36*			*Control n=85*			*p-value*
	Less (<80% RDA)	*Good (≥80% RDA)*	*Mean intake*	*Less (<80% RDA)*	*Good (≥80% RDA)*	*Mean intake*	
	n (%)			*n (%)*			
Macronutrient							
Energy	31 (86.1)	5 (13.9)	864.7	37 (43.5)	48 (56.5)	1344.9	<0.01*
Protein	11 (30.6)	25 (69.4)	29.7	7 (8.2)	78 (91.8)	40.0	<0.01*
Fat	28 (77.8)	8 (22.2)	35.1	44 (51.8)	41 (48.2)	50.2	0.01*
Carbohydrate	33 (91.7)	3 (8.3)	115.0	55 (64.7)	30 (35.3)	157.4	0.01*
Micronutrient							
Vitamin A	22 (61.1)	14 (38.9)	391.4	31 (36.5)	54 (63.5)	714.0	0.02*
Vitamin C	31 (86.1)	5 (13.9)	18.6	43 (50.6)	42 (49.4)	58.9	<0.01*
Calcium	31 (86.1)	5 (13.9)	275.3	53 (62.4)	32 (37.6)	555.0	0.02*
Iron	31 (86.1)	5 (13.9)	3.2	40 (47.1)	45 (52.9)	7.8	<0.01*
Zinc	17 (47.2)	19 (52.8)	2.8	27 (31.8)	58 (68.2)	4.5	0.16

*Independent t-test, statistically significant at *p*-value ≤0.05

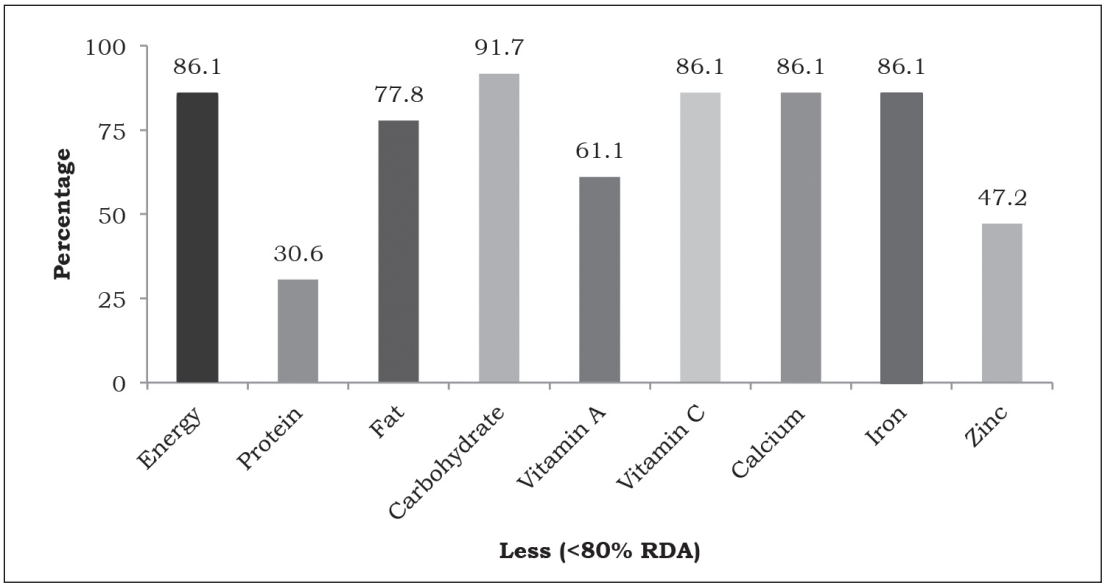

Figure 1. Percentages of macronutrients and micronutrients adequacy in case group

mothers with low education, while in non-stunted children, most of the mothers had higher education (71.8%). In terms of history of illness, there was no significant difference between the two groups. Most stunted and non-stunted children did not have a history of infectious diseases, either acute respiratory infection (ARI) or diarrhoea. Stunted children tended to have mothers with low nutritional knowledge compared to non-stunted children. The characteristics of the children according to case and control groups can be seen in Table 1.

This study showed that majority of stunted children consumed energy, fat, carbohydrates, and protein lesser than the recommended nutritional adequacy, namely 86.1%, 77.8%, 91.7%, and 30.6%, respectively (Table 3). In comparison, the percentages of non-stunted children with intakes less than the recommendation were 43.5%, 51.8%, 64.7%, and 8.2%, respectively. The average energy intake of stunted children was significantly lower (865 kcal/day) compared to the average energy intake of non-stunted children (1345 kcal/day). Similarly, the average protein intake of stunted children was lower (29.7 g/day) compared to non-stunted children (40.0 g/day). Both fat and carbohydrate intakes were also observed to be lower among stunted children (35.1 g/day and 115.0 g/day) compared to non-stunted children (50.2 g/day and 157.4 g/day) (Table 2).

The percentages of stunted children with micronutrient intakes (vitamin A, vitamin C, calcium, iron, and zinc) below the recommended nutritional adequacy were 61.1% for vitamin A, 86.1% for vitamin C, calcium and iron, and 47.2% for zinc. Meanwhile, the percentages of non-stunted children with micronutrient intakes (vitamin A, vitamin C, calcium, iron, and zinc) below the recommended nutritional adequacy were 36.5% for vitamin A, 50.6% for vitamin C, 62.4% for calcium, 47.1% for iron, and 31.8% for zinc. Adequacy of micronutrients in non-stunted children exceeded the recommended adequacy of nutrients,

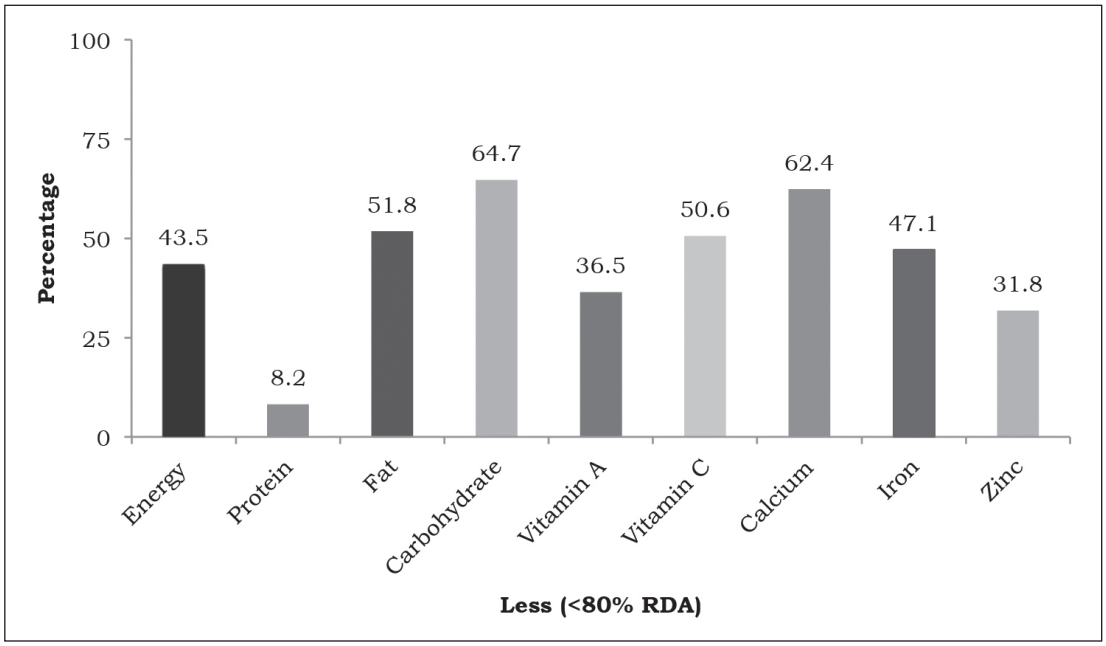

Figure 2. Percentages of macronutrients and micronutrients adequacy in control group

except for calcium, where non-stunted children consumed an average of 555.0 mg/day and stunted children were significantly lower at only 275.3 mg/day (the recommendation is 650.0 mg/day). The proportions of macronutrient and micronutrient intakes among children with and without stunting are displayed in Table 2. Percentages of macronutrients and micronutrients adequacy in case and control groups are presented in Figure 1 and Figure 2, respectively.

Nine nutrients included in the multivariate analysis were energy, protein, fat, carbohydrate, vitamin A, vitamin C, calcium, iron, and zinc intakes. The analysis showed that factors associated with stunting were energy intake (*AOR*=6.0; 95% CI=1.0-35.0) and protein intake (*AOR*=4.0; 95% CI=1.1-15.5) (Table 3). Children with energy intake less than recommendation had six times greater odds for stunting than those with sufficient energy intake. Children whose protein intake was less than recommended had four times greater odds for stunting than those with sufficient protein intake.

DISCUSSION

In terms of demographic and socio-economic characteristics, the two groups in this study were relatively similar. Significant difference was found only in maternal education, whereby stunted children had mothers with lower levels of education than non-stunted children. These results are similar to other studies in Nigeria and Nairobi, which reported that low-educated mothers have limited knowledge, especially regarding child feeding, food choices, and health seeking practices, which consequently contribute to stunting (Abuya, Ciera & Kimani-murage, 2012; Fadare *et al.*, 2019).

Results of this study indicated that children with energy intake less than recommendation have six times greater risk of stunting than children whose

Table 3. Multivariate analysis of factors associated with stunting

Variables	*Case n=36*	*Control n=85*	*Total respondents n=121*	*p-value*	*Adjusted OR (95% CI)*
	n (%)				
Energy intake					
Less (<80% RDA)	31 (86.1)	37 (43.5)	68 (56.2)	0.05*	6.0 (1.0-35.0)
Good (≥80% RDA)	5 (13.9)	48 (56.5)	53 (43.8)		
Protein intake					
Less (<80% RDA)	11 (30.6)	7 (8.2)	18 (14.9)	0.04*	4.0 (1.1-15.5)
Good (≥80% RDA)	25 (69.4)	78 (91.8)	103 (85.1)		
Fat intake					
Less (<80% RDA)	28 (77.8)	44 (51.8)	72 (59.5)	0.25	0.4 (0.1-2.0)
Good (≥80% RDA)	8 (22.2)	41 (48.2)	49 (40.5)		
Carbohydrate intake					
Less (<80% RDA)	33 (91.7)	55 (64.7)	88 (72.7)	0.52	1.8 (0.3-10.1)
Good (≥80% RDA)	3 (8.3)	30 (35.3)	33 (27.3)		
Vitamin C intake					
Less (<80% RDA)	31 (86.1)	43 (50.6)	74 (61.2)	0.11	2.7 (0.8-9.1)
Good (≥80% RDA)	5 (13.9)	42 (49.4)	47 (38.8)		
Iron intake					
Less (<80% RDA)	31 (86.1)	40 (47.1)	71 (58.7)	0.09	3.2 (0.8-11.9)
Good (≥80% RDA)	5 (13.9)	45 (52.9)	50 (41.3)		
Zinc intake					
Less (<80% RDA)	17 (47.2)	27 (31.8)	44 (36.4)	0.12	0.4 (0.1-1.3)
Good (≥80% RDA)	19 (52.8)	58 (68.2)	77 (63.6)		

* Multiple logistic regression, statistically significant at $p \leq 0.05$

energy intake was sufficient (*AOR*=6.0; *95% CI*=1.1-40.0). These results are in line with a randomised controlled trial study conducted by Tessema *et al.* (2018) in rural Ethiopian children aged 6-35 months (*n*=873), who reported that stunted children had significantly lower daily energy intakes than non-stunted children (Tessema *et al.*, 2018). Several other studies also reported similar findings that there was significant relationship between energy intake and stunting (Abebe, Haki & Baye, 2018; Iqbal *et al.*, 2019).

This study also revealed that children with protein intake less than recommendation had four times greater risk of stunting than children whose energy intake was sufficient (*AOR*=4.0; 95% *CI*=1.1-15.5). A study of 873 children in Ethiopia showed that a lack of protein intake, both in quality and quantity, has a significant relationship with stunting. Intakes of tryptophan, protein, and energy, as well as serum levels of tryptophan and insulin-like growth factor 1 (IGF-1) in serum, are positively correlated with the linear growth of children (Tessema *et al.*, 2018). Stunting has a close relationship with protein intake that functions to stimulate insulin in IGF-1 (Millward, 2017; Dror & Allen, 2011). In a study in Bogor District, Indonesia, Fikawati *et al.* (2019) reported that toddlers with inadequate protein intake were almost three times more likely to suffer from stunting compared to children with adequate protein intake. Another study in Bogor found that the majority of children (87.0%) consumed grains, such as rice and bread, while consumption of

eggs, legumes, and animal source foods were low (Trisasmita *et al.*, 2020).

There were significant relationships between energy and protein intakes with stunting after controlling for fat, carbohydrate, vitamin C, iron, and zinc intakes. The results of this study are similar to studies among toddlers aged 25-60 months in Mangkung Village, District of Central Lombok (Anshori, Sutrisna, Fikawati, 2020), which found that among 372 toddlers randomly sampled from *Posyandu*, macronutrient intakes (energy and protein) had significant relationships with stunting incidence.

The results implied that macronutrients are most important to overcome stunting in this population. They support the possible neglect of macronutrient deficiencies among children in developing countries amid the dominance of micronutrient deficiency narratives. Semba (2016) pointed out that protein is the missing essential nutrient to growth in the diet, meanwhile micronutrients supplementation showed limited or no efficacy towards stunting (Semba, 2016; Stammers *et al.*, 2015; Mayo-Wilson *et al.*, 2014). Iqbal *et al.* (2019) found that in low-resource settings, global deoxyribonucleic acid (DNA) methylation was higher among children with low protein, carbohydrate and energy intakes. Stunted children has a higher DNA methylation. This study therefore emphasises the importance of macronutrient sufficiency in preventing stunting among children 2-3 years old.

Low animal source protein intake may relate to the higher prevalence of stunting in Indonesia. Sjarif, Yuliarti & Iskandar (2019) reported that two protein sources had significant associations with stunting, namely growing-up milk and red meat products. The national data on individual food consumption revealed that animal source protein consumption among under-five children was very low, i.e., 39.8 g/day of fish, 20.1 g/day of eggs, 29.4 g/day of meat, and 22.6 g/day of fresh milk (MOH RI, 2014).

The lack of significance between micronutrient and stunting in this study could be caused by several factors. The data showed that micronutrient intakes were closer to recommendation than macronutrient intakes. Moreover, micronutrient serum level was not associated with DNA methylation in the Iqbal study. This could be related to low protein intake, level of body stores, infection status, and bioavailability (Iqbal *et al.*, 2019). This result does not undermine the importance of micronutrients in relation to their roles in linear growth, rather it shows that emphasis on micronutrients booming in recent years should be balanced by re-establishing the importance of macronutrients.

This study has several limitations. Firstly, it cannot ascertain a causal relationship due to temporal factors in the case-control study design. Secondly, this study did not measure some variables associated with the linear growth of children such as environmental sanitation and hygiene. Thirdly, there is a possibility of distorted reporting, which is a potential problem in all dietary assessment methods, and it is not known to what extent parents reported their child's food intake, as well as neglected or discounted for leftovers. We assumed that the data reflected daily consumption since the variety of foods and beverages at this age range is limited, and also that the socio-economic levels of the subjects in these two groups were similar. Fourthly, there is a possibility that sample size was too small as indicated by the large range of confidence interval. Thus, future studies should consider to add more samples.

Based on the results of this study, a priority should be given to nutritional programmes that emphasise increasing

energy and protein intakes. The effects of consumption of high-quality energy and protein foods, especially animal protein, in supporting the linear growth of children must be further investigated with the design of longitudinal intervention studies. Through robust longitudinal studies, it can be ascertained that the contribution of nutrients, both macro- and micronutrients, in the increase of linear growth among children. The amount of energy and protein intakes must be calculated by considering various factors beforehand, such as infectious diseases and the nutritional condition of the child.

CONCLUSION

The results showed that after controlling for fat, carbohydrate, vitamin C, calcium and zinc intakes, energy and protein intakes were factors associated with stunting among children aged 25-30 months in Gambir and Sawah Besar sub-districts, Central Jakarta. Children whose energy and protein intakes were below recommendation had six and four times, respectively, higher risk of stunting than children with sufficient intakes. Macronutrients are important and should be consumed in sufficient quantities every day to prevent stunting.

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Authors' contributions

SF, principal investigator, conceptualised and designed the study, prepared draft of the manuscript, reviewed and revised the manuscript; AS, conducted data analysis and interpretation; RRK, collected and analysed data, and SCG, analysed data and added new related references for manuscript.

Conflict of interest

No conflict of interest.

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Determination of the prevalence of hypertension and factors associated with blood pressure among hospitalised elderly in Hospital Serdang, Selangor, Malaysia

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ABSTRACT

Introduction: Increasing trends of hypertension has been recognised as a common disease among the elderly. This study aimed to determine the prevalence of hypertension and factors associated with blood pressure among hospitalised elderly. **Methods:** This was a cross-sectional study involving 124 patients in Hospital Serdang, Selangor, Malaysia. Data on socio-demography, medical background, anthropometry, blood biochemistry and lifestyle were collected through face-to-face interviews and medical records. Dietary intake was obtained through two days of food history. Malnutrition risks and stress level were determined using the Mini Nutritional Assessment Short-Form (MNA-SF) and the Geriatric Depression Scale (GDS). **Results:** There were 59.7% males and 40.3% females with mean age of 66.81±5.35 years. Majority were found to have hypertension (72.6%). Approximately 38.7% had normal body mass index (BMI). Most of them reported insufficient dietary intakes except for trans fats, sodium, and caffeine. Nearly 62.1% were engaged with physical activity, 23.4% were smoking, and 4.8% were taking alcohol. Approximately 66.1% and 86.3% were classified as having normal nutritional status and normal stress levels. In this study, the prevalence of hypertension among elderly patients warded in Hospital Serdang, Selangor was 72.6% and factors such as length of stay, number of co-morbidities, number of medications, having co-morbidities of hypertension, dyslipidaemia and diabetes mellitus, polypharmacy, height, BMI, fibre, polyunsaturated fat, dietary cholesterol, caffeine, and duration of physical activity were found to be associated with blood pressure. **Conclusion:** The present study found that majority of patients (72.6%) had hypertension. Future studies regarding factors associated with blood pressure are recommended.

Keywords: Hypertension, blood pressure, elderly

INTRODUCTION

Both developed and developing countries are experiencing a phenomenon called "the greying of the planet" due to the reported significant number of people living to an advanced old age in this recent history (Jacob, 2016). According to the United Nations (UN), Malaysia is expected to increase two-fold of its elderly population, individuals aged 60

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years and above; from 7% to 15% in 2030 and further to 22% in 2050 (Abeykoon *et al.,* 2017).

Based on the Clinical Practice Guidelines for Management of Hypertension (MSH, 2018), hypertension is defined as a persistent elevation in systolic blood pressure (BP) of 140 mmHg or greater and/or diastolic BP of 90 mmHg or greater, with a minimum of twice measurements taken on two different occasions. Previous literature has reviewed the status of the prevalence of hypertension in six Southeast Asian countries consisting of Malaysia (43.5%), Indonesia (47.0%), Vietnam (25.1%), Thailand (one of four adults), Philippines (22.3%) and Singapore (23.5%) (Oliva, 2019). The growing trends of hypertension among the elderly have been recognised in most Southeast Asian countries with the prevalence peaking among the age group of 65-69 years old at 74.0% and 53.4% in Malaysia and Singapore, respectively. Data by the National Health and Morbidity Survey (2019) in Malaysia also reported a rise in BP with increasing age as 81.7% of those aged 75 years old and above were found with the highest prevalence of hypertension.

Statistics from the Ministry of Health found high BP as the leading cause of mortality in Malaysia. Enhancement of lifestyle modification, which consists of modifiable factors, such as weight management, regular physical activity, smoking cessation, stress reduction, reduction of alcohol intake, and incorporation of heart-healthy diets, such as Dietary Approaches to Stop Hypertension (DASH) diet, manifests to be the first line of treatments in reducing the prevalence of hypertension (Whelton *et al.,* 2018). Preventive care using non-pharmacologic lifestyle interventions should be encouraged as adjunctive therapy for managing high blood pressure among the elderly in order to reduce the length of hospitalisation, higher tendency of being exposed to infections, and number of treatments received (Oliveros *et al.,* 2020). Moreover, hypertension as a "silent killer" not only results in asymptomatic mortality, but also deteriorates the quality of life for older people.

The cases of hypertension, especially among hospitalised elderly, have become an enormous concern among all health care professional teams working for an efficient management. Despite this, insignificant attention has been placed on the prevalence and associated factors of hypertension among hospitalised patients in the elderly age group of 60 years and above. Most research had been conducted among the general population or in community settings. This study was conducted with the purpose of improving the future health of the elderly in Malaysia. As such, this study aimed to contribute to existing literature by investigating the prevalence of hypertension in hospital settings, as well as factors associated with blood pressure.

MATERIALS AND METHODS

Participants

This was a cross-sectional study conducted at Hospital Serdang, Selangor, Malaysia. Purposive sampling was selected as the sampling design of this study. The appropriate sample size calculated based on the chosen correlation coefficient (r) by Lin *et al.* (2019) was 113, and after adjusting for 10% of non-response rate, the minimum sample size needed in this study was 124 subjects. A total of 124 hospitalised elderly were recruited for this study (response rate of 100%). The inclusion criteria included Malaysian citizen, and aged 60 years and above. This study excluded subjects with psychiatric illnesses, Alzheimer's disease, and those

critically ill who needed to be ventilated or sedated, which might interrupt or delay the process of collecting data during the interview.

Materials

A self-administered questionnaire was developed to assess the socio-demographic characteristics of patients. Medical background and biochemical data were determined through hospital systems or bed-head tickets. Data for anthropometric measurements were obtained through medical records or interview sessions. If anthropometric data cannot be acquired through medical records or interview sessions, a physical examination was conducted with two readings recorded for every measurement.

Dietary intake was obtained through two days of food history on home diet consisting of one day weekday and one day weekend. Home diet was chosen as this type of diet is more accurate to review the trends of food intake among patients. Food intake was recorded using household measurements to assist precision in estimating patients' intakes. The Malaysian Food Composition Database (MyFCD) was referred for the analysis of dietary intakes. The findings were then analysed by using the Nutritionist Pro (Axxya Systems, USA) software.

Mini Nutritional Assessment Short Form (MNA-SF) was used as an adopted questionnaire to assess the risk of malnutrition among patients. It comprises of seven items with a sensitivity of 98%, specificity of 100%, and diagnostic accuracy of 99% for predicting undernutrition (Villalon, Laporte & Carrier, 2011). Items 1 to 5 were determined through face-to-face interview, while items 6 and 7 were determined either through the hospital system or physical examination.

A semi-structured questionnaire was also used to evaluate the lifestyle of hospitalised elderly that consisted of physical activity, smoking status, and alcohol consumption. The findings were compared with standard recommendations from the Medical Nutrition Therapy (MNT) of Hypertension and Clinical Practice Guidelines (CPG) for Hypertension (MSH, 2018).

Stress level was assessed with an adapted questionnaire from the Geriatric Depression Scale (GDS) short form. This questionnaire consists of 15 close-ended questions, which is user-friendly for both healthy and physically ill subjects as it takes only about 5-7 minutes to complete, with 92% sensitivity and 89% specificity evaluated against diagnostic criteria among older populations (Greenberg, 2012).

Patients were classified as having hypertension based on self-report of having hypertension with medical diagnosis from doctors or medical officers and/or currently on treatments or taking any antihypertensive drugs. The BP taken on the day of the interview was further classified based on CPG for Hypertension (MSH, 2018).

Procedure

Data collection was conducted for three months from January to March 2020. Ethical approval was obtained from the MREC (Medical Research and Ethics Committee) (Project reference number: NMRR-18-3027-44602). Following ethical approval, an approval letter was obtained from the heads of department of the selected wards, which were surgical, medical, orthopaedic, urology, cardiology, and cardiothoracic. The content of the interview was explained to patients and informed consent was obtained before data collection. Patients were interviewed face-to-face with the use of a bilingual questionnaire

that consisted of socio-demographic characteristics, medical background, anthropometric measurements, biochemical data, dietary intake, malnutrition risk, lifestyle, and stress level. The findings were analysed using IBM Statistics Version 22. The associations between categorical variables were determined by using Chi-Square Test, while the correlations between continuous variables were done by using Pearson's Product Moment Correlation Test with statistical significance level set at $p<0.05$.

RESULTS

The present study determined the prevalence of hypertension and the associations between socio-demographic characteristics, medical background, anthropometric measurements, biochemical data, dietary intake, malnutrition risks, lifestyle, and stress level with both systolic and diastolic BP.

Participants were 59.7% males and 40.3% females with mean age of 66.8±5.4 years. Approximately 50.8% of the patients were Malays. Most received secondary education (43.6%) and had a total monthly household income of <RM1000 (59.7%). More than half were married (79.9%) and resided in urban areas (76.6%) (Table 1).

Based on Table 2, majority of patients (72.6%) had hypertension. Approximately 68.5% were classified as polypharmacy. Mean body mass index (BMI) was 25.2±5.3 kg/m^2, with 38.7% having normal BMI, followed by overweight (30.6%), and underweight (12.1%). Majority of the patients were presented with normal readings for most biochemical data, but approximately half of them were found with an abnormal level of fasting blood glucose (58.1%) and creatinine level (50.8%). Majority of them reported insufficient dietary intakes except for trans fat, sodium, and caffeine. For lifestyle, most of them (62.1%) were engaged in physical activity, while approximately 23.4% and 4.8% were reported to be smoking and taking alcohol. The mean MNA-SF score was 12.1±2.4, with 66.1% classified as having normal nutritional status. In the assessment for stress level, the mean score of GDS was 2.19±1.72, with majority of the patients classified as having normal stress levels (86.3%) and only 13.7% with mild depression.

The prevalence of hypertension among hospitalised elderly in Hospital Serdang, Selangor, Malaysia was 72.6%, with mean systolic BP of 133.2±16.5 mmHg and mean diastolic BP of 74.5±9.6 mmHg, as illustrated in Table 3. Based on BP taken on the day of the interview, 27.4% had isolated systolic hypertension (ISH), followed by at risk of hypertension (22.6%), normal BP (21.8%), and optimal BP (20.2%). Few patients had stage 1 (5.6%) and stage 2 (2.4%) hypertension.

Referring to Table 4, this study demonstrated no significant associations between age with BP of the patients ($p>0.05$). Length of stay, number of co-morbidities, and number of medications were found to be significantly associated with BP ($p<0.05$). There was a significant positive correlation between height and BMI with systolic BP ($p<0.05$). This study revealed that fibre, polyunsaturated fat (PUFA), dietary cholesterol, and caffeine were associated with BP ($p<0.05$). The duration of physical activity was associated with systolic BP ($p<0.05$).

As shown in Table 5, chi-square test was conducted for socio-demographic characteristics and no significant associations were found between sex, ethnicity, education level, marital status, monthly household income, and living area with BP. Other than that, there was also no significant association found between medical background and BP,

Table 1. Socio-demographic characteristics of hospitalised elderly (*N*=124)

Characteristics	*Total n (%)*	*Male n (%)*	*Female n (%)*
Sex			
Male	74 (59.7)	–	–
Female	50 (40.3)	–	–
Ethnicity			
Malay	63 (50.8)	39 (31.5)	24 (19.4)
Chinese	28 (22.6)	14 (11.3)	14 (11.3)
Indian	31 (25.0)	20 (16.1)	11 (8.9)
Mixed race	2 (1.6)	1 (0.8)	1 (0.8)
Marital Status			
Single	3 (2.4)	3 (2.4)	0 (0.0)
Married	99 (79.9)	68 (54.8)	31 (25.0)
Widow/Widower	22 (17.7)	3 (2.4)	19 (15.3)
Education level			
No formal education	13 (10.5)	5 (4.0)	8 (6.5)
Primary education	38 (30.6)	18 (14.5)	20 (16.1)
Secondary education	54 (43.6)	37 (29.8)	17 (13.7)
STPM/Foundation	4 (3.2)	4 (3.2)	0 (0.0)
Diploma/Bachelor/Master	15 (12.1)	10 (8.1)	5 (4.0)
Monthly household income			
<RM500	32 (25.8)	15 (12.1)	17 (13.7)
RM500-RM1000	42 (33.9)	26 (21.0)	16 (12.9)
RM1001-RM1500	10 (8.1)	7 (5.7)	3 (2.4)
RM1501-RM2000	14 (11.3)	12 (9.7)	2 (1.6)
>RM2000	26 (21.0)	14 (11.3)	12 (9.7)
Living area			
Urban	95 (76.6)	42 (33.9)	38 (30.6)
Rural	29 (23.4)	32 (25.8)	12 (9.7)

except for co-morbidities of hypertension, dyslipidaemia and diabetes mellitus, and also polypharmacy.

DISCUSSION

Based on the definition of BP used in the present study, the prevalence of hypertension among hospitalised elderly in Hospital Serdang, Selangor, Malaysia was 72.6%, which was found to be two to three times higher compared to a previous study (45.6%) conducted among non-institutionalised Malaysian elderly (Eshkoor *et al.*, 2016). However, only 58.0% of hospitalised elderly in Hospital Serdang were reported with hypertension after being referred for BP assessment on the day of the interview. The prevalence might have varied as patients were more likely to receive proper monitoring and treatments during hospitalisation. Upon assessment, approximately 27.4% had ISH, a type of hypertension commonly found among older individuals. Based on the World Health Organization (WHO) ISH criterion of >140/90 mmHg, the prevalence of ISH ranges from 5-35% for different countries in Asia and varies from one community to another according to economic development.

A previous literature that reviewed the status of hypertension in six Southeast Asian countries comprising of

Table 2. Medical background, anthropometric and biochemical data, dietary intake, malnutrition risk, lifestyle, and stress level of hospitalised elderly (*N*=124)

Characteristics	*Mean±SD*
Medical background	
Length of stay (days)	3.93±4.09
Co-morbidities	2.93±1.54
Number of medications	8.12±6.21
Anthropometric	
Weight (kg)	66.5±13.9
Height (cm)	162.3±8.8
BMI (kg/m^2)	25.3±5.3
Biochemical	
LDL-C (mmol/L)	2.55±0.87
HDL-C (mmol/L)	1.15±0.31
TG (mmol/L)	1.42±0.63
Total cholesterol (mmol/L)	4.10±1.52
Fasting blood glucose (mmol/L)	6.99±4.22
Potassium (mmol/L)	4.21±0.67
Creatinine (mmol/L)	161.7±174.1
Dietary intake	
Energy (kcal)	1575±567
Carbohydrate (g)	272.4±320.1
Fibre (g)	6.06±3.99
Protein (g)	52.8±22.5
Fat (g)	43.1±24.2
Saturated fat (g)	7.91±6.78
Polyunsaturated fat (PUFA) (g)	6.40±7.15
Monounsaturated fat (MUFA) (g)	7.28±7.73
Trans fat (g)	0.00±0.00
Dietary cholesterol (mg)	97.4±126.1
Sodium (mg)	1988±1106
Caffeine (cups)	1.07±1.07
Fluid (cups)	4.26±2.02
Malnutrition risks	
Total score MNA-SF	12.1±2.4
Lifestyle	
Physical activity (min/week)	185.9±347.3
Smoking (pieces/day)	3.77±8.55
Alcohol (unit/day)	0.06±0.32
Stress level	
Total score GDS	2.19±1.72

Malaysia, Indonesia, Vietnam, Thailand, Philippines and Singapore consistently presented advanced age as a significant contributing factor for elevated BP (Oliva, 2019). As most of the patients in the present study were males (59.7%), therefore sex, education level, and living areas were also discussed as possible factors associated with hypertension. However, another study with similar findings found no significant association between age, sex differences, and

Table 3. Prevalence of hypertension among hospitalised elderly (*N*=124)

Classification	*Mean±SD*	*Total*	*Male*	*Female*
			n (%)	
Systolic BP (mmHg)	133.2±16.5			
Diastolic BP (mmHg)	74.5±9.59			
Hypertension		90 (72.6)	53 (42.7)	37 (29.8)
Normal blood pressure				
Optimal (<120mmHg, <80mmHg)		25 (20.2)	19 (15.3)	6 (4.8)
Normal (120-129mmHg, 80-84mmHg)		27 (21.8)	15 (12.1)	12 (9.7)
At risk & high blood pressure				
At risk (130-139mmHg, 85-89mmHg)		28 (22.6)	17 (13.7)	11 (8.9)
Stage 1 (140-159mmHg, 90-99mmHg)		7 (5.6)	5 (4.0)	2 (1.6)
Stage 2 (160-179mmHg, 100-109mmHg)		3 (2.4)	1 (0.8)	2 (1.6)
Stage 3 (≥180mmHg, ≥110mmHg)		0 (0.0)	0 (0.0)	0 (0.0)
Isolated Systolic Hypertension (≥140mmHg, <90mmHg)		34 (27.4)	17 (13.7)	17 (13.7)

ethnicity with poor BP control (Cheong *et al.*, 2015). Diverse studies revealed that variations in the suggested factors associated with BP are reasonably due to differences in study design, social and cultural differences, dietary, and lifestyle factors.

Hypertension has been reported as one of the most frequent morbidities with an additional of at least one other diagnosis upon hospital admissions in a cohort study conducted within one Canadian hospital (Specogna *et al.*, 2017). This study also further discussed the presence of co-morbidities that were found to be associated with an increase in hospital stay and a higher cost of hospital care. A study conducted in Malaysia found a significant association between the presence of co-morbidities and the number of medications used, with 51.7% having poor BP control (Cheong *et al.*, 2015). Other than that, there was also a significant relationship between three or more antihypertensive agents with poor BP control. An analysis by the National Health and Nutrition Examination Survey (NHANES) suggested that although polypharmacy helped with the improvement in BP among elderly with three or more BP medications, yet it is also reported as a significant factor for the lack of medication adherence that possibly caused alteration in BP (Egan *et al.*, 2014). Therefore, productive efforts for complex management of blood pressure following the increasing number of older people in Malaysia should be emphasised in minimising the negative impacts on the elderly, as well as on our country's health care status and economy.

A higher prevalence of hypertension was reported among the elderly with high BMI (Eshkoor *et al.*, 2016; Seow *et al.*, 2015). The urbanisation of Malaysia as a developing country has exposed people towards a more sedentary and

Table 4. Correlations between socio-demographic, medical background, anthropometric, biochemical, dietary intake, malnutrition risk, lifestyle, and stress level with blood pressure among hospitalised elderly (*N*=124)

Variables	*Systolic BP*		*Diastolic BP*	
	r	*p*	*r*	*p*
Socio-demographic				
Age	0.07	0.45	0.02	0.84
Medical background				
Length of stay (days)	-0.16	0.07	-0.20	0.03*
Co-morbidities	0.17	0.05*	-0.04	0.66
Number of medications	0.20	0.03*	-0.07	0.42
Anthropometric				
Weight (kg)	0.15	0.10	0.05	0.62
Height (m)	-0.21	0.02*	-0.06	0.53
BMI (kg/m^2)	0.25	0.01*	0.06	0.53
Biochemical				
LDL-C (mmol/L)	0.09	0.33	0.10	0.29
HDL-C (mmol/L)	0.03	0.77	-0.10	0.26
TG (mmol/L)	0.04	0.70	0.11	0.21
Total cholesterol (mmol/L)	0.03	0.75	0.09	0.34
Fasting blood glucose (mmol/L)	0.17	0.07	0.14	0.13
Potassium (mmol/L)	0.00	0.97	-0.05	0.57
Creatinine (mmol/L)	0.16	0.08	0.01	0.89
Dietary intake				
Energy (kcal)	-0.08	0.41	0.00	0.94
Carbohydrate (g)	-0.06	0.52	-010	0.29
Fibre (g)	0.04	0.63	0.20	0.03*
Protein (g)	-0.15	0.09	-0.05	0.59
Fat (g)	0.03	0.72	0.03	0.75
Saturated fat (g)	0.03	0.72	0.05	0.61
Polyunsaturated fat (PUFA) (g)	0.21	0.03*	0.14	0.11
Monounsaturated fat (MUFA) (g)	0.15	0.10	0.11	0.22
Dietary cholesterol (mg)	-0.02	0.03*	-0.20	0.03*
Sodium (mg)	0.07	0.43	0.01	0.90
Caffeine (cups)	0.22	0.01*	0.13	0.15
Fluid (cups)	-0.06	0.50	0.00	0.95
Malnutrition risk				
Total score MNA-SF	-0.05	0.58	-0.06	0.51
Lifestyle				
Physical activity (min/week)	-0.21	0.02*	-0.10	0.26
Smoking (pieces/day)	-0.13	0.14	-0.05	0.58
Alcohol (unit/day)	0.04	0.68	0.07	0.43
Stress level				
Total score GDS	0.08	0.37	0.03	0.78

*Significant at $p<0.05$

Table 5. Associations between socio-demographic characteristics and medical background with blood pressure among hospitalised elderly (n=124)

Variables	*Normal BP n (%)*	*At-risk & high BP n (%)*	x^2	p
Socio-demographic characteristics				
Sex			1.21	0.27
Male	34 (27.4)	40 (32.3)		
Female	18 (14.5)	32 (25.8)		
Ethnicity			0.27	0.61
Malay	25 (20.2)	38 (30.6)		
Non-Malay	27 (21.8)	34 (27.4)		
Education level			2.29	0.13
With education	44 (35.5)	67 (54.0)		
No formal education	8 (6.5)	5 (4.0)		
Marital Status			0.05	0.83
Married	42 (33.9)	57 (46.0)		
Not married	10 (8.1)	15 (12.1)		
Monthly household income			0.57	0.45
≤RM1000	29 (23.4)	45 (36.3)		
>RM1001	23 (18.5)	27 (21.8)		
Living area			0.00	0.95
Urban	40 (32.3)	55 (44.4)		
Rural	12 (9.7)	17 (13.7)		
Medical background				
Referral to dietitian	3 (2.4)	5 (4.0)	0.07	0.79
Comorbidities				
Hypertension	31 (25.0)	59 (47.6)	7.56	0.01*
Dyslipidaemia	15 (12.1)	34 (27.4)	4.27	0.04*
Diabetes mellitus	25 (20.2)	53 (42.7)	8.44	0.00*
Ischemic heart disease	12 (9.7)	28 (22.6)	3.46	0.06
Others	26 (21.0)	36 (29.0)	0.00	1.00
Family history				
Hypertension	15 (12.1)	22 (17.7)	0.04	0.84
Others	27 (21.8)	48 (38.8)	0.16	0.69
Polypharmacy	28 (22.6)	57 (46.0)	8.98	0.00*

*Significant at p<0.05

unhealthy lifestyle, which further increases the rate of BMI exceeding the normal range (Oliva, 2019). It has also been observed that the prevalence of hypertension increased along with the rising number of those who were overweight or obese. On the other hand, another study suggested that higher BMI was able to reduce the risk of developing hypertension among older adults as the main cause leading to hypertension was the gradual increase in arterial stiffness rather than obesity itself (Pikilidou *et al.*, 2013).

Although no significant relationship between biochemical data and blood pressure was found, past literature suggested for the monitoring of biochemical data due to its possibility to cause any other health-related events.

Hypertensive elderly, particularly those with dyslipidaemia, require appropriate treatments to achieve normal BP by controlling associated risk factors including lipid profile. This can be done by having low-density lipoprotein cholesterol (LDL-C) within normal range through discard of endogenous and exogenous cholesterol, reduce triglycerides (TG), and improve high-density lipoprotein cholesterol (HDL-C) level (Gómez, 2012). In the present study, more than half were presented with an abnormal level of fasting blood glucose (FBG) and creatinine. Several studies found significant associations between FBG with systolic and diastolic BP, yet there is a need for extensive research in a longitudinal study to observe the relationship between hypertension and hyperglycaemia due to a lack in conclusive evidence (Yan *et al.*, 2016). Moreover, a study suggested high level of creatinine as a beneficial biomarker for the screening of renal status among hypertensive patients that is necessary for appropriate treatments (Pandya, Nagrajappa & Ravi, 2016).

Consumption of foods high in polyunsaturated fat, dietary fibre, and dietary cholesterol were presented with a positive relationship either with systolic BP alone or with both systolic and diastolic BP (Sakurai *et al.*, 2011). Although majority of the patients (75.8%) in this study had at least two cups of coffee or tea or less, which represented an adequate recommended intake of caffeine, yet caffeine consumption was found to be significantly associated with uncontrolled blood pressure, as supported by previous literature (Lopez-Garcia *et al.*, 2016). Consistent findings suggested that variations in dietary intake such as the DASH eating pattern within recommended amounts helped with the optimal control of blood pressure, especially among older individuals (Tyson *et al.*, 2012). In the present study, most of the patients complained of no appetite, food was hard to chew or swallow, food was not appealing, and poor meal-related situations that might have influenced the insufficient intakes of most of their dietary nutrient components (Yahya *et al.,* 2020). The difference in findings on nutrient components can be due to several reasons such as poor food choices and difficulty in getting the exact information for their daily consumption, as well as variations in lifestyle, as discussed in previous literature (Shahrin *et al.,* 2019a).

A past study conducted in Turkey that focused on non-hospital settings found a significant association between hypertension and malnutrition due to various factors such as health status, taste perception, and decline in physical ability, thus making older people 70% more vulnerable of being malnourished (Basibüyük *et al.*, 2019). This study also discussed the vulnerability of elderly towards diseases, which has resulted in poor nutritional status. However, fewer studies were available to determine the relationship between blood pressure and the use of MNA among older individuals.

Some studies demonstrated a sedentary lifestyle or no physical activity as a significant contributor to the risk of developing an age-related disease such as hypertension (Pilleron *et al.*, 2017) due to its beneficial role in improving muscle strength and flexibility among the geriatric population (Yahya *et al.,* 2019a). However, a study among the elderly in Singapore found that physically active elderly were more likely to perceive their health status to be in a good condition, which then reduced their awareness about the risk of developing hypertension (Seow *et al.*, 2015). Despite the fact that smoking cessation improves BP, cigarette smoking

was found to be prevalent among hypertensive patients in Southeast Asia (Oliva, 2019). Optimal control of BP was observed among current smokers even though they were presented with a lower rate of awareness about their health conditions (Seow *et al.*, 2015). In the present study, only 4.8% reported alcohol intake, with a consumption of <2 drinks per day, appropriate with the recommended intake established by CPG for Hypertension (MSH, 2018).

Increasing events of chronic illness expose older individuals with the risk of developing stress and reduce their health-related quality of life (Yahya *et al.,* 2019b; Yahya *et al.,* 2019c; Shahrin *et al.,* 2019b; Shahrin *et al.,* 2019c). Based on statistics by the WHO, it was estimated that about 15% of older people aged 60 years and above were suffering from mental disorders. Although no significant association was found between stress level and BP, changes that occur throughout the ageing process including the presence of chronic illness, such as hypertension, has been reported with a 5-37% range for depression among elderly in the primary care settings (Jacob, 2016). Thus, good management and social support during hospitalisation can be contributing factors for the improvement of mental health status as well as blood pressure control in the elderly.

CONCLUSION

The findings of this study presented the prevalence of hypertension as 72.6% among hospitalised elderly patients in Hospital Serdang, Selangor. Factors such as length of stay, number of co-morbidities, number of medications, having co-morbidities of hypertension, dyslipidaemia and diabetes mellitus, polypharmacy, height, BMI, fibre intake, polyunsaturated fat, dietary cholesterol and caffeine intakes, and duration of physical activity were found to be associated with BP among these patients.

Nevertheless, variables such as age, sex, ethnicity, education level, marital status, monthly household income, living area, biochemical data, malnutrition risk, smoking status, alcohol intake, and stress level were not found to be associated with BP. Therefore, regular monitoring of BP among hospitalised elderly is crucial to reduce the risk of mortality and morbidity among the geriatric population. The present study provides a better understanding of the factors associated with BP for appropriate preventive measures and intervention to improve the well-being of older people. Further research on the factors associated with BP, especially in hospital settings in Malaysia, is recommended.

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Authors' contributions

SNH, researcher, devised and conducted the study, data analysis and interpretation, prepared the draft of the manuscript; NO, principal investigator, assisted in study and result interpretation, reviewed the manuscript; SNAA, provided critical input and reviewed the manuscript.

Conflict of interest

The authors declared no conflict of interest.

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Associations of eating behaviours, fast food purchasing and availability with BMI-for-age *z*-score among adolescents in Labuan, Malaysia

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ABSTRACT

Introduction: A cross-sectional study was conducted to determine the associations of socio-demographic factors, eating behaviours, fast food purchasing by parents for family meals, and availability of neighbourhood fast-food outlets with BMI-for-age *z*-score (BAZ) among adolescents. **Methods:** Through multi-stage stratified cluster sampling method, a total of 420 adolescents from five selected public secondary schools participated in the current study. Data on socio-demographic factors, eating behaviours, and parent's purchases of fast food were obtained through self-administered questionnaires. The availability of fast-food outlets was assessed using Geographic Information System (GIS). Body weight and height of the adolescents were measured. **Results:** The prevalence of overweight, obesity, thinness and severe thinness among adolescents in the present study were 17.6%, 15.5%, 3.1% and 0.7%, respectively. The current findings showed that a higher monthly household income (r_s=0.12, p=0.02) and less purchases of fast food by parents for family meals (r_s=-0.11, p=0.03) were significantly associated with higher BAZ of the adolescents. However, there were no significant associations between eating outside of home, eating at fast-food restaurants, buying delivery fast food, and availability of neighbourhood fast-food outlets with BAZ. Multiple linear regression showed that less purchases of fast food by parents for family meals significantly contributed towards higher BAZ (β=–0.25, p=0.02). **Conclusion:** A higher household income and less fast food purchasing by parents were associated with higher BAZ. Fast food purchasing of adolescents were not associated with BAZ. Therefore, an appropriate obesity intervention programme should focus on adolescents and their parents from middle- and high-income households in Labuan.

Keywords: Obesity, adolescents, household income, fast-food, GIS

INTRODUCTION

Obesity is a global public health problem. Obesity in adolescents affects their physical health including insulin resistance, pre-diabetes, metabolic syndrome, dyslipidaemia, hypertension, asthma, skin problem, and impaired

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peak bone mass (Atay & Bereket, 2016). Obese adolescents are more likely to stay obese in adulthood (Sahoo *et al.*, 2015). The World Health Organization (WHO) reported that over 340 million children aged 5 to 19 years were overweight or obese in the year 2016 (WHO, 2017). The number of obese children and adolescents increased more than ten times higher from 1975 to 2016 (NCD Risk Factor Collaboration, 2017). The prevalence of overweight and obesity among adolescents in low and middle income Asian countries, including Malaysia, are on the rise (Atay & Bereket, 2016; IPH, 2013; IPH, 2017). The Malaysian School-Based Nutrition Survey (MSNS) in the year 2012 reported that Sabah and Labuan had the lowest prevalence of overweight and obesity (20.9%) compared to other states in Malaysia (IPH, 2013). Five years later, the National Health and Morbidity Survey (NHMS) conducted among adolescents aged 10 to 17 years in the Federal Territory of Labuan (Labuan) reported that the prevalence of overweight and obesity (33.7%) was the highest in Malaysia (IPH, 2017). The prevalence of thinness among adolescents aged 10 to 17 years in Labuan reported in the years 2012 and 2017 were 4.5% and 4.7%, respectively, which was the lowest compared to other states in Malaysia (IPH, 2013; IPH 2017). The drastic increase in the prevalence of overweight and obesity in Labuan warrants the urgent need to further study about the body weight status of adolescents in that city. To date, studies to determine the factors associated with body weight status among adolescents in Labuan are scarce.

Unhealthy eating behaviours such as decreased consumption of vegetables, fruits and milk, and increased consumption of high fat, high sugar foods, and fast foods, increase the risk of chronic health problems (Braithwaite *et al.*, 2014). A previous qualitative study indicated that Malaysian adolescents had the knowledge of healthy eating; however, there were barriers for them to practise healthy eating, including lack of healthy foods available at schools and at home, as well as being attracted to the taste and characteristics of unhealthy foods (Sharifah Intan Zainun *et al.* 2020). Besides, a previous study by Fara Wahida *et al.* (2015) reported that self-efficacy for healthy eating and availability of healthy foods were positively associated with the diet quality of adolescents in Kuala Lumpur. A previous study has shown that frequent consumption of fast foods was associated with overweight and obesity among adolescents (Braithwaite *et al.*, 2014). Furthermore, parent's purchase of fast foods has reduced the benefits of having healthy family meals at home such as lowering the risk of overweight and obesity among adolescents (Boutelle *et al.*, 2007). In contrast, a few previous studies indicated that the frequency of eating fast foods had no significant association with body weight status in adolescents (IPH, 2013). This shows that there are mixed results found in the association between consumption of fast foods and body weight status among adolescents. Thus, eating behaviour is one of the important factors that should be determined in the study of obesity among adolescents.

In addition, studies on the association between built environment and adolescence obesity are increasing in the western countries, and such evidence is needed for developing strategies to combat obesity, especially in promoting and constructing healthier environments (Lytle & Sokol, 2017). The availability of fast-food outlets nearby residences or schools were reported to be associated with an increased likelihood of purchasing fast foods (He *et al.*, 2012), which further increased the

risk of overweight and obesity among adolescents (Virtanen *et al.*, 2015). The Geographic Information System (GIS) method was widely used in public health in the western countries between the years 2007 and 2015 to measure food environment for addressing health needs and improving the built environment (Lytle & Sokol, 2017). To date, there is limited published study on the food environment in Malaysia using GIS. Recently, Kee *et al.* (2019) reported the association between availability of fast-food outlets with the risk of overweight using GIS in West Malaysia, but did not include East Malaysia (Sabah, Sarawak and Labuan). Little is known on the association between built environment and body weight status among adolescents in Labuan. The purpose of the present study was to determine the prevalence of overweight and obesity, and to determine the associations of socio-demographic factors, eating behaviours, parent's purchases of fast food for family meals, and availability of neighbourhood fast-food outlets using GIS with body mass index-for-age z-score (BAZ) among adolescents in Labuan, Malaysia.

MATERIALS AND METHODS

A cross-sectional study was conducted in Labuan, Malaysia. The population of the current study were lower (Form 1 & Form 2) and upper (Form 4) secondary school students. The estimated population for those aged 10 to 19 years in Labuan was 15400 in the year 2016 (DOSM, 2017). Based on Aday and Cornelius's (2006) calculation for prevalence study, the appropriate number of samples to represent the adolescents in the current study was 301. The sample size was adjusted for design effect of 1.3 and non-response rate of 20%. Hence, >480 respondents were needed in the present study.

A multi-stage stratified cluster sampling design was used in the current study. In particular, a list of national secondary schools in Labuan was obtained from the State Education Department of Labuan Federal Territory. At the first stage of sampling, the school locations were stratified into urban and rural, based on the administration of Labuan Corporation. Urban schools were located in the Labuan town area, while rural schools were located in villages (*kampung)*. Two schools from urban and three schools from rural were selected randomly using probability proportionate to size in the current study (Aday & Cornelius, 2006). At the second stage of sampling, classes in each selected school were randomly selected through systematic random sampling. All students from the selected classes were invited to participate in this study using cluster sampling method. While a total of 481 respondents were recruited, 437 students and their parents agreed to participate in the current study.

Ethical approval was obtained from the Ethics Committee for Research Involving Human Subjects Universiti Putra Malaysia [Ref: UPM/TNCPI/RMC/1.4.18.2 (JKEUPM)]. Prior to data collection, permission to conduct the study was obtained from the Ministry of Education Malaysia and the State Education Department of Labuan Federal Territory. Permissions were also obtained from the respective principals of each school. Students' and parents' information sheets and consent forms were distributed to the respondents a week before data collection. Written informed consents of the students and their parents were obtained during the study.

Data collection

Data collection was carried out for two months, starting from August till

September 2018, using student- and parent-administered questionnaires. Anthropometric measurements were assessed by the researcher and trained enumerators. At the beginning of data collection, the adolescents were briefed on the student-administered questionnaire and parent-administered questionnaire by the researchers. Adolescents filled in the student-administered questionnaire in school and the researchers collected the questionnaire on the same day to ensure that they were filled in individually, while parent-administered questionnaire required the adolescents to take it home for their parents or guardians to fill in and was collected by the researchers after completion.

Anthropometry measurements

Body weight of the respondent was measured by using TANITA Digital Weighing Scale THD-304 (TANITA Corporation, USA), while height was measured by using Charder HM202P Stadiometer. Body weight and height of the adolescents were measured by the researchers and trained enumerators using standard procedures. The enumerators were trained before data collection. The adolescent was requested to take off his or her shoes before measuring body weight and height. Each measurement was measured twice with weight recorded to the nearest 0.1 kg and height recorded to the nearest 0.1 cm. A mean of the two measurements was used in data analysis. To ensure accuracy, the digital scale and stadiometer were routinely calibrated. BAZ was calculated by using the AnthroPlus software v1.0.4 (WHO, 2009). Body weight status classification was done using age- and sex-specific cut-offs based on the WHO Growth Reference 2007, which classifies overweight as having z-score >+1 standard deviation (SD), obesity as having z-score >+2SD, thinness as having z-score -2SD - ≤-3SD, and severe thinness as having z-score <-3SD (WHO, 2007).

Socio-demographic characteristics

Information including sex, age and ethnicity were obtained from the student-administered questionnaire, while other information such as monthly household income and parent's education level was obtained from the parent-administered questionnaire.

Eating behaviours

Eating behaviours of the adolescents was assessed using the partial Malay-version Eating Behaviours Questionnaire (EBQ) (Chin & Nasir, 2009). Frequency of eating food outside of home (e.g. hawker centres, coffee shops, or food stalls), eating food at western fast-food restaurants (e.g. KFC, McDonald's, or Marrybrown), and purchase of takeaway or delivery food from western fast-food restaurants were assessed. All items were rated based on a frequency scale, ranging from "never/less than one week" to "7 days/week".

Parent's purchases of fast food for family meals

Purchases of fast food for family meals was assessed by asking the parent "In the past week, how many times was a family meal purchased from a fast-food restaurant, and eaten either at the restaurant or at home?". Parent's purchases of fast food for family meals was used in the Project Families and Eating and Activity in Teens (F-EAT) Survey (Boutelle *et al.*, 2007). The item was made on a 5-point Likert scale ranging from one point to five points. Response options included "never", "1 – 2 times", "3 – 4 times", "5 – 6 times", "7 times», or ">7 times".

Spatial analysis using Geographic Information System (GIS)

The presence of fast-food outlets within

the 500m, 1000m and 1500m buffers of the respondent's residence and school was measured using ArcGIS™ 10.3 (ESRI, Redland, CA) (Gilliland *et al.*, 2012) in the present study. The current study focused on access to fast-food outlets based on evidence of the associations between fast-food outlet density with unhealthy eating and body weight (He *et al.*, 2012; Kee *et al.*, 2019). Fast-food outlets were defined as franchised restaurants with foods ordered at a counter, paid for in advance with limited service and waiting time, and the foods served are usually big in portion size and prepared following standard procedures. (He *et al.*, 2012; Kee *et al.*, 2019). Respondent's residence address was required for analysing data in GIS. Database of every fast-food outlet in Labuan was obtained from the Food Safety and Quality Division, Labuan Health Department, Ministry of Health Malaysia. Fast-food outlets included in the current study were McDonald's, KFC, Pizza Hut, Marrybrown, SugarBun, Pezzo, Uncle Bob, and Bataras Fried Chicken. On-site environmental audits were performed by the researchers within a 1000m buffer around the selected schools during the study to "ground truth" to the accuracy of the database provided. The addresses of respondents' residences, schools, and fast food outlets were converted into geographic coordinates by geocoding service using secondary data (Google earth). The Labuan map was obtained from the Department of Survey and Mapping Malaysia (JUPEM). The addresses of the respondents, fast food outlets, and schools were geocoded using ArcMap™ tools. The residences and schools of respondents, and fast food outlets were plotted as point features on the map. The 500m, 1000m and 1500m buffer zones surrounding each residence and school were generated using buffer analysis. The number of fast-food outlets within the buffer zones of residence and school was calculated using GIS point. The location and body weight status of the respondents were displayed on the map using GIS.

Statistical analysis

Data were analysed using the SPSS version 22.0 (SPSS Inc., Chicago, II, USA) software. All continuous variables were tested for normality. Descriptive statistics were presented as frequency, percentages, mean and SD, while median and interquartile range (IQR) were reported for continuous data if the assumption of normality was not met. Pearson's product-moment correlation coefficient or Spearman's rho was used to assess the correlation between two continuous variables. Independent sample t-test was used to test for a statistically significant difference between two independent sample means. One-way analysis of variance (ANOVA) test was used to test for statistical difference between more than two independent sample means. The significance of the tests was set at $p<0.05$. Variables found to have an association with BAZ in simple linear regression at a level of significance of 0.25 were further analysed through multiple linear regression. Multiple linear regression with the stepwise variable selection method was performed to determine the contribution of each variable towards body weight status (BAZ) at a significance level of $p<0.05$.

RESULTS

Socio-demographic characteristics, eating behaviours, parent's purchases of fast food for family meals, availability of neighbourhood fast-food outlets and body weight status (BAZ)

A total of 437 participants agreed to take part, but 17 respondents had incomplete

anthropometric data or did not complete the questionnaires. Hence, they were excluded from the analysis, resulting in a final sample size of 420 respondents. Thus, the response rate was 87.3%. The socio-demographic characteristics, eating behaviours, parent's purchases of fast food for family meals, availability of neighbourhood fast-food outlets, and body weight status (BAZ) of respondents are presented in Table 1. A total of 420 adolescents were involved in the present study (male: 32.6%, female: 67.4%). Mean age of the respondents was 14.4±1.2 years old. A majority of the respondents were Malays (55.0%), followed by Bumiputra Sabah (29.0%), Chinese (9.0%), Bumiputra Sarawak

Table 1. Socio-demographic characteristics, eating behaviours, parent's purchases of fast food for family meals, neighbourhood fast-food outlets availability and body weight status (BAZ) of the respondents (*n*=420)

	n	%	*Mean±SD/ Median (IQR)*[¶]
Socio-demographic characteristics			
Sex			
Male	137	32.6	
Female	283	67.4	
Age (year)			14.4±1.2
Ethnicity			
Malay	231	55.0	
Chinese	38	9.0	
Bumiputra Sabah	122	29.0	
Bumiputra Sarawak	17	4.0	
Other ethnicities	12	3.0	
[†]School area			
Urban	186	44.3	
Rural	234	55.7	
[‡]Household income level[§] (RM) (*n*=410)			2000 (2885)
Low (B40: < RM3860)	293	71.5	
Moderate (M40: RM3860– RM8319)	88	21.5	
High (T20: >RM8319)	29	7.0	
Father's education level[§] (*n*=376)			
University/ Pre-university	76	20.2	
Secondary school	226	60.1	
Primary school	47	12.5	
No formal education	27	7.2	
Mother's education level[§] (*n*=402)			
University/ Pre-university	85	21.1	
Secondary school	231	57.5	
Primary school	58	14.4	
No formal education	28	7.0	
Eating behaviours (days/week)			
Frequency of eating outside of home			1.9±1.5
Frequency of eating at western fast-food restaurant			1.5±1.4
Frequency of buying takeaway/delivery western fast food			1.4±1.6

Table 1. Socio-demographic characteristics, eating behaviours, parent's purchases of fast food for family meals, neighbourhood fast-food outlets availability and body weight status (BAZ) of the respondents (*n*=420) [Cont'd]

	n	%	*Mean±SD/ Median (IQR)*¶
Parent's purchases of fast food for family meals			2.0 (1.0) ¶
Never	127	30.2	
1 -2 times/week	250	59.5	
3-4 times/week	37	8.8	
5-6 times/week	2	0.5	
7 times or more/week	4	1.0	
Availability of fast-food outlets			
Number of fast-food outlets nearby home			
500m buffer			0 (0) ¶
0	400	95.2	
≥1	20	4.8	
1000m buffer			0 (0) ¶
0	358	85.2	
≥1	62	14.8	
1500m buffer			0 (0) ¶
0	332	79.0	
≥1	88	21.0	
Number of fast-food outlets nearby school			
500m buffer			-
0	420	100.0	
≥1	0	0	
1000m buffer			2.7±3.0
0	234	55.7	
≥1	186	44.3	
1500m buffer			4.9±5.5
0	234	55.7	
≥1	186	44.3	
Body weight status (BMI-for-age, BAZ)			0.36±1.46
Severe thinness	3	0.7	
Thinness	13	3.1	
Normal	265	63.1	
Overweight	74	17.6	
Obesity	65	15.5	

†Based on Labuan Corporation (2019)
‡Based on Department of Statistic, Malaysia (2017)
§Missing data on socio-demographic characteristics of parents
¶Median (IQR)

(4.0%) and other ethnic groups (3.0%). About half of the respondents' mother (56.0%) participated in this study. About two-thirds of the respondents' fathers (60.1%) and mothers (57.5%) had completed secondary school education, while approximately one-fifth of the respondents' fathers (20.2%) and mothers (21.1%) completed tertiary education. Most of the respondents were from a low household income family (71.5%), with a median monthly

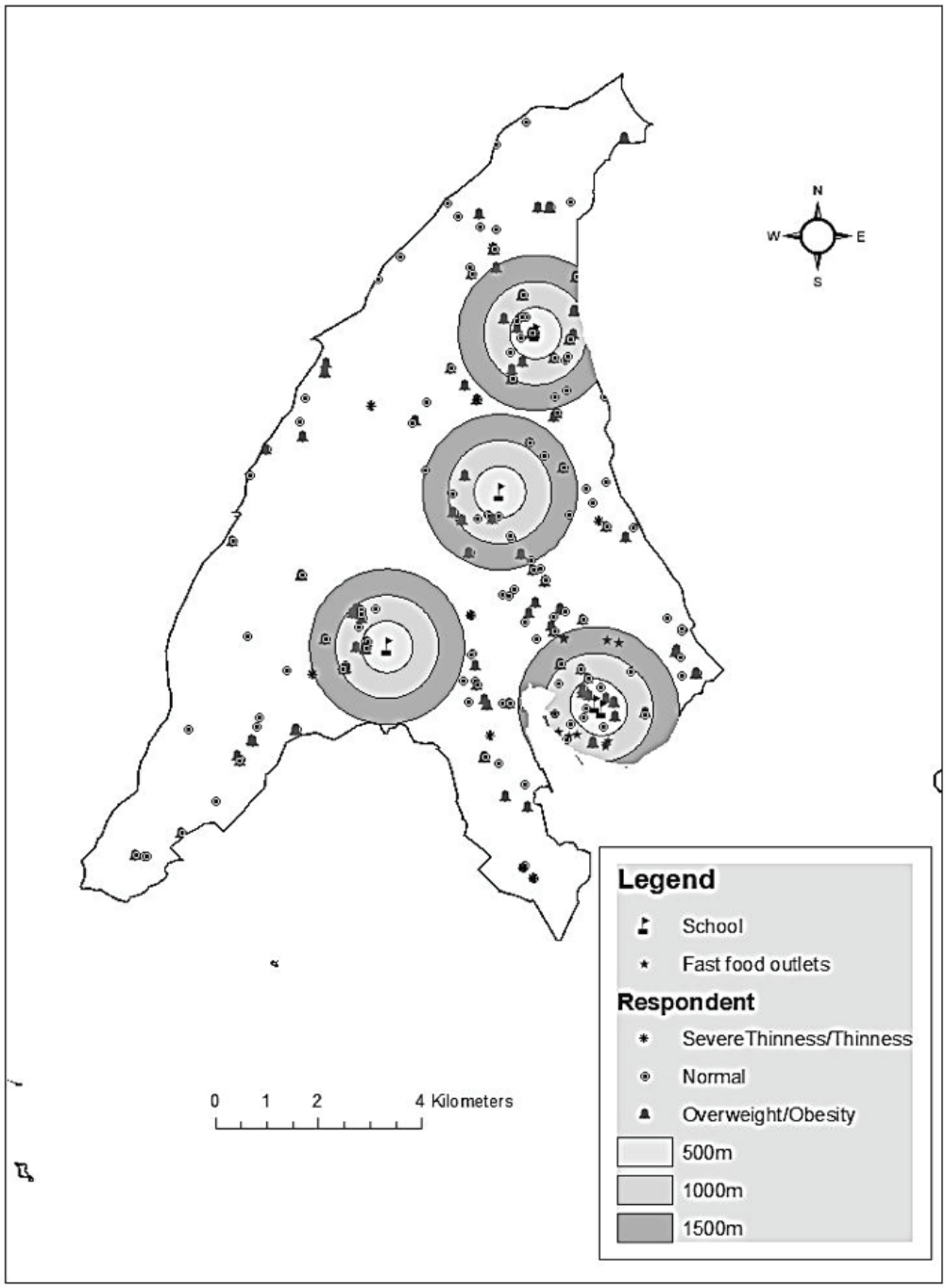

Figure 1. Distribution of fast-food outlets, schools and residences of respondents by body weight status in the Federal Territory of Labuan

household income of RM2000. The mean for the frequency of eating outside of home, frequency of eating at western fast-food restaurants, and buying takeaway or delivery western fast food were 1.9±1.5 days/week, 1.5±1.4 days/week and 1.4±1.6 days/week, respectively. A total of 59.5% parents purchased fast food as their family meals for 1 to 2 times a week. Based on the WHO Growth Reference 2007, a majority of the respondents had normal weight (63.1%), followed by overweight (17.6%), obesity (15.5%), thinness (3.1%), and severe thinness (0.7%), with a mean BAZ of 0.36±1.46.

Figure 1 shows the distribution of fast-food outlets, schools and residences of the respondents by body weight status, which was conducted using GIS. The availability of fast-food outlets within the 500m, 1000m and 1500m

Table 2. Associations of socio-demographic factors, eating behaviours, parent's purchases of fast food for family meals and availability of fast-food outlets with BAZ (*n*=420)

Factors	*Mean±SD (BAZ)*	*r/t/F*	*p*
Sex [a]		-1.30	0.19
Male	0.22±1.61		
Female	0.42±1.38		
Ethnicity [b]		0.52	0.72
Malay	0.43±1.50		
Chinese	0.21±1.57		
Bumiputra Sabah	0.31±1.44		
Bumiputra Sarawak	0.38±1.12		
Other ethnicities	-0.07±1.10		
Monthly household income [c]		0.12	0.02*
Eating behaviours			
Frequency of eating outside of home [d]		0.03	0.60
Frequency of eating at western fast-food restaurant [d]		-0.04	0.46
Frequency of buying takeaway/delivery fast food [d]		-0.04	0.46
Parent's purchases of fast food for family meals [c]		-0.11	0.03*
Number of fast-food outlets nearby home [c]			
within 500m buffer		0.01	0.79
within 1000m buffer		0.01	0.89
within 1500m buffer		0.06	0.22
Number of fast-food outlets nearby school [d]			
within 1000m buffer		0.06	0.19
within 1500m buffer		0.06	0.19

*p<0.05

[a] Independent-sample *t*-test was used for comparing BAZ between males and females;

[b] One-way ANOVA test was used for comparing BAZ between Malay, Chinese, Bumiputra Sabah, Bumiputra Sarawak and other ethnicities;

[c] Spearman Rho Correlation test was used for assessing the correlations between monthly household income, number of fast-food outlets nearby home and parent's purchases of fast food for family meals with BAZ;

[d] Pearson Correlation test was used for assessing the correlations between frequency of eating outside of home, frequency of eating at western fast-food restaurant and number of fast-food outlets nearby school with BAZ

Table 3. Simple and multiple linear regression analyses using BAZ as dependent variable (n=420)

Factors	*Simple linear regression*			*Multiple linear regression*		
	β	*95% CI*	*p*	*β*	*95% CI*	*p*
Sex[†]						
Female	0.20	-0.10, 0.50	0.19*			
Ethnicity[†]						
Chinese	-0.21	-0.72, 0.29	0.41			
Bumiputra Sabah	-0.12	-0.44, 0.20	0.47			
Bumiputra Sarawak	-0.05	-0.77, 0.67	0.89			
Other ethnicities	-0.50	-1.35, 0.35	0.25*			
Eating behaviours						
Frequency of eating outside of home	0.03	-0.07, 0.12	0.60			
Frequency of eating at western fast-food restaurant	-0.04	-0.13, 0.06	0.46			
Frequency of buying takeaway/ delivery fast food	-0.03	-0.12, 0.06	0.46			
Parent's purchases of fast food for family meals [c]	-0.25	-0.45. -0.04	0.02*	-0.25	-0.45, -0.04	0.02**
Number of fast-food outlets nearby school within the 1000m buffer	0.03	-0.02, 0.08	0.19*			
Number of fast-food outlets nearby school within the 1500m buffer	0.02	-0.01, 0.04	0.19*			

β = Unstandardised Regression, CI = Confidence Interval

[†]Reference categories were male and Malay

* p<0.25

**p<0.05, F(1, 419)=5.585, sig-F=0.019, R=0.115, R^2=0.013

Stepwise method was used for variable selection in multiple linear regression;
Homoscedasticity, normality and linearity of the model were checked and model assumptions were met

buffers around respondents' schools was demonstrated (Figure 1). The presence of fast-food outlets was in the town area of Labuan. As shown in Table 1, most of the respondents did not have any fast-food outlets present within the 500m (95.2%), 1000m (85.2%), and 1500m (79.9%) buffers around their residences. All respondents (100%) had no fast-food outlets within the 500m buffer around their schools. However, almost half of the respondents (44.3%) had at least one fast-food outlet within the 1000m and 1500m buffers around their schools. The mean total number of fast-food outlets within the 1000m and 1500m buffers around their schools were three and five, respectively.

Associations of socio-demographic factors, eating behaviours, parent's purchases of fast food for family meals and availability of neighbourhood fast-food outlets with BAZ

Table 2 shows the associations of socio-demographic factors, eating behaviours, parent's purchases of fast food for family meals, and availability of neighbourhood fast-food outlets with BAZ of the respondents. There was a statistically significant, positive correlation between household income and BAZ of the respondents (r_s=0.121, p=0.015). Parent's purchases of fast food for family meals was statistically negatively correlated with BAZ of the respondents (r_s=-0.107, p=0.029). There were no statistically significant associations between sex, ethnicity, frequency of eating outside of home, frequency of eating at western fast-food restaurants, frequency of buying takeaway or delivery fast foods, and availability of fast-food outlets within the 500m, 1000m and 1500m buffers around residences or schools with BAZ of the respondents (p>0.05).

Contributions of socio-demographic factors, eating behaviours, parent's purchases of fast food for family meals and availability of neighbourhood fast-food outlets with BAZ

Table 3 shows the simple and multiple linear regressions of socio-demographic factors, eating behaviours, parent's purchases of fast food for family meals, and availability of neighbourhood fast-food outlets with BAZ of the respondents. Variables tested in the simple linear regression with a p<0.25 were selected for further analysis in the multiple linear regression. The five variables with p<0.25 were sex, ethnicity, parent's purchases of fast food for family meals, availability of fast-food outlets within the 1000m and 1500m buffers of school. Multiple linear regression showed that less parent's purchases of fast food for family meals statistically significantly contributed towards higher BAZ in the respondents (β=–0.246, 95%CI =–0.440, –0.041, p=0.019), which explained a total of 1.3% of the variances in BAZ of the respondents at 0.05 level of significance.

DISCUSSION

In the present study, the prevalence of overweight and obesity (33.1%) was ten times higher than the prevalence of thinness and severe thinness (3.8%) among adolescents aged 12 to 16 years. The high prevalence of overweight and obesity among adolescents in Labuan indicated that obesity intervention programme was necessary. The present study was consistent with the prevalence of overweight and obesity among adolescents in the nationwide Adolescents Nutrition Survey Malaysia 2017 (33.7%). Additionally, the prevalence of overweight and obesity in the present study was higher than the prevalence of overweight and obesity reported in China (24.3%) between the years 2011 and 2015 (Zhang *et al.*, 2018). However, the study in China used the International Obesity Task Force (IOTF) classification, while the current study used the WHO Growth Reference (2007). Different cut-off points for the classification of body weight status may have led to different results in the prevalence of overweight and obesity. The WHO reference could have overestimated the prevalence of overweight and obesity among adolescents compared with the IOTF references (Banjade, Naik & Narasannavar, 2015).

The current study found that the majority of respondents were from low household income families (<RM3860/ month). The current study showed that higher monthly household income

was associated with higher BAZ of the respondents. This indicated that BAZ of the adolescents was dependent on household income. The adolescents who came from higher income families were more likely to enjoy eating at western style fast-food restaurants as compared to those from lower income families (Aloia *et al.*, 2013). In addition, higher household income is associated with food choices and increased purchasing of fast foods (Thornton, Bentley & Kavanagh, 2011). In the current study, the adolescents from higher income families had higher body weight as they might have received more pocket money from their parents to eat at hawker stalls or local restaurants, buying takeaway western fast foods, and eating at western fast-food restaurants.

The present study showed that there was no significant difference in BMI-for-age by sex, whereby the finding was similar with a previous study among early adolescents in Hulu Langat District, Selangor (Woon, Chin & Mohd Nasir, 2015). However, the current finding was inconsistent with previous studies (Aryati *et al.*, 2017; IPH, 2015; IPH, 2017; Lai *et al.*, 2015). For instance, a study among adolescents aged 13 to 17 years by Aryati *et al.* (2017) reported that body weight status was significantly higher in females as compared to males in Terengganu. In contrast, nationwide studies reported the prevalence of overweight and obesity to be higher in male adolescents compared to female adolescents (IPH 2013; IPH 2017). A previous study among Malaysian adolescents living in day-school hostels found that sex was significantly associated with thinness, but not overweight in adolescents (Lai *et al.*, 2015). However, a previous study by Lai *et al.* (2015) was not comparable with the current study as the study subjects in the current study were from day-schools, in which their dietary behaviours may differ from adolescents living in day-school hostels as indicated by Lai *et al.* (2015).

The present study showed that less parent's purchases of fast food for family meals was associated with higher BAZ of the adolescents, which was inconsistent with a previous study, whereby parent's purchases of fast food for family meals was not associated with adolescents' BMI (Boutelle *et al.*, 2007). Besides, the previous study also indicated that parent's purchases of fast food was associated with increased consumption of salty snack foods and decreased consumption of vegetables (Boutelle *et al.*, 2007). The higher frequency of taking fast foods may increase the risk of obesity during adulthood when energy needs are reduced (French *et al.*, 2007). In addition, a previous study found that parents with overweight or obese children were less likely to pressure their children to finish all the foods (Leiu & Chin, 2019). Therefore, we hypothesised that parents with higher body weight adolescents in the current study were more concerned about their child's body weight, hence restricted their fast food intake and reduced the purchasing of fast food for family meals to manage their children's body weight during the study period.

The present study also found that less purchases of fast food for family meals contributed towards higher BAZ of the adolescents. The present study could explain 1.3% of the variances in BAZ of the respondents as only one variable was retained in the final model. R^2 value was low in the present study as there is a possibility that some risk factors were not measured in the study such as physical activity, body image perception, energy expenditure and energy intake. Therefore, further study is suggested to include energy intake, physical activity, energy expenditure, body image perception, home environment and

physical environment factors in the study.

The present study found that eating behaviours such as the frequency of eating at western fast-food restaurants and buying take away or delivery fast foods was not significantly associated with BAZ of the adolescents, inconsistent with a previous study (Braithwaite *et al.*, 2014), which reported that frequent consumption of fast foods increased the risk of overweight and obesity. On the other hand, the present study was consistent with other previous studies (French *et al.,* 2007; IPH, 2013). French *et al.* (2007) found that the frequency of taking fast food was associated with male adolescents, but not female adolescents. However, in this current study, majority of the respondents were females. Another possible explanation is that adolescents are experiencing growth and therefore higher energy intake is needed. With that, we hypothesised that adolescents' body weight was less influenced by high caloric foods, either eaten at local food stalls or western fast-food restaurants. Besides, a previous study indicated that early adolescents aged 10 to 11 years old with higher body weight had lower energy intake (Woon, Chin & Mohd Nasir, 2015). Previous study found that majority of adolescents who correctly perceived themselves to be overweight and obese had the intention to lose weight (IPH, 2017). Therefore, we hypothesised that respondents with higher body weight were dissatisfied with their body size and consequently restricted their food intakes during the study period.

The current findings indicated no association between the availability of fast-food outlets around residences and schools with BAZ of respondents, which was consistent with previous studies (Berge *et al.*, 2014; Kelly *et al.*, 2019). For instance, a study by Berge *et al.* (2014) among 2682 adolescents with a mean age of 14.5 years indicated that high density of fast-food outlets within 1600m of home and fast-food outlets within 1200m were not significantly associated with BAZ of adolescents. This could be explained by previous evidence indicating no associations found between fast-food outlets around schools with consumption of soft drink, sweets and chips (Kelly *et al.*, 2019). However, the current finding was inconsistent with Kee *et al.* (2019), which reported that the availability of fast-food outlets within a 1000m radius of residences was significantly associated with being overweight among children aged 5 to 18 years. The inconsistent finding of the current study could be due to the greater percentage of respondents who had no fast-food outlets present around their residences and schools. Previous studies (He *et al.*, 2012; Virtanen *et al.*, 2015) were conducted in urban environments that consisted of high density fast-food outlets, whereas the current study consisted of low density fast-food outlets. Besides, the students with higher household income levels in the current study were buying more foods at hawker centres, coffee shops, or food stalls, as well as buying takeaway or delivery fast foods instead of eating at their neighbourhood fast-food outlets. Therefore, the current study was unable to show significant associations between the availability of neighbourhood fast-food outlets around residences and schools with BAZ of the adolescents.

There were several limitations in the study. The cross-sectional design in this study was unable to determine the causal relationship between risk factors and BAZ. Additionally, the number of male and female respondents in the current study was not equally distributed, whereby female respondents were higher compared with male respondents that could have affected the results of the study. Another limitation of this study

was the lack of information on energy intake, types of foods purchased, and physical activity, which might have been important factors that contributed to BAZ of the adolescents. Furthermore, the outcome of this study is not guaranteed to be representative of the adolescents and parents in Malaysia due to its sampling design. However, the findings gave important information on body weight status and the associations between factors and body weight status (BMI-for-age) among adolescents in Labuan. The study was also able to demonstrate the distribution of fast-food outlets and residences of respondents by body weight status on a map.

CONCLUSION

The current study showed that the prevalence of overweight and obesity was higher than the prevalence of thinness and severe thinness among adolescents in the Federal Territory of Labuan. Higher household income and less parent's purchases of fast food for family meals were associated with higher BAZ among the adolescents in Labuan. The multiple linear regression indicated that less parent's purchases of fast food for family meals significantly contributed towards higher BAZ of the respondents. Therefore, appropriate intervention programmes need to be taken, focusing on adolescents and their parents from middle and high household income families to address the obesity problem in the population. Although the current study reported that the availability of fast-food outlets and frequency of taking fast foods were not associated with BAZ of the adolescents, intervention programmes should still focus on promoting healthy menu and healthy cooking in restaurants and school canteens to create a healthier food environment so that adolescents can have access to healthier food choices. Parents play an important role in helping their children to practise healthy eating and maintain a healthy body weight. Parents who were concerned about their children's body weight should encourage their children to practise good eating habits, reduce purchasing of high caloric foods in restaurants or fast-food outlets and prepare healthy meals for the family frequently. The present study also found that the study variables explained 1.3% of the variances in BAZ of the adolescents. This indicated that other variables that were not measured in the study also contributed to the variances of BAZ of the adolescents. Therefore, other factors such as behavioural factors, family and environmental factors, physical activity, physical environment, and nutrition knowledge should be considered in future studies to determine their potential effects on BAZ of adolescents.

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Authors' contributions

HSF, designed the study, conducted the study, data analysis and interpretation, and prepared the draft of the manuscript; CYS, principal investigator, designed the study, led the study, advised on data analysis and interpretation, and reviewed the manuscript; ARMS, designed the study, advised on analysis using GIS and reviewed the manuscript; LPY, designed the study, advised on data analysis and interpretation, and reviewed the manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

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Risk factors of stunting during the complementary feeding period 6-23 months in the Philippines

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ABSTRACT

Introduction: Stunting persists as a public health problem in the Philippines, affecting 30% of under-five children. This study aimed to identify the drivers of stunting in young Filipino children aged 6-23 months. **Methods:** Data were extracted from the cross-sectional Updating Survey conducted in 2015 by the Food and Nutrition Research Institute of the Department of Science and Technology (FNRI-DOST). Potential predictors of stunting, which were categorised into child-related characteristics, feeding practices, maternal socio-demographic status and health practices, and household economic and food security status, were examined using descriptive and regression analyses. **Results:** Of the 2,275 children aged 6-23 months, 18.7% were stunted and 8.3% were severely stunted**.** The risk of stunting increased significantly among older children aged 12-23 months (relative risk ratio, RRR 3.04), males within 6-23 months of age (RRR 1.99), and low-birth-weight infants (RRR 2.19). Children born from teenage mothers (RRR 1.90), mothers with short stature (RRR 2.33), and mothers with low education (RRR 1.59) posed higher risks of becoming stunted relative to their counterparts. Mothers with >4 children (RRR 2.44), coming from the poorest households (RRR 4.27), having untimely introduction of complementary foods (RRR 4.44), and not meeting the minimum meal frequency (RRR 2.30) increased the risks of severe stunting. **Conclusion:** The study illustrated the multi-factorial nature of stunting among Filipino children aged 6-23 months old. Therefore, a multi-sectoral approach is needed to address the underlying factors of stunting among young Filipino children to help achieve the country's nutrition targets by 2025.

Keywords: Stunting, complementary feeding, 1000 days, Philippines

INTRODUCTION

Stunting during the first two years of life has gained global attention due to its immediate and long-term irreversible consequences on individual development, including poor physical growth, poor cognitive and psychomotor developments, poor school performance, reduced work capacity, and adverse pregnancy outcomes (Agedew, 2015). The key implication is grounded on a very narrow window of time during which stunting can be reversed or prevented by nutrition interventions, with little or no catch-up growth beyond the first 1,000 days period (UNICEF, 2013).

Children are considered stunted if their height-for-age is >2 standard deviations (*SD*) below the median distribution provided in the World Health Organization (WHO) Child Growth Standards (WHO, 2006).

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Stunting, based on a lifecycle approach, starts *in utero* and continues during the first two years of life due to inappropriate breastfeeding and complementary feeding practices, micronutrient deficiency, and repeated infections, which can trap a child in a vicious cycle of malnutrition (UNICEF, 2019). Evidence from large-scale studies showed that mothers who suffered from stunting in childhood are at greater risks of having stunted children (Black *et al.*, 2013). Similarly, children being small for their gestational age (both pre-term and term) are strongly associated with maternal height and low body mass index (BMI), which are in turn associated with adolescent health and pregnancy (Christian *et al.*, 2013). In addition, a longitudinal study conducted in Cebu, Philippines showed that the likelihood of stunting is increased by diarrhoea, febrile respiratory infections, and early supplemental feeding (Adair & Guilkey, 1997).

The WHO considers childhood stunting as one of the most significant barriers to human development. Moreover, one of the six global nutrition targets for 2025 aims to reduce the global number of children under five who are stunted by 40% (WHO, 2014). In order to help attain the country's sustainable development goal targets by 2030, the Philippine government, through its development plan and nutrition strategy laid out in the Philippine Plan of Action for Nutrition, set the target of reducing stunting by 20% by 2022. The Philippines' nationally representative survey data in 2015 showed that nearly one in every five children <5 years of age was stunted, and that figure remained unchanged over the years (FNRI-DOST, 2016). A similar picture is depicted among children <2 years of age, where only a 5.0% reduction in stunting prevalence was observed between 2003 and 2015 (FNRI-DOST, 2016). Significant linear growth faltering and micronutrient deficiencies start in the second six months of infancy, when complementary foods are essential to provide sufficient diet for growth and development. Based on the recent nutrition survey in 2018, less than half (48.5%) of the children aged 0-23 months were appropriately breastfed while receiving timely complementary foods.

Given this evidence, the WHO (2014) recommended that context-specific factors should be considered in designing nutritional approaches to accelerate the rate of reduction. Since reduction in stunting prevalence among children under two is low in the Philippines, this study aimed to identify the determinants of stunting in young children 6-23 months old who are in the critical stage of complementary feeding period. Results could provide evidence for the government and other developmental agencies to design context-specific interventions and strategies to help accelerate the reduction rate of stunting during the first 1,000 days of life in the Philippines and other similar countries.

METHODS AND MATERIALS

Study design and participants

The study utilised secondary data from the cross-sectional Updating Survey (UPS) conducted in 2015 by the FNRI-DOST (FNRI-DOST, 2016). The 2015 UPS adopted the household listings from the 2003 Master Sample (MS) of the Philippine Statistics Authority. The MS was derived from a multi-stage stratified sampling design where the first stratification was based on the country's 17 administrative regions as the primary sampling domain or primary strata. Sub-stratum was created from each of the provinces, highly urbanised cities, and component cities. The province is the largest unit in the political structure of the Philippines and consists of varying numbers of municipalities and component cities, depending on geographic size. From each of the sub-stratum, primary sampling units (defined as a barangay or contiguous barangays with at least 500 households,

from both urban and rural areas) were generated. From these, enumeration areas (EAs) consisting of 150 to 200 households were drawn. The third and final stage of sampling involved the selection of households from the EAs as ultimate sampling units where the subjects were drawn. All children aged 6-23 months from sample households, along with their demographic and economic information, infant and young child feeding practices, and maternal characteristics, were included in the study.

Data collection

Face-to-face interviews were conducted by trained field workers among mothers/ caregivers of children 6-23 months old using a pre-tested questionnaire uploaded in the electronic Data Collection System (e-DCS) to collect all relevant information on the child, including feeding practices, maternal, and household information. To identify the child's feeding practices, the child's actual food intake from the previous day was obtained from the mother or primary caregiver through a 24-hour food recall using a paper-based questionnaire and measuring tools. The mother or caregiver was asked about the child's complete food intake starting from the time the child woke up and ending when the child fell asleep at night. For breastfeeding babies, the number of times the baby breastfed throughout the day and night was also asked. Recumbent length was measured by trained field workers using an infantometer following standard protocols. Length referred to the measurement in recumbent position, the recommended way to measure children <2 years of age or <85 cm tall. At least two measurements were obtained, and averages were computed and recorded to the nearest 0.1 cm. Age in months was computed to determine the nutritional status of the children.

Study variables

Dependent variables

a. Stunting was determined based on the WHO Child Growth Standards (WHO, 2006) length-for-age *z*-score of children <-2SD of the reference mean.
b. Severe stunting was determined based on the WHO Child Growth Standards (WHO, 2006) length-for-age *z*-score of children <-3SD of the reference mean.

Independent variables

a. Child characteristics included age in months (6-11 months and 12-23 months), sex, and birth weight (<2,500g and ≥2,500g).
b. Maternal characteristics included maternal age (<20, 20-29, and ≥30 years), height (<151cm and ≥151cm), using 151cm as the average height of Filipino women based on the 2015 UPS of the FNRI-DOST; BMI (<18.5, 18.5-24.5, >24.5 kg/m2); parity (1, 2-3, ≥4); educational attainment (primary level or lower, secondary level, tertiary level); employment status (working, not working); number of antenatal check-ups (1-3 and 4 or more); received nutrition advice during antenatal care (yes, no); intake of iron-folic acid (IFA) (with, without); method of delivery (normal delivery, caesarean section delivery); place of delivery (at home and others, health facility); and assistance during delivery (health professionals, traditional birth attendant and others).
c. Household characteristics included household food security status (food insecure, food secure), based on the Household Food Insecurity Access Scale (HFIAS); wealth status (poorest, poor, middle, rich, richest), computed

based on household wealth index; area of residence (rural, urban); toilet facility, classified as improved (water sealed toilet) or not improved (no toilet/not water-sealed/open pit); and household size (≤5, >5).

d. Infant and young child feeding practices included the WHO-UNICEF core indicators of appropriate complementary feeding, such as: a) prelacteal feeding, referring to the practice of temporarily giving any liquid food within the first three days of life while waiting for breastfeeding to be established; b) timely introduction of solid, semisolid, or soft foods, which refers to the giving of solid, semisolid, or soft foods to children aged 6-8 months; c) minimum dietary diversity, which refers to the giving of foods to children 6-23 months old from at least four of the seven food groups, namely grains, roots and tubers, legumes and nuts, dairy products (milk, yoghurt, cheese), flesh foods (meat, fish, poultry, and liver/organ meats), eggs, vitamin A-rich fruits and vegetables, and other fruits and vegetables; d) minimum meal frequency, which refers to the feeding frequency during the previous day, i.e., two times for breastfed infants aged 6-8 months, three times for breastfed children aged 9-23 months, three times for non-breastfed children aged 6-23 months. 'Meals' included meals as well as snacks (other than trivial amounts), and frequency was based on caregiver's report; e) minimum acceptable diet (MAD), which was determined using both minimum dietary diversity and minimum meal frequency as criteria for meeting MAD. All other indicators were based on the 24-hour recall of infant's dietary intake as reported by the mother.

Ethical consideration

The 2015 UPS of the Nutritional Status of Filipino Children and Other Population Groups was approved by the FNRI Institutional Ethics Review Committee. Information regarding the survey's purpose, objectives, and procedures were discussed with the respondents before obtaining their verbal and written informed consent to participate in the survey.

Statistical analysis

Descriptive statistics, such as means and percentages, were used to describe the children aged 6-23 months who were sampled in the study. Sampling weights were calculated as the product of base-weights, (unit) non-response adjustment, and post-stratification adjustment. Post-stratification adjustments were made to ensure that the survey estimates conformed to well-known population by age-sex distribution. Thus, all estimates, such as proportions and regression analysis, were computed based on weighted data. Bivariate analysis was done to test the association of stunting with child-related characteristics and feeding practices, as well as maternal and household characteristics. Pearson's Chi-square test was performed to determine the association of each predictor with stunting. All independent variables with significant associations with child stunting were entered into the multinomial logistic regression analysis. The coefficients of the multinomial logistic regression model were interpreted in terms of relative risk ratio (RRR). In the final model, potential risk factors associated with stunting and severe stunting among children 6-23 months old were determined. All statistical analyses were done using

Table 1. Characteristics of study children 6-23 months old and their mothers, and the socio-demographic and economic status of households: Philippines, 2015 (*n*=2,275)

Characteristics	*n*	*Proportion*	*95% Confidence Interval*	
			LL	*UL*
Child characteristics				
Age in months				
6-11	797	35.1	33.0	37.3
12-23	1478	64.9	62.7	67.0
Sex				
Male	1155	49.9	47.7	52.1
Female	1120	50.1	47.9	52.3
Birth weight				
<2,500g	314	13.2	11.6	14.9
≥2,500g	1961	86.8	85.1	88.4
Maternal characteristics				
Age in years				
<20	149	6.7	5.6	7.8
20-29	1130	50.6	48.4	52.8
≥30	996	42.8	40.7	44.9
Height				
<151 cm	1060	45.5	43.3	47.8
≥151 cm	1215	54.5	52.2	56.7
BMI (kg/m^2)				
<18.5	309	13.4	12.0	14.9
18.5-24.5	1326	58.3	56.1	60.6
>24.5	640	28.3	26.2	30.4
Parity				
1	712	31.9	29.8	34.0
2-3	966	42.9	40.7	45.1
≥4	597	25.3	23.5	27.1
Educational attainment				
Primary level or less	328	13.3	11.8	14.9
Secondary level	1207	54.1	51.9	56.4
Tertiary level	740	32.6	30.5	34.7
Employment status				
Working	487	21.7	19.9	23.6
Not working	1788	78.3	76.4	80.1
Number of prenatal check-ups				
1-3	283	12.0	10.6	13.6
4 or more	1992	88.0	86.4	89.4
Received nutrition advice during ANC				
No	991	42.5	40.2	44.9
Yes	1284	57.5	55.1	59.8
Intake of IFA				
Without	1994	87.8	86.1	89.4
With	281	12.2	10.6	13.9

Table 1. Characteristics of study children 6-23 months old and their mothers, and the socio-demographic and economic status of households: Philippines, 2015 (*n*=2,275) [Cont'd]

Characteristics	*n*	*Proportion*	*95% Confidence Interval*	
			LL	*UL*
Method of delivery				
Normal	2021	88.4	86.7	89.9
Caesarean	254	11.6	10.1	13.3
Place of delivery				
At home	262	10.9	9.5	12.5
Health facility	2013	89.1	87.5	90.5
Assistance during Delivery				
Doctor/Nurse/Midwife	2113	93.4	92.2	94.4
Traditional birth attendant and others	162	6.6	5.6	7.8
Household characteristics				
Household size				
≤5	835	36.5	34.4	38.6
>5	1440	63.5	61.4	65.6
Food security status				
Food insecure	1712	74.6	72.5	76.6
Food secure	563	25.4	23.4	27.5
Wealth quintile				
Poorest	516	19.5	17.9	21.1
Poor	545	21.8	20.0	23.6
Middle	476	21.6	19.8	23.5
Rich	406	20.1	18.3	22.0
Richest	332	17.1	15.3	19.0
Area of residence				
Rural	1322	50.6	47.9	53.3
Urban	953	49.4	46.7	52.1
Toilet facility				
No toilet/not water-sealed/open pit	283	11.3	10.0	12.8
Water-sealed	1992	88.7	87.2	90.0

the statistical software package STATA version 15 (Corp LLC, Texas, USA). The level of significance was set at $p<0.05$ for all statistical tests performed.

RESULTS

General profile of study children

Table 1 shows the characteristics of study children and their mothers, as well as the socio-demographic and economic status of the households. The study covered 2,275 young children aged 6-23 months, which was composed of children aged 6-11 months (35.1%) and 12-23 months (64.9%), with almost equal representation of boys (49.9%) and girls (50.1%). Less than one-fifth of the study children (13.2%) were low-birth-weight (<2,500g). Most mothers of the study children were ≥20 years old (93.4%). More than half (58.3%) of mothers of the study children had normal BMI, while 13.4% were undernourished and 28.3% had BMI above normal. Almost half of

the mothers (45.5%) were under 151 cm in height. About one-third (31.9%) were first time mothers, while 42.9% had 2-3 children and 25.3% had ≥4 children. More than half (54.1%) of the mothers reached secondary level, while 32.6% were at tertiary level in terms of educational attainment. Majority of the mothers (78.3%) were not working at the time of the survey. Most of them (88.0%) received at least 4 times of prenatal check-ups throughout the course of their pregnancy. More than half (57.5%) received nutrition advice during prenatal check-up, while only 12.2% reported having consumed iron-folic acid supplements during their pregnancy. Meanwhile, most mothers (88.4%) delivered their child through normal delivery, in a health facility (89.1%), and with the assistance of health professionals (93.4%). More than two-thirds (63.5%) of the children belonged to households with >5 members. Majority of the study children (74.6%) belonged to food insecure households and many were from poor households (41.3%). An almost equal proportion of children were from rural (50.6%) and urban (49.4%) areas. Most households had improved toilet facility.

Prevalence of stunting in relation to child, maternal and household characteristics

Stunting and severe stunting prevalence by child characteristics are presented in Table 2. Stunting and severe stunting were significantly higher among older children aged 12-23 months (23.1% and 11.0%, respectively), boys (22.7% and 10.4%, respectively), and low-birth-weight children (28.3% and 13.1%, respectively) than their subgroup counterparts. Moreover, stunting and severe stunting were significantly higher among children born from mothers with height <151 cm (24.7% and 12.2%, respectively), and with BMI <18.5 kg/m^2 relative to their counterpart children. Similarly, stunting and severe stunting were higher among children 6-23 months old whose mothers had lower educational attainment (28.1% and 10.8%, respectively) and were not working (20.0% and 7.9%, respectively), compared to children whose mothers reached at least secondary level of education (14.9% and 6.5%, respectively) and were working (14.4% and 9.8%, respectively). More severely stunted children were noted among those born via normal as opposed to caesarian delivery (9.0% vs. 3.0%), born at home than at a health facility (15.2% vs. 7.5%), and born through the assistance of traditional birth attendants than of health professionals (17.3% vs. 7.7%). In terms of household characteristics, higher proportions of severely stunted children were recorded from food insecure (9.3%) than from food secure households (5.4%). Stunting was also higher among children from the poorest (21.6%) and poor households (24.3%) than those from the richer households (12.4%). Likewise, cases of stunting and severe stunting were higher among households with unimproved toilet facilities (24.3% and 14.6%, respectively) compared to households with water-sealed toilet facilities (18.0% and 7.5%, respectively).

Prevalence of stunting in relation to feeding practices

Table 3 shows the prevalence of stunting by feeding practices of children 6-23 months old. Provision of prelacteals, timing of introduction to complementary foods, minimum meal frequency (MMF), and MAD were found to be significantly associated with stunting and severe stunting. Children who did not receive prelacteals (20.0%) had a higher prevalence of stunting than those who were given prelacteals (14.6%). A greater percentage of children who were introduced to complementary foods either too early or too late were stunted (20.4%) and severely stunted (9.6%) compared to those who received timely

Table 2. Prevalence of stunting and severe stunting in children 6-23 months old by child, maternal, and household characteristics: Philippines, 2015 (*n*=2,275)

Characteristics	*Stunted*		*Severely stunted*	
	HAZ <-2SD (%)	*p-value*	*HAZ <-3SD (%)*	*p-value*
Child characteristics				
All	18.7		8.3	
Age in months		<0.01*		<0.01*
6-11	10.8		3.4	
12-23	23.1		11.0	
Sex		<0.01*		<0.01*
Boys	22.7		10.4	
Girls	14.8		6.2	
Birth weight		<0.01*		<0.01*
<2,500g	28.3		13.1	
≥2,500g	17.3		7.6	
Maternal characteristics				
Age in years		0.08		0.57
<20	25.5		6.0	
20-29	18.0		8.6	
≥30	18.6		8.4	
Height		<0.01*		<0.01
<151 cm	24.7		12.2	
≥151 cm	13.7		5.1	
BMI (kg/m^2)		0.22		0.02*
<18.5	22.3		10.5	
18.5-24.5	17.9		9.0	
>24.5	18.8		5.9	
Parity		0.41		<0.01*
1	17.7		6.1	
2-3	18.4		7.8	
≥4	20.6		12.2	
Educational attainment		<0.01*		0.05*
Primary level or less	28.1		10.8	
Secondary level	18.8		8.9	
Tertiary level	14.9		6.5	
Employment status		<0.01*		0.18
Working	14.4		9.8	
Not working	20.0		7.9	
Number of prenatal check-ups		0.94		0.04*
1-3	18.9		11.9	
≥4	18.7		7.9	
Received nutrition advice		0.58		0.09
No	19.3		9.5	
Yes	18.3		7.5	
Intake of IFA		0.82		0.83
Without	18.8		8.4	
With	18.2		8.0	

Table 2. Prevalence of stunting and severe stunting in children 6-23 months old by child, maternal, and household characteristics: Philippines, 2015 (*n*=2,275) [Cont'd]

Characteristics	*Stunted*		*Severely stunted*	
	HAZ <-2SD (%)	*p-value*	*HAZ <-3SD (%)*	*p-value*
Method of delivery		0.07		<0.01*
Normal	19.3		9.0	
Caesarean	14.3		3.0	
Place of Delivery		0.18		<0.01*
At home and others	21.7		15.2	
Health facility	18.4		7.5	
Assistance during Delivery		0.09		<0.01*
Doctor/Nurse/Midwife	18.4		7.7	
Traditional birth attendant and others	23.7		17.3	
Household characteristics				
Food security status		0.06		<0.01*
Food insecure	19.8		9.3	
Food secure	15.8		5.4	
Wealth quintile		<0.01*		<0.01*
Poorest	21.6		13.9	
Poor	24.3		8.0	
Middle	17.9		9.3	
Rich	16.3		7.0	
Richest	12.4		2.8	
Area of residence		0.04*		0.03*
Rural	20.4		9.6	
Urban	17.0		7.0	
Toilet facility		0.02*		<0.01*
No toilet/ not water-sealed/open pit	24.3		14.6	
Water-sealed	18.0		7.5	
Household size		0.20		0.99
≤5	17.3		8.3	
>5	19.6		8.3	

*Significantly different across categorical variables at $p<0.05$ using Pearson's Chi-square test (test of proportion).

introduction of complementary foods (9.9% and 1.3%, respectively). Similarly, children who failed to meet the MMF had a higher proportion of severe stunting (13.0%) than those who met the MMF (8.1%). Children who met the minimum acceptable diet, however, had a higher proportion of severe stunting (10.8%) than those who did not meet the MAD (7.7%).

Risk factors of stunting

Results of the multinomial logistic regression analysis conducted to determine the predictors of stunting after controlling for potential confounding variables are shown in Table 4. In terms of child-related characteristics, belonging to an older age group increased the relative risk of being stunted. Children aged 12-23 months had about three-

Table 3. Prevalence of stunting and severe stunting in children 6-23 months old by feeding practices: Philippines, 2015 (*n*=2,275)

Feeding practices	*Stunted*		*Severely Stunted*	
	HAZ <-2SD (%)	*p-value*	*HAZ <-3SD (%)*	*p-value*
Breastfeeding initiation				
Never	26.1	0.58	0.0	0.26
Within one hour	19.3			
Beyond one hour	17.3			
Do not know	19.8			
Ever had exclusive breastfeeding				
No	14.4	0.06	6.9	0.39
Yes	19.4		8.6	
Prelacteal feeding				
Not given	20.0	0.01*	8.5	0.67
Given	14.6		7.8	
Introduction to complementary foods				
Untimely	20.4	<0.01*	9.6	<0.01*
Timely	9.9		1.3	
MDD				
Not met	18.5	0.62	7.9	0.26
Met	19.3		9.4	
MMF				
Not met	23.6	0.17	13.0	0.03*
Met	18.5		8.1	
MAD				
Not met	18.7	0.97	7.7	0.05*
Met	18.8		10.8	

*Significantly different across categorical variables at $p<0.05$ using Pearson's Chi-square test (test of proportion).

fold higher risk of being stunted (RRR 3.04; 95% CI 2.14-4.32) and three times more risk of being severely stunted (RRR 3.31; 95% CI 1.87-5.84) than children aged 6-11 months old. Likewise, male children had two times higher risk of stunting (RRR 1.99; 95% CI 1.56-2.54) and severe stunting (RRR 2.24; 95% CI 1.58-3.18) than their female counterparts. Low birth weight (LBW) can also lead to a more than two-fold increase in the risk of being stunted (RRR 2.19; 95% CI 1.63-2.94) and severely stunted (RRR 2.34; 95% CI 1.48-3.69). Teenage mothers had 90% higher risk of having a stunted child (RRR 1.90; 95% CI 1.11-3.25), while mothers 20-29 years old had 66% greater risk of having a severely stunted child (RRR 1.66; 95% CI 1.10-2.50). Shorter mothers also had more than two-fold higher probability of having a stunted child (RRR 2.33; 95% CI 1.83-2.97) and a three-fold risk of having a severely stunted child (RRR 3.01; 95% CI 2.12-4.30). Mothers with more than four children, meanwhile, had double the risk of having a severely stunted child (RRR 2.44; 95% CI 1.135-4.41). Mothers who did not finish any grade levels or reached at most primary level of education had 59% greater risk of having a stunted child (RRR 1.59; 95% CI 1.09-2.32). Children from the poorest households had more than four-fold greater risk of being severely stunted (RRR 4.27; 95% CI 1.96-9.28)

Table 4. Multivariate analysis of child, maternal, household characteristics, and feeding practices associated with stunting and severe stunting in children 6-23 months old: Philippines, 2015 (*n*=2,275)

Characteristics	*Stunting*				*Severe Stunting*			
	RRR†	*p-value**	*(95% C.I.)*‡ *LL*	*UL*	*RRR*†	*p-value**	*(95% C.I.)*‡ *LL*	*UL*
Child characteristics								
Age in months								
6-11	ref. category							
12-23	3.04	<0.01	2.14	4.32	3.31	<0.01	1.87	5.84
Sex								
Male	1.99	<0.01	1.56	2.54	2.24	<0.01	1.58	3.18
Female	ref. category							
Birth weight								
< 2,500 g	2.19	<0.01	1.63	2.94	2.34	0.000	1.48	3.69
≥ 2,500 g	ref. category							
Maternal characteristics								
Age in years								
<20	1.90	0.02	1.11	3.25	1.64	0.30	0.65	4.13
20-29	1.16	0.30	0.88	1.52	1.66	0.02	1.10	2.50
≥30	ref. category							
Height								
<151 cm	2.33	<0.01	1.83	2.97	3.01	<0.01	2.12	4.30
≥151 cm	ref. category							
Parity								
1	ref. category							
2-3	1.19	0.30	0.86	1.64	1.46	0.12	0.91	2.32
≥4	1.20	0.35	0.82	1.76	2.44	<0.01	1.35	4.41
Education								
Primary level and less	1.59	0.02	1.09	2.32	0.85	0.59	0.48	1.53
Secondary level	1.07	0.68	0.79	1.44	0.97	0.90	0.62	1.52
Tertiary level and above	ref. category							
Wealth status								
Poorest	1.43	0.14	0.89	2.31	4.27	<0.01	1.96	9.28
Poor	1.69	0.03	1.05	2.73	2.42	0.03	1.07	5.44
Middle	1.29	0.28	0.81	2.04	2.87	0.01	1.29	6.38
Rich	1.23	0.41	0.75	2.01	2.32	0.03	1.07	5.03
Richest	ref. category							
Feeding practices								
Prelacteal feeding								
Not given	0.67	0.01	0.49	0.92	0.88	0.59	0.56	1.39
Given	ref. category							

Table 4. Multivariate analysis of child, maternal, household characteristics, and feeding practices associated with stunting and severe stunting in children 6-23 months old: Philippines, 2015 (*n*=2,275) [Cont'd]

Characteristics	*Stunting*				*Severe Stunting*			
	RRR†	*p-value**	*(95% C.I.)*‡		*RRR*†	*p-value**	*(95% C.I.)*‡	
			LL	*UL*			*LL*	*UL*
Complementary feeding introduction								
Untimely	1.28	0.33	0.78	2.09	4.44	<0.01	1.59	12.34
Timely	ref. category							
MMF								
Not met	1.82	0.02	1.12	2.95	2.30	<0.01	1.34	3.97
Met	ref. category							
Constant	0.02	<0.01	0.01	0.04	0.00	<0.01	0.00	0.00

†Relative Risk Ratio
‡95% Confidence Interval; Lower Limit (LL); Upper Limit (UL)
*Significant at $p<0.05$

compared to children from the richest households. Similarly, children from the poor, middle and rich quintiles had more than two times higher risk of becoming severely stunted as compared to their counterparts in the richest quintile. In terms of feeding practices, a history of not giving any prelacteal feed during the first three days of life reduced the risk of stunting by 67% (RRR 0.67; 95% CI 0.49-0.92). Untimely introduction to complementary foods, either too early or too late, increased a child's risk of being severely stunted by more than four-folds (RRR 4.44; 95% CI 1.59-12.34). Children who failed to meet the MMF had almost two-fold higher risk of being stunted (RRR 1.82; 95% CI 1.12-2.95) and more than double the risk of being severely stunted (RRR 2.30; 95% CI 1.34-3.97) than children meeting the MFF. The indicators of minimum dietary diversity (MDD) and MAD were found to be not associated with child stunting after controlling for confounding factors. No significant association was noted between stunting and other breastfeeding indicators.

DISCUSSION

Study findings reiterated the multi-factorial nature of stunting among children 6-23 months of age in the Philippines. Stunting and severe stunting were determined by the following proximal and distal factors: a) child-related characteristics (older age at 12-23 months, being male, and having low birth weight); b) maternal socio-demographic factors (younger age of <20 years and 20-39 years old, short stature of <151cm, high parity of >4, and lower educational attainment, and non-working status); c) prenatal care practices (<4 prenatal check-ups, vaginal method of delivery, childbirth at home, and assisted by traditional birth attendants); d) postnatal factors that affect the feeding practices of children 6-23 months old; and e) household socio-economic and demographic factors (poverty, food insecurity, residence in rural areas, and lack of improved toilet facility).

Associations of child, maternal, and household characteristics with stunting

Older age in children (12-23 months) and being male were found to increase the likelihood of stunting and severe stunting in the Philippines, as indicated by the results of the multinomial regression analysis. This is supported by the findings of Capanzana *et al.* (2020) and Adair and Guilkey (1997), which indicated that stunting in the Philippines follows an age and sex pattern. Based on this study, stunting prevalence is the same for both girls and boys at 12% during the first six months. However, between six and 18 months of age, linear growth in boys falters faster than in girls, resulting in a higher stunting prevalence among boys (29%) than girls (20%). Similarly, low birth weight (LBW<2,500g) increases the likelihood of stunting among children aged 0-23 months. This finding provides evidence that LBW can be used as a proxy for undernutrition *in utero,* which is strongly linked to the nutritional status of women at the time of conception and during pregnancy (Black *et al.*, 2013). By and large, foetal growth restrictions and LBW are identified as important contributors to stunting and wasting among children. To quantify the burden of LBW in the Philippines, a recent study examined the global prevalence and burden of small-for-gestational-age (SGA) and estimated that in 2012, 25.6% of Filipino newborns were SGA and 22.7% of neonatal deaths were attributable to SGA (either term or preterm), placing the Philippines among the top 10 countries with the highest SGA burden globally based on the INTERGROWTH-21st project (PSA & ICF, 2018).

Maternal factors that determined the likelihood of stunting included being <20 years old, having a height of <151cm, parity of >4, lower educational attainment, and non-working status. Poor nutritional status in pregnant teenage Filipino women is considered a major factor that can lead to poor child nutrition even as economic conditions improve. These findings are consistent with several studies conducted in Bangladesh (Donowits *et al.*, 2018; Alam *et al.*, 2017; Hasan *et al.*, 2019). Moreover, maternal weight at birth was reported as the strongest predictor of linear growth at two years of age (Donowitz *et al.*, 2018). The children of underweight mothers (BMI <18.5 kg/m^2) in the study of Donowitz *et al.* (2018) had 1.11 times the risk of being stunted (95% confidence interval, CI: 1.02–1.20) than Bangladeshi children of normal weight mothers. Mothers with BMI <18.5 kg/m^2 had 3.55 times higher odds (adjusted Odds Ratio, *aOR* 3.55, 95% CI: 2.34–5.38) of having stunted children than mothers with BMI ≥18.5 kg/m^2 in urban slum areas in Bangladesh (Alam *et al.*, 2017). Another important predictor of stunting among children <2 years is maternal short stature (<145cm), as reported by several studies (Ahmed *et al.*, 2012; Hasan *et al.*, 2019). Mothers with short stature (<145cm) have 4.7 times (95% CI: 2.28–9.56) higher chance of having a stunted child compared to mothers with greater height (Hasan *et al.*, 2019). Short mothers are also more likely to have a stunted child at two years of age (Addo *et al.*, 2013). A study done by Espo *et al.* (2002) in Malawi on the determinants of linear growth also found an association between short maternal stature and stunting at 12 months of age. This is because mothers and their offspring are likely to share the risk of having short stature both through genetic susceptibility and environmental exposure (Espo *et al.*, 2002). Goyal and Canning (2017) reported that the children whose mothers were <18 years old had 1.15 times (95% CI: 1.08–1.122) higher risk of being stunted. Furthermore, maternal education and working status have emerged as important factors that can predict stunting among children 6-23 months old. Infants born from mothers with at

least secondary education have a lower risk of stunting than children born from mothers without or with only elementary education. This probably reflects the role of formal education in the acquisition of knowledge for more effective meal selection and feeding practices for children. This finding corroborates with a study in Bangladeshi children whose mothers had ≥10 years of education had a 22% reduction in the risk of being stunted relative to those whose mothers had no education, while those whose mothers had 5–9 years of education had a 12% decrease in risk (Mistry *et al.*, 2019). Infants aged 6-23 months whose mothers were working had higher odds of being severely stunted as opposed to children with non-working mothers, possibly indicating the greater burden of caregiving and housework among non-working mothers who spend more time taking care of their children.

Other risk factors associated with stunting among children aged 6-23 months based on the bivariate analysis included inadequate health care during pregnancy (<4 prenatal check-ups) and childbirth (home birthing and births assisted by traditional birth attendants). These findings highlighted that the health care services availed by mothers during pregnancy and birth delivery affected their child's health and nutrition outcomes, reiterating the importance of addressing the first 1,000 days of a child's life. In the Philippines, the utilisation of prenatal care and care during delivery is high. Majority (80%) of mothers of children under 2 attended at least four antenatal visits and received assistance during delivery by a skilled practitioner (85%). However, the analysis of the 2015 national nutrition data showed that the disparity in maternal prenatal care including birth services was very high and associated with income and education (Capanzana *et al.*, 2020), of which 95% of mothers with college education had skilled assistance during delivery, while only 62% of mothers with elementary education or less had skilled assistance. This can probably explain the significant associations between stunting and inadequate prenatal check-ups and birth assisted by unskilled birth attendants. Furthermore, the ability of mothers to access adequate nutrition and health care for herself and her baby prior to and during pregnancy, as well as for postnatal care services highlights the importance of maternal health seeking behaviours, as mothers who underwent more prenatal check-ups and gave birth in hospitals may be more likely to avail of immunisation for their children or seek health care professionals for consultation when their children are ill.

The negative impacts of poor environmental conditions during the first 1,000 days of life provide the general picture of the factors associated with stunting in the Philippines. The risk of stunting linked to food insecurity, residence in rural areas, and poor sanitation (indicated by the absence of latrine or improved types of toilet) in the bivariate analysis points to the importance of household income as an underlying determinant of nutritional status in children <2 years of age. The negative impact of household food insecurity on childhood stunting was reported in Bangladesh (Alam *et al.*, 2017; Mistry *et al.*, 2019), where significant negative association between food insecurity and stunting among children under 2 years was documented. Other studies reported, however, that only severe food insecurity was significantly responsible for short stature in children (Choudhury *et al.*, 2017; Raihan *et al.*, 2018). Empirically, higher income enables households to secure adequate, diverse, frequent, and safe foods, and to ensure proper hygiene and sanitation that may result in a more enabling environment that leads to better nutrition among household members, specifically young children under 2 years of age. In the study of Capanzana *et al.* (2020), children in food

secure households and with access to animal source foods (ASFs) were around 10% less likely to be stunted compared to children from food insecure households and with poor access to animal source foods, though the inclusion of socio-economic factors in the adjusted model attenuated these associations, likely reflecting the role of income in mediating access to foods. Improved hygiene and toilets were also identified as protective factors that prevented stunting in children (Ahmed *et al.*, 2012; Alam *et al.*, 2017; Mistry *et al.*, 2019).

Associations of breastfeeding and complementary feeding with child stunting

After controlling for household socio-economic, child and maternal characteristics as potential confounding variables in the regression analysis, the history of not giving prelacteal feeds during the first three days of life reduced the risk of stunting. Untimely introduction of complementary foods (either too early or too late) increased the child's odds of being stunted by almost twice and of being severely stunted by more than four times. This is consistent with the findings of a meta-analysis conducted in Bangladesh (Islam *et al.*, 2020), where the initiation of complementary feeding at or after seven months of age increased the risk of stunting by 1.23 times (adjusted β=1.23, 95% CI: 1.05–1.44) with respect to those who were introduced to complementary foods at 5–6 months of age. Children meeting the minimum meal frequency in this study had significantly lower odds of becoming stunted than children who failed to meet the MMF. This parallels the results of other studies that showed that children who took foods at less than the required frequency had higher risks of being stunted (Hasan *et al.*, 2019). For children who received soft, semi-solid, and solid foods according to their age, the chance of chronic malnutrition was 1.34 times (p=0.005) lower (Zongrone *et al.*, 2012). The MDD indicator, intended as a proxy indicator of micronutrient adequacy intake, was not associated with stunting in this study. This result was unexpected given the considerable amount of evidence demonstrating the positive association between diverse diets and better child growth outcomes. The small proportion of children meeting the MDD indicator (19.3% among stunted; 9.4% among severely stunted) in this study may not have allowed for sufficient power to detect differences in child stunting. Similarly, the MAD indicator was not associated with stunting in this study. This might also be due to the small proportion of children meeting the MAD indicator, which is driven largely by the MDD component of the MAD, as a composite indicator of MDD and MMF. Capturing the complex dynamics of complementary feeding in a single indicator may contribute to the lack of association observed in MDD and MAD with child stunting.

Way forward

The evidence from this study suggests that the risk factors of stunting among young children 6-23 months include maternal nutrition prior to and during pregnancy, and during the first two years of life, which points out the importance of the first 1,000 days approach. The major challenges to address the multi-factorial nature of stunting in the Philippines warrant critical planning and significant investments, both in nutrition specific and nutrition sensitive interventions to improve the two major drivers: maternal and young child nutrition as well as food security and diversity. Further, greater focus should be placed on adolescent girls and pregnant women for the improvement of birth outcomes, health and nutrition through sound policy framework and nutrition action plan, both at the national and local levels, followed by scaling up effective nutrition interventions. In view of the scaling up of nutrition interventions, nutrition

services should be mainstreamed into the health system nationally and locally. At the local level, nutritionist-dedicated nutrition interventions should be in place to ensure priority, along with strong monitoring and evaluation mechanisms of the various nutrition interventions.

Strengths and limitations

This study has several strengths, one of which was that it utilised a large, national, and population-based survey with a high response rate (97.0%) among eligible respondents. Also, the survey was conducted by trained researchers and employed standard equipment and techniques of measurements. Results can therefore be generalised for the entire country and can also be compared with other countries. Moreover, this study used the WHO conceptual framework in determining a broad range of factors that influence stunting during the first 1,000 days of life. Study analysis and results could also serve as crucial inputs for action planning and future research on stunting. The primary limitation of this study is that its results only reflect associations, as relationships between the identified factors and stunting cannot be inferred. This is due to the cross-sectional nature of the study design, wherein data was collected at a single point in time. Another limitation is that other factors were not considered, such as micronutrient levels, infection, and childcare stimulation.

CONCLUSION

These findings illustrate the multi-factorial nature of the stunting problem in the Philippines during the complementary feeding period from 6 to 23 months. Identified predictors of stunting among children 6-23 months are older age; being male; having low birth weight; being born from mothers in younger age groups, with low educational attainment, shorter stature, and higher parity; history of prelacteal feeding within the first three days of life, untimely introduction of complementary foods; less frequent feeding; and poor wealth status. Findings of the study support the efforts to promote and ensure not only the timely introduction of complementary foods, but also the diversity, appropriate frequency, and acceptability of foods to ensure adequate energy and micronutrient consumption among young children. With this, a multi-sectoral approach is needed to address the different underlying factors of stunting among young children.

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Authors' contributions

MOG, conceived and carried out the study; EAG, reviewed and edited the manuscript; MLVM, analysed and interpreted the data. All authors read and approved the manuscript.

Conflict of interest

The authors declare that they have no competing interests.

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Malnutrition and its associated factors among children under 5 years old in Putrajaya: a study protocol

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ABSTRACT

Introduction: Prevalence of malnourished children in Putrajaya was unexpectedly high in 2016. This paper describes the study protocol for a case-control study conducted to identify the associated factors of malnutrition among children under 5 years old in Putrajaya. **Methods:** This study involved two phases. Phase I was 'screening' where all children aged 6-59 months in 118 preschools and four government health clinics were measured for their weight and height. The World Health Organization Anthro software was used to determine the nutritional status of these children. Phase II was the 'interview' where children from screening were sampled into four pairs of case and control. The optimum sample size for the case of stunted, wasted, underweight, and overweight were 380, 335, 318, and 308, respectively. The same number of controls were recruited. Parents/caregivers of selected children were approached to obtain data on parental factors, children factors, food intake factors, and environmental factors that contributed to malnutrition. Data analysis was performed by multiple logistic regression in SPSS version 26. **Results:** Screening phase successfully measured 8,261 (50.1%) children from an estimated 16,500 children under 5 years old in Putrajaya. The number of children who were stunted, wasted, underweight, and overweight were 2,105 (25.5%), 512 (6.2%), 1,516 (18.4%), and 248 (3.0%), respectively. As overweight was under-sampled, the number of controls for overweight was doubled to increase the power of the study. Parents/caregivers of selected cases and controls were interviewed in their household or any other venues at their convenience. **Conclusion:** This protocol promises beneficial outputs to stakeholders and policy makers that can be used for combating malnutrition in children.

Keywords: Malnourished children, children under five, study protocol, case-control, Putrajaya

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INTRODUCTION

Malnutrition is a state of disordered nutrition, in which a combination of varying degrees of over- or undernutrition and inflammatory activity has led to a change in body composition, diminished functions and health outcomes (Soeters *et al.*, 2017). Undernutrition is defined as inadequate or imbalanced intake or absorption of micro- or macronutrients that leads to multiple conditions including acute and chronic malnutrition and micronutrient deficiencies; while overnutrition usually is associated with overweight and obesity, a form of malnutrition where the amount of nutrients consumed exceeds the amount required for normal growth, development, and metabolism (Black *et al.*, 2016). The co-existence of under- and overnutrition in a population is recognised as a "nutrition transition", which has been linked to rapid economic development, urbanisation, and overall modernisation in both low- and middle-income countries (Shetty, 2013).

According to the findings from the National Health and Morbidity Survey (NHMS) 2016, the prevalence of stunting, wasting, underweight, and overweight among children under 5 years old in Malaysia were 20.7%, 11.5%, 13.7%, and 6.4%, respectively (IPH, 2016a). Compared to previous NHMS 2011 and NHMS 2015, the prevalences of stunting and underweight have increased throughout this period. However, for wasting, the prevalence decreased from NHMS 2011 to NHMS 2015, and increased in NHMS 2016. On the contrary, the prevalence of overweight increased from NHMS 2011 to NHMS 2015, but decreased in NHMS 2016 (IPH, 2015; IPH, 2011). The current categorisation of prevalence threshold for malnutrition in children under 5 years old discloses that stunting and wasting in Malaysia are of high public health significance, while overweight is regarded as medium public health significance. This categorisation predicts a huge burden on health care services in future if the current condition remains as high public health significance (De Onis *et al.*, 2019).

Putrajaya, which is the administrative capital of Malaysia, recorded the fourth highest prevalence for stunting (24.3%) among children under 5 years old in the country in 2016. Meanwhile, the prevalences for other malnutrition indicators - wasting (8.7%), underweight (12.9%), and overweight (4.5%) in Putrajaya were approximately the same as the national prevalences (IPH, 2016a). These malnutrition issues among children under 5 years old, specifically in Putrajaya, has been highlighted in the government's cabinet meeting. The top management has since requested for more data and immediate action. One of the proposed efforts is a comprehensive study to find out the factors contributing to childhood malnutrition in Putrajaya.

Table 1 illustrates the associated factors of malnutrition in children according to previous local and international studies. Generally, four categories of associated factors can be formed, which are parental factors, children factors, food intake factors, and environmental factors (Stewart *et al.*, 2013; Pasricha & Biggs, 2010; Wong, Moy & Nair, 2014; Harding, Aguayo & Webb, 2018; Rahman, 2016; Andegiorgish *et al.*, 2012; Park *et al.*, 2013). All associated factors in Table 1 were translated into assessment modules in this study. This paper describes the study protocol of a case-control study to identify the associated factors of malnutrition among children under 5 years old in Putrajaya.

Table 1. Associated factors of malnutrition among children under 5 years old from literature review

Associated factors from previous studies	*Stunted*	*Wasted*	*Underweight*	*Overweight*
Parental factor				
Parental height	✓ adf	✓ g		
Parental body weight status		✓ g		✓ bc
Lower education	✓ adf	✓ adf	✓ adf	✓ bc
Working mother				✓ c
Low household income	✓ adf	✓ adfg	✓ adf	
Higher household income				✓ c
Pre-pregnancy BMI >25kg/m^2				✓ bc
Gestational diabetes mellitus				✓ bc
Children factor				
Low birth weight	✓ adef	✓def	✓ adef	
High birth weight				✓ bc
Male in gender	✓ f	✓ fg		✓ bc
Delayed initiation	✓ df			
More than four siblings	✓ adef	✓ ef	✓ adef	
Frequent illness (monthly)	✓ adef	✓ adef	✓ adef	
Worm infection	✓ adef	✓ adef	✓ adef	
Anaemia		✓ adf	✓ adf	
Rapid weight gain under 1 year				✓ c
Firstborn in the family				✓ c
Food intake factor				
Non-exclusive breastfeeding	✓ df	✓ df	✓ df	
Early cessation of breastfeeding	✓ df	✓ df	✓ df	✓ c
Complementary feeding not at 6 months	✓ df	✓ df	✓ cf	✓ c
Received bottle-feeding		✓ df	✓ df	✓ c
Using pacifier		✓ df	✓ df	
Infrequent & inadequate feeding	✓ adef	✓ def	✓ adef	
High calorie and sugar intake				✓ c
Low dietary diversity	✓ adef	✓ def	✓ adef	✓ c
Food insecurity	✓ adef	✓ ade	✓ ade	
Environmental factor				
Inadequate child stimulation and activity	✓ df	✓ d	✓ d	✓ bc
Poor care practice	✓ df	✓ d	✓ d	✓ c
Screen time >2 hours				✓ c
Long sleep duration				✓ c

[a] Pasricha & Biggs, 2010
[b] Andegiorgish *et al.*, 2012
[c] te Velde *et al.* 2012
[d] Stewart *et al.*, 2013
[e] Wong *et al.*, 2014
[f] Rahman, 2016
[g] Harding *et al.*, 2018

MATERIALS AND METHODS

Study design

This was a case-control study to identify the associated factors of malnutrition among children under five in Putrajaya. Four case groups were formed, which were stunted [height-for-age <-2 standard deviations (SDs)], wasted [Body mass index (BMI)-for-age <-2SDs], underweight (weight-for-age <-2SDs), and overweight (BMI-for-age >2SDs). The control group consisted of children who had normal z-scores for all malnutrition indicators (2SDs to -2SDs).

Study location

This study was conducted from September 2018 to January 2019 in Putrajaya. It involved two phases - screening and interview. Screening was conducted in all 118 preschools and all four government health clinics in Putrajaya from 12 September 2018 to 12 October 2018. The interview phase with the selected participant's parents/ caregivers was conducted from 16 October 2018 to 31 January 2019 in their house or office, their child's kindergarten or any other venues at their convenience.

Study population

Children aged 6 to 59 months old, Malaysia citizen, and living in Putrajaya for at least six months were the inclusion criteria for this study. The exclusion criteria were children who were mentally or physically disabled, ill at the time of data collection, and children with a chronic disease that caused them the inability to take part in this study.

Sample size estimation

The sample size of this study was calculated based on the objective of identifying the associated factors (refer to Table 1) of stunting, wasting, underweight, and overweight among children under 5 years old. Sample size calculation was done using PS (Power and Sample Size Calculation) software based on the formula for comparing two proportions, according to identified associated factors in the findings from NHMS 2016 and other previous studies, with type 1 error (α) equals to 0.05 and power (β) equals to 0.80. The minimum sample size for the groups of stunted, wasted, underweight, and overweight were 380, 335, 318, and 308, respectively. Each case group was compared with the same number of children with normal nutritional status. The ratio of case to control in this study was one to one.

Respondent recruitment

Respondent recruitment for phase I (screening) was carried out in all 118 registered preschools under the Department of Social Welfare and all four government health clinics in Putrajaya. All available children who came into these facilities during the screening period were included in the database.

Respondent recruitment for phase II (interview) began after the selection of children for case and control groups from the screening database. Database of the children from screening were divided into five groups (stunted, wasted, underweight, overweight, and normal). Random between function in Excel was used for random selection of 380 stunted children, 335 wasted children, 318 underweight children, and 308 overweight children. The selected cases from each group were then tabulated by sex and age groups (6 –11 months, 12–35 months, and 36–59 months). Then, the control groups were recruited by matching the sex and age group of each case group using the random between function in Excel with a one to one ratio. Ethics approval for the study was obtained from the Medical Research Ethics Committee (MREC),

Ministry of Health Malaysia (NMRR-18-847-41455). Parents or caregivers of selected participants signed the consent forms prior to taking measurements and participating in the interview sessions.

Tools and instrument

Four sections of data collection were carried out. The first was a face-to-face interview with parents or caregivers by trained interviewers. The collected information were saved in tablets using a custom designed application, named Survey Creating System (SCS). The information included sociodemographic and socioeconomic characteristics, participants and mothers' health and medical history, knowledge and practice of parents or caregivers towards child feeding, dietary behaviour of the child, infant and young child feeding (IYCF) history (WHO, 2010), food security (Radimer/Cornell hunger and food security instrument (Sharif & Ang, 2001), and early years physical activity questionnaire (EY-PAQ) (Bingham, 2016).

The second section, which was anthropometric measurements for children and their parents or caregivers, were measured by nurses. Body weight was measured using the TANITA Personal scale HD 319 (TANITA Cooperation, Tokyo, Japan) and height was measured using a SECA Stadiometer 213 (SECA Cooperation, Humberg, German). The value of the measurement was rounded to the nearest 0.1kg for weight and 0.1cm for height. For baby or children who could not stand properly, their weight was measured using the SECA 354 digital baby scale and length using the SECA 210 mobile baby measuring mat. The World Health Organization (WHO) Anthro Software version 3.2.2 was used to identify eligible cases and controls (WHO, 2011a).

The third section was an anaemia test. Since anaemia is a risk factor for undernutrition in children, this study only measured haemoglobin levels of stunted, wasted, and underweight children, as well as their respective controls (Pasricha & Biggs, 2010; Khan, Awan & Misu, 2016). Haemoglobin levels of children were tested from a finger-prick blood sample using the portable HemoCue® Haemoglobin 201 analyser (HemoCue AB, Ängelholm, Sweden). Anaemia in children is defined as a haemoglobin concentration of less than 11.0g/dl as suggested by WHO (WHO, 2011b).

The fourth section was collecting data from a three-day food diary. The three-day food diary (two days weekdays and one day weekend) of children was completed by their parents or caregivers. For children who went to preschools, their teachers were given the responsibility to record their food intake in the food diary during weekdays. The information provided were verified by the interviewers before data entry. Total energy and nutrient intakes were analysed using the NutritionistPro software.

Field preparation and logistic support

Data collection was carried out by six teams. Each team consisted of a team leader, a research assistant, and a nurse. The list of preschools in Putrajaya was obtained from the Department of Social Welfare. All 118 preschools were informed about this study by the Department of Social Welfare. Invitation letters to participate were distributed to parents or caregivers by the preschools' management staffs.

Body weight and height of preschool children were measured during the screening phase. Information of child's name, date of birth, gender, name of parents or caregivers, living address, and contact number of parents or caregivers were obtained from the preschool authorities. In addition,

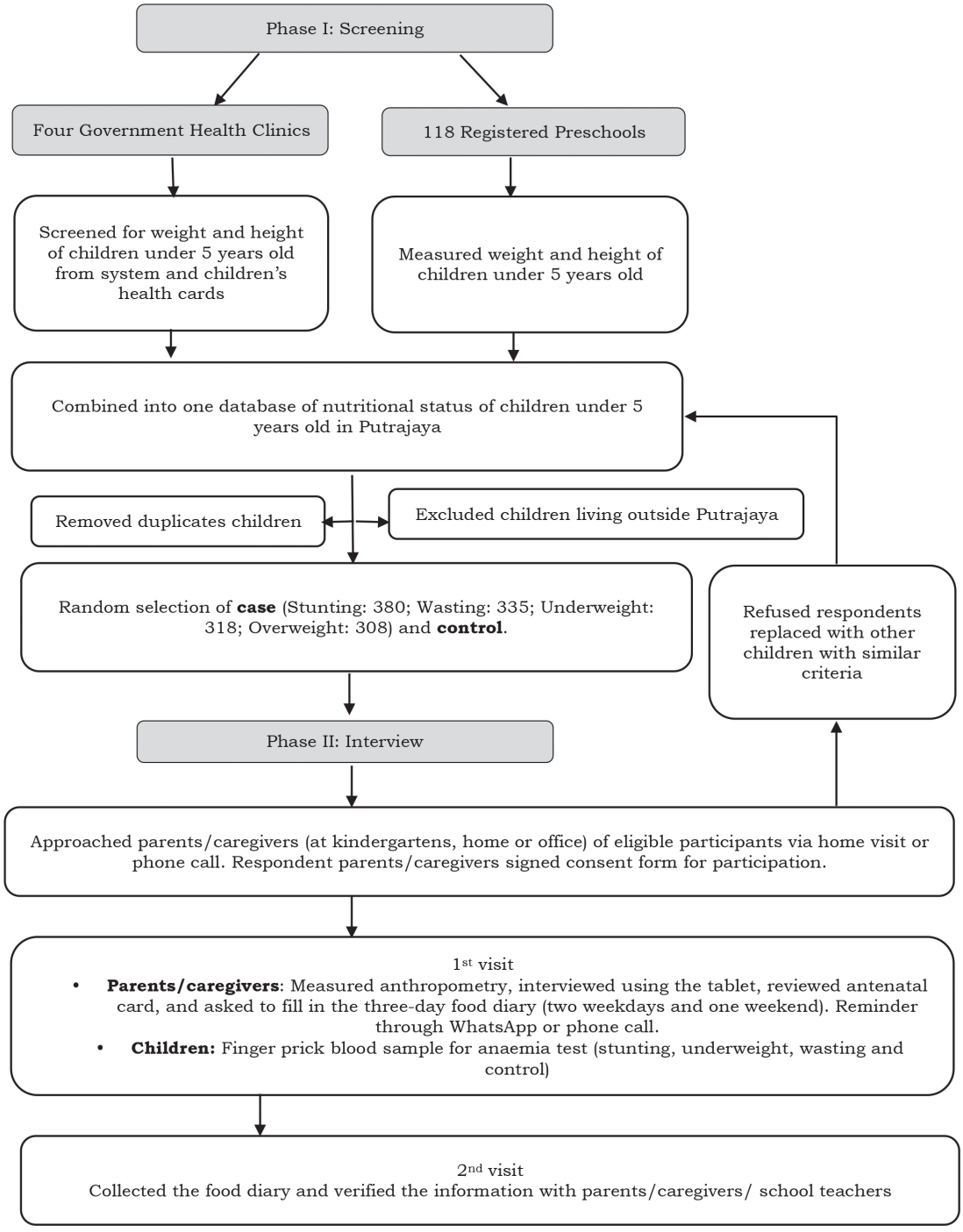

Figure 1. Data collection flow from screening phase to interview phase

the data collectors visited all four government health clinics in Putrajaya, located in Precincts 9, 11, 14, and 18. Information on the latest weight and height, name of child, date of birth, gender, name of parents or caregivers, living address, and contact number of parents or caregivers were obtained from the patients' management system or record books at the clinics.

Data obtained from all 118 preschools and four government health clinics were combined in one database. Duplicates of children from preschools and government health clinics were removed, while children living outside of Putrajaya were excluded from the database. Children who met the inclusion criteria were divided into five groups, which were stunted, wasted, underweight, overweight, and normal. Then, they were randomly selected according to the sample size required for each group.

During the interview phase, parents or caregivers of the selected children were approached through phone calls and invitation letters. The data collectors visited all parents or caregivers who agreed to participate in this study. Two health clinics were established as interview centres to provide additional option for parents or caregivers. Figure 1 demonstrates the data collection flow from screening phase to interview phase.

Data management

Each selected respondent was given a unique identification number (ID) prior to the interview phase. Data from the tablets were sent directly to the server of the Institute for Public Health (IPH) via internet. Data processing and management were conducted simultaneously by the data manager at IPH to ensure that all data were correctly received. Data were then extracted into the Microsoft Excel format. The three-day food diary were delivered to IPH weekly. The data entry team in IPH received and converted the participants' food intakes into gram based on standard recipes. After conversion to gram, the data were keyed into the NutritionistProTM software version 7.5 (Axxya System, Washington, United States of America). NutritionistProTM analysed the food intakes into calories and nutrient intakes by referencing the Malaysian Food Composition Database (MyFCD) and other established databases.

Data analysis

Descriptive statistics were used to describe the studied variables. Single and multiple logistic regression were performed to analyse potential factors of malnutrition such as the questionnaire on maternal and birth characteristics. Odds ratio (*OR*) and its 95% confidence interval (CI) were estimated and computed for each significant factor and continuous data using binary logistic regression. A factor with an *OR* significantly ($p<0.05$) >1.00 was taken as a risk factor of child malnutrition, while an *OR* significantly ($p<0.05$) <1.00 was regarded as a protective factor. The goodness of fit for the final logistic regression model was analysed using the Hosmer-Lemeshow technique. The statistical significant level was set at 0.05. All statistical analyses were performed using SPSS version 26.

RESULTS

Out of 8,261 children under 5 years old recruited during screening, a total of 2,105 (25.5%), 512 (6.2%), 1,516 (18.4%), and 248 (3.0%) were found to be stunted, wasted, underweight, and overweight, respectively (Table 2). There were children who were found to have >1 indicator of malnutrition. Therefore, they were allocated into >1 case group.

Table 2. Distribution of case groups (stunted, wasted, underweight, and overweight) and control (normal) from this study and findings from NHMS 2016

Indicator	*Screening Phase*			*NHMS 2016*
	Sample size required	*n*	*% (95%CI)*	*% (95%CI)*
Stunted	380	2105	25.5 (24.57, 26.43)	24.3 (19.05, 30.42)
Wasted	335	512	6.2 (5.68, 6.72)	8.7 (6.39, 11.75)
Underweight	318	1516	18.4 (17.56, 19.24)	12.9 (9.56, 16.76)
Overweight	308	248[†]	3.0 (2.63, 3.37)	4.5 (3.18, 6.36)
Normal	380	5223	63.2 (62.22, 63.22)	–

[†]less than required sample size

In general, the number of overweight children recruited into the overweight group was less than the minimum required sample size. A total of 5,223 (64.0%) children were normal and eligible to be allocated into the control group.

Table 2 shows the results of screening for this study with comparison to the findings from NHMS 2016 in Putrajaya. On average, the prevalences of different malnutrition groups in this study were comparable with the results from NHMS 2016, except for underweight. The prevalence of underweight was significantly higher in this study according to 95% confident interval compared to NHMS 2016.

DISCUSSION

This paper described the methodology to identify or determine factors associated with malnutrition among children under five years old in Putrajaya. The case-control study design was chosen as this was the best approach to determine whether an exposure (tested variable) is associated with an outcome (case/control) with limited time and minimum cost (Song & Chung, 2010). The cases and controls were also matched by sex and age groups to improve the study efficiency by enhancing precision in the analysis. The increase in efficiency occurs because it ensures similar number of cases and controls in confounder strata (sex and age groups) (Pearce, 2016).

The ratio of one-to-one for case group and control group was applied in this study. At the same time, all four case groups were compared with the same control group in order to provide adequate power for this study with minimum sample size. It also shortens the data collection time and reduces study expenses. However, this study has a limitation where only 248 overweight children were found, which was lower than the minimum sample size required for the overweight group. Therefore, the number of participants in the control group was increased to double the ratio of overweight to control as one to two so that it can provide adequate power to detect a significant association (Kang, Choi & Koh, 2009).

The phase I results from this study found that 25.5% of children under five years old in Putrajaya were stunted, 6.2% were wasted, 18.4% were underweight, and 3.0% were overweight. Through 95% CI, the prevalence of underweight was significantly higher when compared to the findings in NHMS 2016 for Putrajaya (12.9%). Meanwhile, the prevalence for the rest of the malnutrition indicators in this study were more comparable with the findings for Putrajaya in NHMS 2016 (24.3% stunted, 8.7% wasted, and 4.5% overweight) (IPH, 2016a).

The significantly higher prevalence of underweight children in this study was mainly due to the sampling technique used. Compared to household visits in NHMS 2016, our data collection was conducted in preschools and government health clinics in Putrajaya. Based on the current practice of 'Standard Operation Procedure for Malnourished Children' (MOH, 2015), underweight children are required to come to health clinics for regular monitoring of their weight status. Therefore, the bulk of underweight children sampled from health clinics has influenced our data, increasing its prevalence.

The prevalence of malnutrition from this study or NHMS 2016 for Putrajaya was lower compared to the prevalence in urban areas of Indonesia. About 34.9%, 23.4%, and 13.0% children from the urban areas of Indonesia were stunted, underweight, and overweight, respectively (Rachmi *et al.*, 2016). Meanwhile, in the urban areas of the Philippines, 26.0%, 18.0%, and 5.0% of their children were stunted, underweight, and wasted, respectively (Rohner *et al.*, 2013). However, the current Global Nutrition Report 2020 found a significant urban–rural divide especially in stunting prevalence. Out of 110 countries with available stunting data by location, children living in rural areas (35.6%) had higher stunting rates than those living in urban areas (25.6%). However, prevalences of wasting and overweight were more comparable. There were 12.4% wasted children reported in rural versus 11.4% in urban areas, and 4.0% overweight children in rural versus 4.9% in urban areas (Micha *et al.*, 2020).

Although this screening phase successfully recruited >50% of the children population in Putrajaya, the convenient selection of the participants from clusters (118 preschools and four government health clinics) was not comparable with the random selection of participants from NHMS 2016. NHMS 2016 used a complex sampling approach with a sample frame provided by the Registration Department (IPH, 2016).

The sociodemographic characteristics in this study were not evenly distributed as Putrajaya is densely populated by government servants, and majority are Malays (DOSM, 2017). Therefore, the findings cannot be generalised across different ethnicities. Nevertheless, we believe the outcomes of this study will provide sufficient information for stakeholders and policy makers to plan an effective prevention to reduce the prevalence of malnutrition among children in Putrajaya or other locations with similar characteristics.

CONCLUSION

This case-control study was planned to identify the associated factor of malnutrition among children in Putrajaya. Therefore, the results of this study provides valuable information to combat the issue of malnutrition among children under 5 years old in Putrajaya.

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Authors' contributions

MHA, principal investigator, conceptualised and designed the study, led the data collection, prepared the draft of the manuscript and reviewed the manuscript; NAMZ, co-principal investigator and led the data collection; FO, conceptualised and designed the study and led the data collection; AB, led the logistic support and data collection, reviewed the manuscript; RS, advised on data collection and interpretation, and reviewed the manuscript; CSM, led data management in central and reviewed the manuscript; AHMZA, managed data entry, prepared the draft and reviewed the manuscript; NIAK, managed data entry, prepared the draft and reviewed the manuscript; NAA, conceptualised and designed the study, advised in analysis and reviewed the manuscript; HAS,

advised in analysis and reviewed the manuscript and interpretation; PBK, advised in data collection, assisted in drafting of the manuscript, reviewed the manuscript; MAO, advised in data collection and data analysis, and reviewed the manuscript; TA, conceptualised and designed the study, advised in data collection and data analysis, and reviewed the manuscript.

Conflict of interest

There is no conflict of interest.

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The effect of *Hylocereus polyrhizus* (red dragon fruit) on whole gut transit time of young Malaysian adults

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ABSTRACT

Introduction: The red dragon fruit (*Hylocereus polyrhizus*) is a popular fruit, not only where it originated from, in Central America, but across the world including in Asia. It contains healthy minerals, vitamins and antioxidants, and has been shown to have gut motility action in animals. **Methods:** To determine the effect of red dragon fruit on whole gut transit time, a cross-sectional study of whole gut transit time using two different stool markers was conducted among 128 young Malaysian adults. **Results:** Red dragon fruit, in a half fruit serving of 225±25 grams, reduced mean whole gut transit time from 26.0±12.9 hours to 21.9±12.8 hours (p<0.001) when colour change in stools was used as an indicator. The tests also showed that 14.8-17.3% of individuals had whole gut transit time ≥40 hours with carbon as a stool marker compared to only 7.8-8.6% when red dragon fruit was consumed and used as a marker. **Conclusion:** This study demonstrated a laxative effect of red dragon fruit among young adults.

Keywords: *Hylocereus polyrhizus,* laxative, whole gut transit time, young adult

INTRODUCTION

Hylocereus polyrhizus or *Hylocereus costaricensis* is a tropical fruit with vibrant red skin and sweet, seed-speckled magenta pulp. It originated from Central America where it is known as pitaya and is a member of the cactus family. It is now widely grown in Asia where it is commonly known as red dragon fruit (RDF), on account of its scaly skin. A similar fruit, *Hylocereus undatus,* the white fleshed dragon fruit, is also popular. Besides its carbohydrate and fibre content, the fruit contains iron, potassium, magnesium, vitamins A and C (Ariffin *et al.*, 2009). In addition, it contains betacyanins and polyphenols which have beneficial antioxidant properties (Ding *et al.,* 2009). The tiny black seeds which are swallowed with the flesh contain essential fatty acids (Ariffin *et al.*, 2009). The red colour of its flesh is derived from betacyanin, which colours stools a visible reddish tinge and the urine also when taken in excessive amounts (Ding *et al.,* 2009).

Animal studies have found that *Hylocereus polyrhizus* modulates gut microbiota and has an effect on gut motility in mice (Song *et al.*, 2016; Khuituan *et al.*, 2019). This effect of RDF is of interest because laxatives and healthy agents to improve human bowel function are in constant demand. It has been estimated that up to 16% of the population complains of constipation

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and it accounts for 2.5 million physician office visits annually in the United States (Sharma *et al.*, 2017). Constipation consists of a constellation of symptoms including excessive straining, prolonged attempts to defecate, and stools of hard consistency. Primary or functional constipation is not only a disease itself, but straining at stools and hard stools also bring on perianal diseases such as anal fissures, haemorrhoids, and anorectal abscesses (Merchea *et al.*, 2016; Nugent *et al.*, 2018).

And yet, there has not been widespread adoption of objective clinical measurements of bowel habits, not least because even medical practitioners find probing into bowel habits distasteful. Whole gut transit time (WGTT) is one objective measure. It can be measured using wireless capsules, radiopaque markers or more simply, ingestion of a dye (Lee *et al.*, 2014; Kumar *et al.,* 1987; Waller *et al.,* 2011; Séverine *et al.*, 2001). The normal WGTT ranges between 10-73 hours (Lee *et al.*, 2014). As a measure to study the practical effect of RDF on bowel action, we examined the WGTT of healthy young adults sampled from students at the International Medical University, Seremban, Malaysia.

MATERIALS AND METHODS

Ethical approval

Ethical clearance was obtained from the International Medical University Joint Committee (CSc-Sem6-(12)2018). The authors were accountable for all aspects of work to ensure the accuracy or integrity of any part of the work.

Study design and sampling

In this cross-sectional study,128 young adults aged 20–24 years old in a medical school were conveniently sampled to fulfil the minimum number of the required sample size calculated (Charan & Biswas, 2013). The volunteers accounted for 38% of the student population in the campus. Pregnant females and individuals on medication were excluded in this study. Demographic data were also collected in a self-administered questionnaire. This study acquired ethical approval and written consent was obtained from the participants.

Whole gut transit measurement

Two measuring tools were selected in this study - carbon, in activated charcoal tablets, and *Hylocereus polyrhizus,* RDF itself. A pilot test among five volunteers showed that both tools demonstrated changes in stool appearance after consumption, which was easily detected when the subject was informed on what to look for. All subjects underwent four test rounds. On two occasions, subjects were asked to consume six 250mg tablets of activated charcoal (1.5gm) within 1 hour of passing motion and to take note when they had stool colour change. After that, on two more occasions, they consumed half of one RDF, which amounted to 225±25 grams, within one hour of passing motion. The measurement of whole gut transit time was determined by documenting the times starting with the intake of the measuring tool and ending with positive stool changes. There was an interval of one week between tests with carbon and RDF.

Categorising

In addition to recording the duration of WGTT, in hours, we also grouped the results into two categories (<40 hours and ≥40 hours). WGTT consistency was grouped for each measuring tool (activated charcoal tablets/RDF), with the same WGTT category within the same measuring tool indicating a consistent WGTT. Most western-based studies suggested 30-40 hours as normal mean colonic transit time (Kim & Rhee, 2012).

In this study, 40 hours was selected as the cut-off for short and long WGTT among subjects. It is common practice for most people to open their bowels at about the same time each day. It can therefore be expected that WGTT would cluster at 24 hours and 48 hours or multiples of the hours of a day (Séverine *et al.*, 2001). The use of 40 hours allows for individuals from 'up to four hours late one day' and 'four hours early the next' to be captured in the latter group.

Data analysis

The analysis of data was performed with SPSS 25. The tests included Mann-Whitney test for non-parametric data and Pearson's Chi-square test for categorical data.

RESULTS

The mean age of the participants was 22.7±1.1 years. There were 80 (62.5%) females and 48 males included in this study. They consisted of 75 (58.6%) Chinese, 33 (25.8%) Indians, 16 (12.5%) Malays and 4 (3.1%) of other races. Figure 1 shows the box plots of four attempts to measure the WGTT of the 128 volunteers. The means of the two attempts with carbon were 26.0±13.6 hours and 26.3±12.1hours, which showed no significant difference (p=0.787). Mean

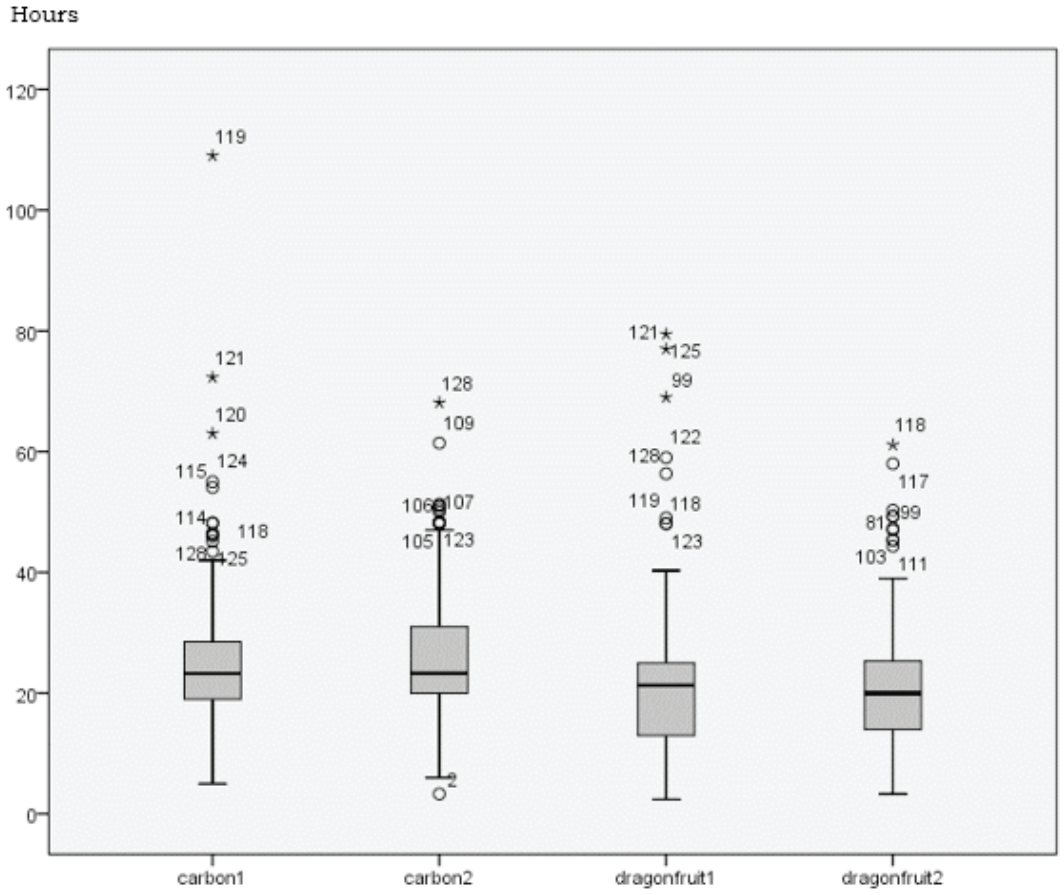

Figure 1. Whole gut transit time for young adults on two occasions using carbon and two occasions using RDF as indicator

Table 1. Number of subjects having short (<40 hours) and long (≥40 hours) WGTT with carbon and RDF

WGTT	*<40 hours*	*≥40 hours*	*<40 hours once and ≥40 hours once*	*Remainder (not consistent across the carbon and RDF measurement)*
	n (%)	*n (%)*	*n (%)*	*n (%)*
Carbon 1	108 (84.4%)	19 (14.8%)		
Carbon 2	105 (82.0%)	22 (17.3%)		
Consistent (Carbon)	99 (77.3%)	13 (10.2%)	15 (11.7%)	
RDF 1	114 (89.1%)	11 (8.6%)		
RDF 2	116 (90.6%)	10 (7.8%)		
Consistent (RDF)	109 (85.2%)	5 (3.9%)	11(8.6%)	
Consistent always (Carbon and RDF)	92 (74.2%)	2 (1.6%)		30 (23.1%)

WGTT for the two attempts with RDF, 22.6±13.6 hours and 21.4±10.9 hours, also showed no significant difference (p=0.319). However, the mean WGTT for subjects using carbon as an indicator (26.0±12.9 hours) was significantly different (p<0.001) compared to when RDF fruit was used as an indicator (21.9±12.8 hours).

Table 1 shows the number of individuals with short (40 hours) and long (≥40 hours) WGTT. WGTT was short for 82-90% of individuals during each of the occasions when it was measured. The laxative effect of RDF can be noted in that 14.8-17.3% of individuals had WGTT ≥40 hours compared to only 7.8-8.6% with RDF. Grouping also allowed us to note how many individuals were not consistent in the same group. This inconsistent group was 11.7% for carbon and 8.6% when consuming RDF. A total of 74.2% subjects had short WGTT constantly.

DISCUSSION

A fairly high proportion of young adults (74.2%) had a short bowel transit time constantly over four occasions, which appears to be a healthy habit to have. However, as the box plot showed, there were outliers with WGTT of over 120 hours (hence the data was non-parametric and required the Mann-Whitney test). These were individuals in which constipation, where there is associated hard stools and straining, was likely to occur. In addition, there were individuals who were not regularly long or short in their WGTT. Repeated measures of WGTT helped identify these individuals appropriately.

Effect of RDF on WGTT

It was clear that RDF had a laxative effect. It reduced mean WGTT by 4.2 hours. It reduced WGTT from ≥40 hours to <40 hours for 22 (17.2%) of the subjects at least once. On the other hand, in three individuals who had short WGTT with carbon, their WGTT was ≥40 hours once with RDF and in one person, it was associated with long WGTT twice. As with any laxative agent, the effect is not perfectly consistent as other factors and events in the life of an individual affects his/her bowel movement.

Khuituan *et al.* (2019) has shown that dragon fruit oligosaccharides reduced total gut transit time by 30% in

mice. The experiment revealed dragon fruit oligosaccharides to have bulk-forming effects and increased colonic smooth muscle contractions in mice. The studied mice did not show any morphological changes in their colonic mucosa or muscular layer after two weeks of consistent feeding with dragon fruit oligosaccharides at 500mg/kg (Khuituan *et al.*, 2019). This gave us reassurance that the laxative effect of RDF is healthy and there is no evidence to suggest that it is harmful. No subjects in our study reported any untoward effects. Oligosaccharides in dragon fruit demonstrated additional beneficiary effects on animal model in various studies. Peerakietkhajorn *et al.* (2020)'s study demonstrated that dragon fruit oligosaccharides increased the probiotics population (*Bifidobacteria, Lactobacilli)* in proximal and distal colon of mice. Furthermore, Pansai *et al.* (2019) found immune boosting properties of prebiotic dragon fruit oligosaccharides in animal model.

Limitations

Activated charcoal tablets are generally inert in regards to WGTT, but may rarely cause delayed bowel motion (Chyka *et al.*, 2005). We have not investigated the diet of our subjects, and as we know, dietary differences may affect WGTT. However, this factor may be nearly impossible to control for even with a regimented diet. Nevertheless, most Malaysians share much in common in their diet, especially our group of students who were based in the same campus.

Our measure of WGTT depended on subjects' reporting about when they observed a colour change and this relied on the co-operation of the subjects. Therefore, we cannot ascertain if they have identified the colour change accurately.

Strengths

We achieved a high response rate with data from 128 subjects and complete data in 125 subjects. Our sample population of students shared many similarities and common features in their environment, which controlled for factors that may have influenced WGTT measurements such as different activities, lifestyle and weather, that is known to influence hydration. In addition, not regimenting the diet of our subjects showed us the real effect RDF had among individuals in their daily life. Bowel habit varied day-to-day in all individuals and repeated measurements to obtain a mean was an advantage.

CONCLUSION

This study revealed a laxative effect of red dragon fruit among young adults. Further large scale, randomised controlled trials are needed to study the potential usage of dragon fruit as a dietary modification in constipation-related disorders.

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Authors' contributions

LKG, principal investigator, conceptualised and designed the study, conducted data analysis and interpretation, prepared the draft of the manuscript and reviewed the manuscript; LCV, conducted data collection, assisted in drafting of the manuscript, reviewed the manuscript.

Conflict of interest

We declare that we have no potential financial and non-financial conflicts of interest in the subject matter or materials discussed in this manuscript.

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Effect of high-intensity interval training and pre-meal water consumption on lipid profile in overweight and obese students

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ABSTRACT

Introduction: Obesity and overweight in adolescents and adults are associated with chronic diseases. The objective of this study was to determine the effect of high-intensity interval training and pre-meal water intake on the lipid profile of overweight and obese students. **Methods:** This was a pre-post experimental study. Twenty-seven overweight and obese students (mean BMI 26.0±3.1 kg/m^2 and mean age 19.7±0.7 years) were divided randomly into three groups. The first group (n=9; BMI=26.6±3.6 kg/m^2) received Plain Water Intake (PWI) intervention, whereby students received three bottles of plain water (600 mL) per mealtime (total 1.8 L/day) and consumed *ad libitum* 30 to 45 minutes before mealtime (breakfast, lunch, and dinner). The second group (n=9; BMI=25.9±2.4 kg/m^2) received High-Intensity Interval Training (HIIT) intervention and underwent three exercise sessions per week (18 minutes/day; 70–85% of HRmax) that was introduced through a video recording. The last group (n=9; BMI= 25.7±3.4 kg/m^2) received a combination of PWI+HIIT intervention. Nutritional status, nutrient intake, and lipid profile [total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C)] were assessed before and after the interventions. Data were analysed using paired sample t-test and Analysis of Variance (ANOVA). **Results:** The PWI group showed a significant increase in HDL-C, while the HIIT group showed a significant reduction in TC (p<0.05). On the other hand, the PWI+HIIT group showed significant improvements in lipid profile (TC, TG and HDL-C) (p<0.05). **Conclusion:** A combination of PWI+HIIT intervention may be effective in improving lipid profile.

Keywords: High-Intensity Interval Training; lipid profile; water consumption

INTRODUCTION

Overweight is a global public health problem that has a negative impact on health. Obesity has become a risk factor for various degenerative diseases, such as coronary heart disease, type 2 diabetes mellitus and osteoarthritis (Aronne & Isoldi, 2007). The prevalence of overweight has increased in recent years. Therefore, many efforts are required to keep weight within the normal range. In 2016, there were 39% of adults (39% men and 40% women) who experienced overweight and 13% who were obese; meanwhile, over 340 million children and adolescents were overweight and obese (WHO, 2016).

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Based on the data taken from the Indonesian National Basic Health Research (RISKESDAS) in 2018, the prevalence of obesity in adult men and women in Indonesia were 21.8% (NIHRD, 2018). The prevalence has increased when compared with data from the same resources in 2007 and 2013 (NIHRD, 2018). Some of the causes of overweight and obesity are high consumption of energy-dense foods and lack of physical activity (Popkin, Adair & Ng, 2017).

A combination of exercise and diet is the most effective way to optimise improvement in nutritional status (Gaesser, Angadi, & Sawyer, 2011). Previous research has shown that regular aerobic exercise can improve cardiometabolic risk profile such as increasing high-density lipoprotein cholesterol (HDL-C) levels and decreasing the levels of total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and triglycerides (TG) (Süel, 2013). One of the exercises that can help in lipid profile management is High-Intensity Interval Training (HIIT) (Gripp *et al.*, 2020). HIIT is a cardio exercise that can improve fitness and maintain body composition through short duration, high-intensity trainings (Kessler, Sisson, & Short, 2012).

Consuming adequate amount of water is highly recommended as one of the efforts to maintain and control weight. Studies have shown that regular water consumption provides metabolic stimulation, such as the thermogenesis process (Buschmann *et al.*, 2003). A previous study showed that the consumption of plain water was associated with weight loss and decreased energy intake (Stookey *et al.*, 2007). Another study indicated that overweight and obese adult subjects lost weight by consuming two cups (500 mL) of plain water 1-2 hours before mealtime (lunch and dinner) (Dennis *et al.*, 2011). Therefore, taking pre-meal water to reduce meal energy intake can be an effective weight control strategy (Jeong, 2018).

Based on these several studies, the researchers of this study were interested in studying the combination of plain water intake (PWI) and HIIT intervention, and their effects on lipid profile (TC, TG, HDL-C, and LDL-C). This study aimed to analyse the efficacy of HIIT, pre-meal water consumption (PWI), and a combination of both interventions on lipid profile in overweight and obese students.

MATERIAL AND METHODS

Design and subjects

The study was a pre-post experimental study with three intervention groups. This research was conducted from October 2014 to April 2015 at the Sport Nutrition and Nutritional Status Laboratory, IPB University. Participants were recruited from the student population at IPB University, Indonesia. Twenty-seven overweight and obese students (five men and 22 women) were randomly selected to participate in this study. Inclusion criteria were: Individuals who were (a) overweight and obese with a body mass index (BMI) ≥25 kg/m^2, (b) aged 18-23 years, and (c) not active smokers. The exclusion criteria were those who: (a) consumed weight loss supplement(s), (b) consumed alcohol, and (c) suffered from illnesses. All subjects willingly participated in the study by signing a prepared informed consent form. The study protocol was approved by the Ethics Committee of the Faculty of Medicine, University of Indonesia (Number 572/UN2.F1/ETHICS/2015).

Measurement of anthropometric and biochemical indices

Anthropometric measurements included body weight (kg), height (cm), body mass index (BMI) (kg/m^2), percentage of body

fat (%), and total body water (TBW). Body weight (kg) was measured by Vakind® Portable scale, while BMI (kg/m^2) and percent body fat (%) were measured by Body Composition Monitor Omron (HBF-516B). Venous blood samples were collected in the morning (07.00-08.00 am) by specialised nurses, after 8-12 hours of fasting. Lipid profile components consisting of TC, TG, HDL-C, and LDL-C were measured by using the enzymatic calorimetric method (Cholesterol CHOD-PAP and Triglycerides GPO-PAP).

Nutrient intake

Dietary intake was recorded at week 0 and week 8 for two days each week (on weekend and weekday) using a 24-hour dietary recall. Habitual beverage consumption was estimated by a registered nutritionist utilising a food frequency questionnaire. Beverage intake during the intervention was divided into water intake and energy intake from carbonated drinks, electrolytes drinks, coffee or tea, juice or fruit juice, and milk. Nutrition composition such as energy, protein and fat was assessed before and after the interventions. This study employed the Indonesian Food Composition Table (TKPI) to calculate for nutrients intake from foods and beverages.

Intervention

The duration of intervention administered for each group was two months. Different treatments were given for each group: pre-meal water consumption (PWI group, *n*=9) in the first group, HIIT (HIIT group, *n*=9) in the second group, and a combination of PWI and HIIT (PWI+HIIT group, *n*=9) in the third group. PWI intervention was given to subjects by managing the pattern of plain water consumption; that was, drinking a 600 mL bottle before each mealtime with a total water intake of 1.8 L/day despite the fact that 1.5 L/day, 30-50 minutes before each meal has been regarded as effective (Davy *et al.*, 2009). Plain water intake was set as follows: one bottle of 600 mL water before each mealtime (breakfast, lunch and dinner) ad libitum during the intervention period.

HIIT intervention was given 3 times/week (70–85% of HR-max) for 18 minutes each session (Eather *et al.*, 2019). Heart rate (HR) was measured by a smartphone application. A recorded video was utilised to ease the subjects in following the HIIT movements. The HIIT training protocol was divided into three parts: warm up, four sets of 20-s body weight HIIT workout with 10-s rest (broad jumps, squat jump, switch foot jumps, and squad jumps squad) and cool down. Training intensity was gradually increased during each exercise.

The compliance of subjects towards PWI and HIIT interventions was monitored during the study. Supervision through in-person interviews was conducted to figure out what the subjects were experiencing during the interventions. Each subject consumed a total of 84 bottles of water per month, and underwent three times/week of HIIT intervention.

Statistical analysis

Data analyses were performed gradually, starting from the data collected in the field and from questionnaires, until they were ready to be analysed. The data obtained from the field or questionnaire were through several stages: editing, coding, and entry stages. Univariate analysis was performed to determine the data distribution descriptively. Mean values before and after the interventions in all ratio data (nutrient intake, nutritional status, and lipid profile) for the three intervention groups were analysed by applying paired sample *t*-test. Meanwhile, Analysis of variance (ANOVA) was utilised to compare the means of nutrient intake, nutritional

Table 1. Subjects' characteristics based on intervention groups

Characteristics	*PWI (n=9)*	*HIIT (n=9)*	*PWI+HIIT (n=9)*
Men/women, *n*	1/8	2/7	2/7
Age (year)	19.9±0.6	19.8±0.4	19.5±0.9
Weight (kg)	69.7±19.0	62.6±6.5	63.6±9.6
BMI (kg/m^2)	26.6±3.6	25.9±2.4	25.7±3.4
Percent body fat (%)	22.5±8.9	24.6±5.6	24.8±7.1
Total body water, TBW (L)	36.0±6.5	34.8±5.2	35.3±7.3
Total cholesterol (mg/dL)	180.8±30.8	190.3±13.0	178.7±21.8
Triglyceride (mg/dL)	91.5±22.4	84.5±32.4	88.3±26
HDL-C (mg/dL)	51.5±10.4	56.8±11.0	57.5±8.2
LDL-C (mg/dL)	111.6±28.2	111.0±11.5	101.7±15.3

Data are presented in mean±*SD*

status, and lipid profile among the three intervention groups.

RESULTS

The subjects of this study were 27 people ranging from 17-19 years old. The mean age for each group were 19.9±0.6 years old (PWI group), 19.8±0.4 years old (HIIT group), and 19.5±0.9 years old (PWI+HIIT group), respectively. Lipid profile described that TC found in the HIIT group was higher than the others. Subjects' characteristics based on intervention groups are presented in Table 1.

Types of beverages and the amount of water intake were analysed in this study. The types of beverages analysed were plain water, carbonated drinks, electrolytes drinks, coffee and tea, juice or fruit juice, and milk. Mean consumption of plain water in the PWI, HIIT, and PWI+HIIT groups were 2300±737 mL, 1752±791 mL, and 2500±719 mL, respectively. Water intake and energy intake from beverages in the PWI+HIIT group was higher than the other groups. Total water intake and energy intake according to types of beverages consumed are shown in Table 2.

Percent body fat (PBF) and BMI of the PWI+HIIT group showed the most significant decrease of -4.1±4.7% and -0.05±3.3 kg/m^2. Based on ANOVA, there was no significant difference in PBF and BMI among the three groups. However, based on paired *t*-test for before and after intervention, there was a change in PBF and BMI in the PWI+HIIT group. Energy intake of the PWI group was 1964±527 kcal, 1933±248 kcal for the HIIT group, and 2002±563 kcal for the PWI+HIIT group. Protein intake for the PWI group was 52.4±15.1 g, 50.5±14.6 g for the HIIT group, and 46.2±12.5 g for the PWI+HIIT group. There was no significant difference in nutrient intake (p>0.05).

After an eight-week intervention, it was shown that HDL-C of the PWI group significantly increased and TC of the HIIT group significantly reduced (p<0.05). Compared to the other groups, PWI+HIIT group had a significant decrease in TC and TG, with improved HDL-C (p<0.05). The average nutrient intake, nutritional status, and lipid profile of the subjects at baseline and after eight weeks of intervention are presented in Table 3. After the intervention, the compliance of the three intervention groups had an

Table 2. Water and energy intake from beverages based on intervention groups

Beverages	*Water and energy intakes from beverages*					
	PWI		*HIIT*		*PWI+HIIT*	
	Water intake (mL)	*Energy intake (kcal)*	*Water intake (mL)*	*Energy intake (kcal)*	*Water intake (mL)*	*Energy intake (kcal)*
Plain water	2300±737	0	1752±791	0	2500±719	0
Carbonated drinks	183±173	80±77	94±69	231±159	99±73	231±159
Electrolyte drinks	244±187	63±56	255±195	69±60	220±170	54±54
Coffee or tea	110±142	55±72.6	95±125	60±84	175±170	117±126
Juice or fruit juice	100±61.2	43±44	120±63	35±20	60±84	29±42
Milk	127±148	62±65	105±44	34±41	80±71	29±38
Total	3063±798	303±101	2558±737	292±143	3262±635	328±156

Data are presented in mean±*SD*

adherence rate of >90% (PWI: 98.8%; HIIT: 98.1%; PWI + HIIT: 97.7%).

DISCUSSION

Health experts commonly recommend consuming eight glasses of water to maintain health and well-being. Consuming more water than normally consumed at mealtimes (breakfast, lunch and dinner) under dietary recommendations can reduction in meal energy intake (Jeong, 2018). Another recommended and suggested action to maintain health and fitness is by doing physical activity. Doing physical activity for at least 150 minutes of at least moderate intensity per week is highly recommended to maintain health.

HIIT is a cardio exercise that combines high-intensity exercise with moderate or low-intensity exercise within a specific time or interval, which takes about four to six minutes on average. The duration for HIIT is very diverse, with an average of 15-20 minutes, depending on the duration of warm-up, workout, and cool-down sessions. In this study, the duration of HIIT was 18 minutes. Hence, it is preferable and favourable because it improves fitness more quickly, takes a relatively shorter time, and is more fun. HIIT is also a physical exercise that is modified for individuals with different fitness levels and special conditions, namely obesity and diabetes. It has been shown to effectively reduce the risk of injury and decrease glucose intolerance in obese women with diabetes (Madsen *et al.*, 2015). It is one of the physical and cardio exercises that can improve nutritional status and health.

Characteristics of HIIT makes it a form of strenuous exercise; whereby its Excess of Post-Exercise Oxygen Consumption (EPOC) provides an extra 6-15% of energy expenditure during exercise (Laforgia, Withers, & Gore, 2006). A study showed that the contribution of EPOC to facilitate weight loss can result from calorie restriction (Tucker, Angadi & Gaesser, 2016). Results from a previous study showed that losing body weight by 5% had a positive impact on the decrease of TC and TG levels (Fayh *et al.*, 2013). Efforts to improve nutritional status can be more effective if they are applied with a combination of diet and physical activity.

Improving nutritional status can also be done by managing food and beverage

Table 3. Nutrient intake, nutritional status and lipid profile before and after the intervention

Variable	*Intervention groups*					
	PWI (n=9)		*HIIT (n=9)*		*PWI + HIIT (n=9)*	
	Baseline	*8 weeks*	*Baseline*	*8 weeks*	*Baseline*	*8 weeks*
Nutrient intake						
Energy (kcal)	1972±378	1885±434	1945±664	1872±414	2242±606	2154±563
Protein (g)	48.3±8.2	56±13.2	41.3±4.2	47.6±20.1	47.9±9.1	55.4±21.3
Fat (g)	46.1±12.9	48.2±13.3	43.9±10.5	47.6±20.0	45.1±7.7	44.9±7.6
Nutritional status						
Weight (kg)	69.7±19.1	69.9±18.6	62.6±6.5	63.2±6.4	63.6±9.6	62.5±9.2
BMI (kg/m^2)	26.6±3.6	26.7±3.6	25.9±2.4	25.8±2.4	25.7±3.4[a]	25.2±3.2[a]
Percent body fat (%)	22.5±8.9	22.9±7.7	24.6±5.6	23.5±3.7	24.8±7.1	20.7±8.5
Total body water, TBW (L)	36.0±6.5	35.1±6.3	34.8±5.2	33.3±4.5	35.3±7.3	35.2±5.3
Lipid profile						
Total cholesterol (mg/dL)	180.8±30.8	171.6±19.6	190.3±13.0[a]	180.6±21.5[a]	178.7±21.8[a]	164.2±12.7[a]
Triglyceride (mg/dL)	91.5±22.4	79.2±17.1	84.5±32.4	73.2±28.9	88.3±26.5[a]	74.8±12.5[a]
HDL-C (mg/dL)	51.5±10.4[a]	59.3±8.3[a]	56.8±11.0	63.1±8.5	57.5±8.2[a]	65.5±6.8[a]
LDL-C (mg/dL)	111.6±28.2	99.7±19.8	111.4±11.5	104.2±16.9	101.7±15.3	89.6±9.9

Data are presented in mean±*SD*

[a] There were significant differences before and after the intervention (paired *t*-test, $p<0.05$)

consumption. The relationship of water intake with overweight is independent, just like factors such as physical exercise, smoking status, cigarettes utilisation, and energy intake. The effect of water intake and water balance could be useful for preventing overweight and obesity (García *et al.*, 2019). It has been shown that pre-meal plain water consumption of 500 mL and hypocaloric diet led to weight loss in obese adults (Davy *et al.*, 2009). This indicates that the mechanism of water intake before each meal to control nutrient intake may potentially prevent obesity (Daniels & Popkin, 2010). Based on the results of this study, pre-meal water consumption of 600 mL and HIIT reduced nutrient intake by <5%. Meanwhile, the results from a previous study showed that HIIT intervention improved VLDL-C (Campbell, Wallman, & Green, 2010). Furthermore, HIIT was also reported to be beneficial to increase HDL-C levels, improve nutritional status, and maximal oxygen uptake (VO_2max) (Nalcakan, 2014).

Increased HDL occurred in all intervention groups, with the PWI group at 6.7±6.6 mg/dL, HIIT group at 5.7±6.0 mg/dL, and PWI+HIIT group at 6.6±6.2 mg/dL. However, the PWI group and PWI+HIIT group were significantly different (p<0.05). Results of a previous study showed that the HDL-C levels (mg/dL) in adolescents who were given a 12-week intervention increased by 9.7% (mg/dL), but there were no changes in their TC levels (mg/dL) (Tjønna *et al.*, 2008). Based on the review of 13 research studies regarding HIIT, HDL-C level (mg/dL) would increase after intervention if its level at baseline was very low, with a minimum duration of eight weeks intervention (Kessler *et al.*, 2012). When compared to the results in this study, HDL-C levels was increased by 10% after a duration of eight weeks intervention.

In comparison with a study in Taiwan, it was found that aerobic exercise and badminton were also associated with higher HDL-C levels (Nassef *et al.*, 2019). HIIT workout has been proven successful in reducing fat in the abdominal section of young women within 15 weeks (Trapp, Chisholm & Boutcher, 2007). The results of this study were in accordance with a previous study presenting that HIIT intervention for 12 weeks in obese adolescent boys, with an intensity of 80-95% maximum heart rate, for 20 minutes could reduce total body fat, abdominal fat, and improve fitness (VO_2max) (Heydari, Freund & Boutcher, 2012). In fact, a study on the effect of aerobic exercise with different intensities and methods showed that HIIT was proven effective to increase aerobic fitness (VO_2max) by 6-8% (Byrd *et al.*, 2019). Besides that, HIIT intervention was also proven effective to improve strength, cardiorespiratory fitness, and lower TG levels in physically active men (Cuddy, Ramos & Dalleck, 2019).

However, not all HIIT interventions can improve lipid profile in the body. A previous study showed that HIIT intervention could not improve the levels of blood lipid profile (TC, TG, HDL-C, and LDL-C), but it might increase subjects' aerobic capacity. The researchers in that study explained that the weakness of their study lied in a relatively short duration of intervention (12 weeks) and small number of subjects (Ouerghi *et al.*, 2014). If compared to the eight-week duration of this study, PWI and HIIT intervention had been able to improve the levels of lipid profile (TC, TG, and HDL-C) in the body, except for LDL-C levels. Changes in lipid profile values in the body are affected by many factors, including age, diet high in saturated fat

and cholesterol, genetics, hormones, body weight, level of physical activity, and other diseases.

Combining various physical activities such as HIIT, endurance training, and low-intensity training is one of the strategies to maintain health and improve nutritional status. A study showed that HIIT was proven to be more effective in improving lipid profiles and keeping blood pressure in the normal range compared to other interventions (Paoli *et al.*, 2013). A recent study has also found that water pre-loading before main meals may be effective as a weight loss strategy in adult obesity (Parretti *et al.*, 2015). In this study, the combination of PWI +HIIT group intervention was proven to be more effective in improving the levels of lipid profile (improved 8 mg/dL of HDL-C, reduced <14.6 mg/dL of TC and <135 mg/dL of TG) when compared to the PWI group (improved 7.8 mg/dL of HDL-C) and HIIT group (reduced 9.7 mg/dL of TC). However, there was no significant difference between lipid profile among the three groups by ANOVA (p>0.05).

Review of several studies on the effect of the provision of drinking water on weight loss showed that the results had not been consistent. Therefore, in future studies, it is recommended to increase the number of subjects and use a longitudinal study design so that the results can be applied to the population. This study has some weaknesses, namely the short duration of intervention, the absence of a measurement for hydration status, and the small number of subjects. Most study results focus on the process of improving nutritional status by doing exercise and following a specific diet. Therefore, health and fitness need to be maintained in optimum condition by engaging in exercise and practising healthy food habits, as well as increasing one's motivation. It must be continuously done (sustainable), especially in overweight and obese adolescents.

CONCLUSION

A combination of PWI and HIIT may be effective in improving the lipid profile of obese and overweight students. The intervention decreased the levels of TC (mg/dL) and TG (mg/dL), while improved HDL-C. For further studies, inflammatory biomarkers and other fitness components such as speed, flexibility, strength, and endurance can be added as variables.

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Authors' contributions

NAZ, principal investigator, conceived the presented idea, prepared the draft of the manuscript, developed the theory and performed the computations and wrote the paper; HAR, verified the analytical methods, analysed and interpreted the data and reviewed the manuscript; DMR, designed the model and the computational framework, analysed the data and reviewed the manuscript; MK, designed the exercise programme.

Conflict of interest

The authors have no conflicts of interest that are directly relevant to the content of this research.

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Risk factors of hospital-acquired malnutrition in children: A study in a rural hospital of West Borneo, Indonesia

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ABSTRACT

Introduction: Hospital-acquired malnutrition (HAM) is prevalent among hospitalised children in developing countries. This condition relates to worse clinical outcomes, prolongs length of stay in hospitals, and increases mortality. A multidisciplinary approach should be performed to prevent and manage this problem. However, HAM is often underdiagnosed, especially in rural hospitals with limited human resources. This study aims to delineate the risk factors of HAM among hospitalised children in a rural hospital. **Methods:** This nested case-control study derived from the implementation of a nutritional screening programme in Parindu Hospital, Sanggau, West Borneo, was conducted from December 2018 to February 2019. HAM was defined as a loss of body weight of >2% after hospitalisation. Independent variables such as the age of patients, fever, gastrointestinal loss, pre-existing malnutrition, length of stay, and grade of disease were analysed in univariate and multivariate analyses using logistic regression. Risk factors were expressed as odds ratio and adjusted odds ratio (*aOR*) with 95% confidence interval (CI). **Results:** Thirty-three patients were analysed as cases with 59 controls. Median age was younger in the case group (49 months, *IQR* 14-72.5) than control group (88 months, *IQR* 43-116). After adjustment for other covariates, age <5 years old (*aOR* 5.50, 95% CI 1.95-15.59) and moderate-to-severe grade of disease (*aOR* 3.50, 95% CI 1.09-11.09) were significant risk factors of HAM in our study. **Conclusion:** Risk factors of HAM in children hospitalised in a rural hospital were age <5 years old and moderate-to-severe grade of disease.

Keywords: Hospital-acquired malnutrition, children, rural hospital

INTRODUCTION

Children are more vulnerable to malnutrition due to a higher amount of energy required for growth and their limited energy reserve (Gouveia & Silva, 2017). Hospitalised children have an increased energy requirement to cater for higher metabolic demands and nutrient turnover rates. These conditions place children at risk of malnutrition and subsequent deterioration of their nutritional status after hospital admission, which is known as hospital-acquired malnutrition (HAM) (Quadros *et al.*, 2018).

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Malnutrition relates to worse clinical outcomes, such as prolonged recovery time and higher requirements of intensive care. Malnutrition also increases complications, nosocomial infections, and mortality rates. Longer length of stay in hospital and more complicated treatments of malnourished patients are also an economic burden (Mazzocchi, 2015).

Nutritional assessment and management are integral parts of a holistic treatment in all hospitalised patients. These interventions should ideally be conducted by a multidisciplinary team consisting of paediatrician, nutritionist, nurses, and other hospital staff. However, daily and comprehensive management to all hospitalised children are sometimes time-consuming and difficult to obtain due to the lack of resources (McCarthy *et al.*, 2019; Mehta *et al.*, 2013; Walls *et al.*, 2012).

The shortage of paediatricians and nutritionists in West Borneo is immense. In the 2018 National Health Report of the Republic of Indonesia, there were only 33 nutritionists and one paediatrician across all health facilities in Sanggau Regency, West Borneo, with its 463,995 inhabitants. Particularly in Parindu Hospital, there is only one visiting paediatrician working twice a week and one certified nutritionist responsible for the entire hospitalised patients. This situation is a common problem in many similar hospitals in the rural areas of West Borneo, making ideal nutritional management challenging (Kemenkes RI, 2018; MOH Republic of Indonesia, 2017).

Identification of risk factors and implementation of nutritional screening tools will help hospital staff put more attention on paediatric patients with a higher probability of having HAM (Joosten & Hulst, 2011; Spagnuolo *et al.*, 2013). These will be helpful in hospitals with a lack in human resources. Previous studies have been conducted in tertiary hospitals in Indonesia, but studies in rural hospital settings are lacking. Rural hospitals have a different subset of patients, diagnoses, and available resources. This study therefore aims to delineate the risk factors of HAM among hospitalised children in the rural hospital of Parindu, Sanggau Regency, West Borneo, Indonesia.

MATERIALS AND METHODS

This was a nested case-control study derived from a cohort of a nutritional screening programme conducted in Parindu Hospital, Sanggau Regency, West Borneo Province, Indonesia, from December 2018 to February 2019.

The inclusion criteria for cases were: 1) Patients aged 2 months to 18 years old; 2) Hospitalised $\geq$48 hours; 3) Had complete daily anthropometry measurement data; 4) A loss of body weight >2% compared to initial reference weight (Gouveia & Silva, 2017). Controls were selected from a similar population that yielded the cases, but without any loss of body weight >2% compared to initial reference weight. Exclusion criteria were as follows: 1) Referred to another hospital within two days of hospitalisation; 2) Death within 2 days of hospitalisation.

Anthropometry was performed by a certified nutritionist on patients with minimal or without clothing during their hospital stay, in the morning and after voiding. The measurement of dehydrated patients was performed after dehydration was resolved, which was confirmed by a physician-in-charge. Anthropometry findings were plotted on the World Health Organization (WHO) Growth Standards 2006 to assess nutritional status based on weight-for-height z-score (WHZ) for children <5 years old and body mass index-for-age

(BMI/age) *z*-score for children ≥5 years old. Chronic malnutrition, based on the WHO criteria, was diagnosed with height-for-age *z*-score (HAZ) below -2 standard deviation (SD) (Gouveia & Silva, 2017).

Fever was defined as a rise in body temperature by any measurement of >37.5 °C for ≥2 days. Gastrointestinal loss was defined as either diarrhoea or vomiting >3 times/day or any increase in stoma quantity for ≥2 days. Classification of disease inflammation severity was based on stress factors derived from the American Academy of Pediatrics (AAP) and the American Dietetic Association (ADA). Grade 1 conditions involved mild stress factors e.g., admission for diagnostic procedures, minor infection not necessarily requiring hospitalisation or other mild episodic illnesses. Grade 2 conditions involved moderate stress factors e.g., severe but not life-threatening infection, fracture or chronic illness without acute deterioration. Grade 3 conditions involved severe stress factors e.g. AIDS, malignancy, severe sepsis, major surgery, multiple injuries or acute deterioration of chronic disease (Maryani *et al.*, 2016; Sermet-Gaudelus *et al.*, 2000).

All statistical analyses were performed using SPSS 24.0 for Windows. Univariate analysis using chi-square or Fisher's exact test was done between independent and dependent variables. Risk factors were expressed as odds ratio (*OR*) or adjusted odds ratio (*aOR*) with 95% confidence interval (CI). Logistic regression was performed to identify significant risk factors of HAM. To identify all variables known to be important in the multivariate analysis, purposeful selection method was applied by including variables with a significant univariate test and any variables with a *p*-value of <0.25 (Bursac *et al.*, 2008). Significance level was considered at $p<0.05$.

Written informed consent was obtained from parents or accompanying guardians during the hospital stay. Ethical approval was obtained from the Medical and Health Research Ethics Committee of Universitas Gadjah Mada under protocol number KE/0354/03/2019. All information about the subjects were decoded to make them confidential.

RESULTS

Thirty-three patients with HAM served as cases with 59 subjects considered as controls. The median age of all subjects was 64.5 months (Interquartile range/*IQR* 30-108). The median age was younger in the case group (49 months old) compared to the control group (88 months old). Pre-existing acute malnutrition was found in 27.1% subjects, of which 6 (6.5%) had severe malnutrition and 19 (20.6%) had moderate malnutrition. Chronic malnutrition was found in 26 (28.2%) patients with a higher proportion in the case group (36.3%) than in the control group (23.7%).

Most patients were hospitalised due to infectious diseases, of which dengue infection was the most prominent diagnosis, followed by acute gastroenteritis. Five patients (5.4%) were hospitalised due to surgical disease. The length of stay in both groups was similar. Only seven patients (7.6%) were hospitalised for >7 days, with a maximum stay of ten days in three patients. The baseline characteristics of the subjects are depicted in Table 1.

The clinical profile of our study subjects is shown in Table 2. Children aged <5 years old had a higher proportion of HAM (69.7%) than children who were ≥5 years old (30.3%). In univariate analysis, age <5 years old, fever >48 hours, and moderate-to-severe grade

Table 1. Baseline characteristics of subjects

Variables	*Cases (n=33)*		*Controls (n=59)*	
	n	*%*	*n*	*%*
Sex				
Male	14	42.4	24	40.7
Female	19	57.6	35	59.3
Initial nutritional status				
Severely wasted	3	9.1	3	5.1
Wasted	7	21.2	12	20.3
Normal	23	69.7	43	72.9
Overweight	0	0.0	1	1.7
Obese	0	0.0	0	0.0
Initial height				
Normal height	21	63.7	45	76.3
Stunted	4	12.1	9	15.3
Severely stunted	8	24.2	5	8.4
Length of stay, median days (range)	4 (2-10)		4 (2-10)	
Diagnosis				
Infection	26	78.8	44	74.6
Surgery	2	6.0	3	5.1
Others (e.g. epilepsy, asthma, dyspepsia)	5	15.2	12	20.3

Table 2. Clinical profile of subjects

Variable	*Hospital-acquired malnutrition*		
	Total, n=92	*Cases, n=33*	*Controls, n=59*
Age, *n* (%)			
<5 years old	42 (45.6)	23 (69.7)	19 (32.2)
≥5 years old	50 (54.4)	10 (30.3)	40 (67.8)
Acute malnutrition, *n* (%)			
Yes	24 (26.0)	10 (30.3)	14 (23.7)
No	68 (74.0)	23 (69.7)	45 (76.3)
Chronic malnutrition, *n* (%)			
Yes	26 (28.2)	12 (36.4)	14 (23.7)
No	66 (71.8)	21 (63.6)	45 (76.3)
Length of stay, *n* (%)			
>7 days	7 (7.6)	3 (9.1)	4 (6.8)
≤7 days	85 (92.4)	30 (90.9)	55 (93.2)
Fever ≥48 hours, *n* (%)			
Yes	54 (58.6)	24 (72.7)	30 (50.8)
No	38 (41.4)	9 (27.3)	29 (49.2)
Gastrointestinal loss, *n* (%)			
Yes	20 (21.7)	11 (33.3)	9 (15.2)
No	72 (78.3)	22 (66.7)	50 (84.8)
Grade of disease, *n* (%)			
Moderate-Severe	57 (62.0)	26 (78.8)	31 (52.5)
Mild	35 (38.0)	7 (21.2)	28 (47.5)

Table 3. Multivariate analysis of risk factors for hospital-acquired malnutrition

Risk Factor	*Univariate Analysis*			*Multivariate Analysis*		
	Crude OR	*95% CI*	*p-value*	*Adjusted OR*	*95% CI*	*p-value*
Age						
<5 years old	4.82	1.93-12.17	<0.01	5.50	1.95-15.59	<0.01
≥5 years old	1.00			1.00		
Acute malnutrition						
Yes	1.40	0.53-3.63	0.49	–	–	
No	1.00					
Chronic malnutrition						
Yes	1.84	0.72-4.65	0.19	1.70	0.57-5.10	0.34
No	1.00					
Length of stay						
≥7 days	1.37	0.28-6.55	0.69†	–	–	
<7 days	1.00					
Fever ≥48 hours						
Yes	3.35	1.26-8.92	0.04	1.99	0.67-5.95	0.21
No	1.00					
Gastrointestinal loss						
Yes	2.58	1.03-6.47	0.04	3.19	1.00-10.20	0.05
No	1.00					
Grade of disease						
Moderate-Severe	2.78	1.01-7.65	0.01	3.50	1.09-11.19	0.03
Mild	1.00					

†Fisher's exact test

of disease have a *p*-value <0.05. These three variables and chronic malnutrition variables with a *p*-value of <0.25 were analysed further in logistic regression to be expressed as *aOR*.

Risk factors are described in *OR* as depicted in Table 3. After adjustment for other covariates, age <5 years old (*aOR* 5.50, 95% CI 1.95-15.59) and moderate-to-severe grade of disease (*aOR* 3.50, 95% CI 1.09-11.09) were significant risk factors of HAM in our study, with the age of patient having the most significant odds ratio.

DISCUSSION

Pre-existing malnutrition was prevalent in our subjects. Twenty-four patients (26%) had acute malnutrition upon admission. Among patients with HAM, 23 (69.7%) patients had a normal nutritional status upon admission compared to ten (30.3%) patients with pre-existing acute malnutrition. Several studies found that the incidence of HAM was higher in previously well-nourished children. This might be caused by the higher catabolic process that exceeds the anabolic process in well-nourished children (Rocha, Rocha & Martins, 2006; Gouveia & Silva, 2017).

Children with chronic malnutrition have a decreased level of amino acids. A diminished level of amino acid storage will increase gluconeogenesis in the liver and amino acid breakdown in muscles (Nasar *et al.*, 2014; Mac & Gap, 2017). These conditions will deteriorate the nutritional status of children who are in a state of illness. Although a higher proportion of HAM was found in patients with pre-existing chronic malnutrition,

the result was not significant in either univariate or multivariate analyses.

Length of hospital stay was associated with weight loss during hospitalisation in several previous studies (Rocha *et al.*, 2006; Joosten & Hulst, 2011; Shaughnessy & Kirkland, 2016). However, in our study, the median duration of stay was similar in both groups. This finding might have been caused by the different conditions of patients admitted to our hospital compared to previous studies that were conducted in bigger hospitals that usually have more variety of diagnosis and length of stay.

The age of patients was a significant risk factor in this study. Patients aged <5 years old had a 5-fold higher chance of having HAM (*OR* 5.50, 95% CI 1.95-15.59), as demonstrated by the higher proportion of HAM in children aged <5 years old (69.7%) than children aged >5 years old (30.3%). Younger children have higher energy per unit body mass and daily energy requirement, which makes the imbalance between daily requirement and consumption more severe than in older children. Any increase in nutritional demands experienced by hospitalised children will compete with the calorie requirement needed for growth that is higher in younger children (Mazzocchi, 2015). The difference in body composition among age groups also contributes to a higher risk of younger children having malnutrition (Djafarian *et al.*, 2015).

Fever, burns, ascites or fluid loss can alter the balance between calorie consumption and requirement, which contributes to HAM (Mehta *et al.*, 2013; Shaaban, Nassar & El-Gendy, 2018). In our study, half of the patients with HAM had some kind of gastrointestinal loss although this finding was not statistically significant. Fever increases calorie requirements in children, whereby heat production increases calorie requirement by 13 percent for each degree Celcius (Gouveia & Silva, 2017). However, similar to a previous study, after adjustment for other covariates, fever for more than 48 hours was not a significant risk factor of HAM (Maryani *et al.*, 2016).

Response to trauma, infection or inflammation in acute or chronic diseases may result in malnutrition through the alteration of metabolism, appetite, absorption or assimilation of nutrients (Mazzocchi, 2015). Any state of disease, whether critical or not, may directly or indirectly influence components of energy expenditure. This will subsequently have a marked effect on the nutritional status of a child. Thus, underestimation or overestimation of energy during illness can result in an energy imbalance that contributes to HAM *(Maryani et al.*, 2016; Mazzocchi, 2015).

The underlying disease of a patient is related to weight loss during hospitalisation. Diseased tissue promotes an acute inflammatory response which results in rapid lean body mass catabolism. A disease also frequently induces anorexia and fever, vomiting or diarrhoea, which worsens the imbalance between requirement and intake (Mehta *et al.*, 2013). The grade of disease was a significant risk factor of HAM in this study (*OR* 3.50, 95%CI 1.09-11.19). Children admitted due to moderate-to-severe or grades 2 or 3 disease according to AAP or ADA were associated with body weight loss > 2% (Maryani *et al.*, 2016; Sermet-gaudelus *et al.*, 2000).

There were several limitations in this study. We did not classify the severity of fever and gastrointestinal loss in this study, whereas theoretically, the severity of fever and loss correlate with the severity of weight loss. The spectrum of diagnosis in our study was also not

broad although it does reflect our local pattern of hospitalisation in a rural hospital in Indonesia.

HAM is an overlooked problem, especially in rural hospital settings. Daily nutritional observation and intervention for every single patient admitted to the hospital is time-consuming when limited human resources is available. There are several ways to overcome this situation. First, by using simple nutritional screening tools such as $STRONG_{KIDS}$ (Screening Tool for nutritional status and growth) to determine the risk of malnutrition upon admission to the hospital (Children *et al.*, 2015; Joosten & Hulst, 2011). Second, with the identification of risk factors, close observation of patients with a high risk of malnutrition can be performed to facilitate early prevention and intervention. Third, training of nurses or hospital staff other than nutritionists to make comprehensive assessments and possible interventions (Girsang & Sidiartha, 2018; Joosten & Hulst, 2011; McCarthy *et al.*, 2019). These strategies and options can be considered based on local regulations and the capacity of each health facility.

CONCLUSION

Risk factors of hospital-acquired malnutrition are age <5 years old and moderate-to-severe grade of disease. Identification of these risk factors and the implementation of nutritional screening tools should be performed in rural hospitals to overcome hospital-acquired malnutrition problems in children.

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Authors' contributions

DP, principal investigator, performed data analysis and interpretation, conceptualised and designed the study, prepared the draft of the manuscript and reviewed the manuscript; SH, led the data collection; NN, performed data analysis and interpretation, assisted in drafting of the manuscript and reviewed the manuscript.

Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship and publication of this article. All authors received no specific grants from any funding agency in the public, commercial or non-profit sectors.

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Factors associated with sugar-sweetened beverages consumption among Malaysian adolescents: findings from the Adolescent Nutrition Survey 2017

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ABSTRACT

Introduction: Childhood obesity is a public health problem in Malaysia. Intake of sugar-sweetened beverages (SSB) is associated with obesity in children. There is a lack of studies on factors associated with SSB consumption in Malaysia. This study aimed to determine the sociodemographic factors associated with SSB consumption among Malaysian adolescents. **Methods:** Data of 2,021 students, aged 10-17 years on sociodemographic, SSB intake and anthropometrics were drawn from the school-based Adolescent Nutrition Survey 2017. A multistage stratified cluster sampling was used to obtain a nationally representative sample of primary and secondary school students. Body mass index (BMI)-for-age status was determined based on calculated z-score using the World Health Organization 2007 reference. SSB consumption was obtained from a food frequency questionnaire. **Results:** The prevalence of overweight and obesity among Malaysian adolescents were 16.6% and 14.7%, respectively. Malaysian adolescents consumed 1.4 cups of SSB per day. Rural children had a significantly higher SSB intake (1.5 cups) than urban (1.3 cups) children, while males (1.5 cups) had a significantly higher intake than females (1.3 cups). There were no significant differences in SSB consumption between thin, normal, overweight and obese adolescents. **Conclusion**: Almost all Malaysian adolescents consumed SSB during one month prior to the survey and the average amount consumed was 1.4 cups per day. Rural locality and male were associated with higher SSB consumption. There were differences in SSB consumption between Chinese and Malays, between Chinese and Indians, and between Chinese and Bumiputra Sarawak. There were no differences in consumption between the different BMI-for-age categories.

Keywords: Sugar-sweetened beverage, adolescent, obesity, Malaysia

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INTRODUCTION

Childhood obesity is one of the most serious public health challenges of the 21st century. Overweight and obese children are likely to stay obese into adulthood and more likely to develop non-communicable diseases like diabetes and cardiovascular diseases at a younger age (Juonala *et al.*, 2011). Worldwide prevalence of overweight and obesity among children and adolescents (aged 5-19) was 18% in 2016 (WHO, 2017). In Malaysia, the prevalence of overweight and obesity was 30.4%, which affected about 1 million Malaysian adolescents (IPH, 2017). However, thinness and stunting are still prevalent among Malaysian adolescents (IPH, 2017; IPH, 2012). The problem of double burden of malnutrition faced by Malaysia is also found in low-income and middle-income countries such as China (Song *et al.* 2018), Mexico (Kroker-Lobos *et al.*, 2014), and Jordan (Al-Domi *et al.*, 2019).

Sugar-sweetened beverage (SSB) is defined as any drinks with added sugar. This includes tea, coffee, malted drinks, soft drinks, carbonated beverages, sports drinks, and fruit drinks (Luger *et al.*, 2017). Intake of SSB has been shown to be associated with weight gain and obesity indices in children. Systematic review and meta-analysis from prospective cohort studies and randomised controlled trials concluded that SSB consumption promotes weight gain in children to adults (Malik *et al.*, 2013), and SSB consumption is positively associated with or has effect on obesity indices in children, adolescents and adults (Luger *et al.*, 2017). Previous studies also found that older children and adolescents were more likely to consume SSBs than younger children (Rao *et al.*, 2015). Besides that, evidence has shown that males were more likely to consume SSBs than females (Park *et al.*, 2012a; Park *et al.*, 2012b; Rao *et al.*, 2015).

The SSB consumption patterns in Asian countries vary. In a study conducted in China, it was found that 46.1% of children (6 to 13 years) regularly drank SSBs. The prevalence of obesity for regular SSB drinkers (11.6%) and other beverages drinkers (10.1%) was significantly (p=0.0001) higher than regular milk drinkers (7.6%). The adjusted odds ratio (*OR*) (95% CI) for obesity was 1.46 (1.21, 1.75) in regular SSB drinkers, compared to regular milk drinkers. (Shang *et al.*, 2012). Among Korean adolescents, Lee, Kwon & Lee (2013) reported that the mean total SSB intake among those aged 7 to 18 years was 98.7mL/day, with means of 114.1mL/day for boys and 82.1mL/day for girls. Being overweight and obese was significantly associated with greater *OR*s for high SSB intake among boys aged 7 to 12 years (*OR*=1.72) (Lee *et al.*, 2013). A more recent study in Korean children and adolescents 9 to 14 years old found that the mean SSB intake among boys who consumed >200mL/day was 301.7 mL/day and among girls, the mean was 260.9 mL/day (Ha *et al.*, 2016). Boys who consumed >200mL/day had 48% lower odds of being obese (adjusted *OR*, 0.52; 95% CI, 0.26–1.05; p for trend = 0.0310) compared to boys who did not drink SSBs. No significant association was observed in girls.

In Indonesia, SSBs were consumed by 62% children and 72% adolescents. An SSB intake of one or more servings per day was observed in 24% children and 41% adolescents (Laksmi *et al.*, 2018). The National Health Examination Survey in Thailand in 2009 reported that over 30% and 16% of adolescents aged 6-14 years and over 15 years, respectively, consumed SSBs almost every day or more often. These rates were found to be an increase of 50% and

100%, respectively, since the previous survey in 2003 (Lim *et al.*, 2014).

The Malaysia School-Based Nutrition Survey in 2012 reported that 24.5% of adolescents consumed sweetened tea daily and 42.2% of them consumed it weekly, with a mean intake of 397.7 mL/day and 564.7 mL/day, respectively. Chocolate drinks was the second most popular SSB with 24.0% of adolescents consuming it daily and 45.8% consuming it weekly, with a mean intake of 398.2mL/day and 686.7ml/day, respectively (IPH, 2012). In the 2017 survey, malted drinks was the most popular SSB among the adolescents where 80.0% of them consumed it and the median intake was 99.7mL/day, (IPH, 2017).

The consumption of SSB in this region is mostly higher compared to Australia where the proportion of children and youth aged 2 to 18 years who consumed SSBs on the day of the survey declined by 31% (from 68.1% in 1995 to 46.7% in 2011–2012) (Brand-Miller & Barclay, 2017). Several determinants that influence children's intake of SSB have been identified. They occur at the individual, interpersonal, and environmental levels. At the individual level, it was found that SSB preference, TV viewing time, snack consumption, and frequent use of fast food restaurants were positively associated with SSB intake (Park *et al.*, 2012a; Paes *et al.*, 2015). At the interpersonal level, lower parental socioeconomic status, lower parental age, parental SSB consumption, parental positive attitude to soft drinks were found to influence children's SSB consumption (Paes *et al.*, 2015). At the environmental level, school policy reduced SSB consumption, while home availability of SSB showed positive association with SSB intake (Paes *et al.*, 2015). Other factors that were significantly associated with increased SSB intake were being male, ethnicity, and low socioeconomic status (Paes *et al.*, 2015).

The high level of SSB consumption and the increasing trend of obesity among adolescents in this country is of increasing concern among the healthcare providers and policy makers. Studies in other countries have shown that the consumption of SSB is closely related to obesity. However, there is a lack of studies on factors such as age, sex, urban or rural locality, ethnicity and obesity associated with SSB consumption among Malaysian adolescents. Therefore, the aim of this study was to determine the factors associated with SSB consumption among Malaysian adolescents.

A unique feature of this project is that it is a national level survey with a representative sample of school children from the adolescent age group that measured SSB intake as well as weight, height and several other socio-demographic data.

MATERIALS AND METHODS

Study design and sampling method

Data on sociodemographic factors, food frequency intake and anthropometrics in this study were drawn from the Adolescent Nutrition Survey (ANS) in 2017 based on a nationally representative sample. The ANS 2017 was a school-based cross-sectional study using multistage stratified cluster sampling design to ensure the recruitment of a nationally representative sample of Standards 4 to 6 (10-12 years of age) and Forms 1 to 5 (13-17 years of age) school children. Details of the ANS 2017 methodology are described elsewhere (IPH, 2017).

Malaysia was stratified into 16 states (including the Federal Territory of Kuala Lumpur, Putrajaya, and Labuan). The first stage of sampling involved a random selection of schools from a list of eligible schools provided by the Ministry

of Education. Schools were selected randomly with probability proportional to school enrolment size. A total of 311 schools were selected to participate in this survey. The second stage of sampling was selection of classes. Systematic random sampling was used to select classes from each selected school. All students in the selected classes were eligible to participate in the survey. The third stage of sampling was done for the purpose of administering the Habitual Food Intake module which included the food frequency questionnaire on SSB consumption. A total of 2,096 students were selected randomly from each selected class. After data cleaning, a total of 2,021 students were included in the final analysis. The inclusion criteria were Malaysians, aged 10 to 17 years old, not deaf, dumb or bed ridden, and attended school on the day of the survey.

Ethics approval and consent to participate

Ethical approvals of the study were obtained from the Medical Research Ethics Committee (MREC), Ministry of Health Malaysia (NMRR- 16-698-30042) prior to conducting the study. Informed written consent was taken from all respondents and their parents/ guardians at the beginning of the study.

Data collection

The ANS school-based survey was conducted from March to May 2017. Trained data collectors obtained written informed consents from the respondents and their parents/guardians before taking anthropometric measurements, and conducted a self-administered questionnaire among students using a structured, bilingual (Malay and English) questionnaire. The questionnaire included data on socio-demographic characteristics, location (urban or rural areas), sex, age, ethnicity, and school category (primary or secondary).

Anthropometric measurements

Body weight was measured using a digital weighing scale (TANITA HD 319) with an accuracy of ±100 gm. Subjects were weighed without shoes and in light clothing. Height was measured to the nearest 0.1 cm using a stadiometer (SECA 213). Weight and height measurements were done using standard procedures (Lee & Nieman, 2010). Z-score for body mass index (BMI)-for-age was calculated using the World Health Organization (WHO) AnthroPlus software (WHO, 2009) based on WHO growth reference for school-aged children and adolescents (WHO, 2007).

Dietary intake

Assessment of SSB

Dietary information was collected by trained nutritionists using a semi-quantitative food frequency questionnaire (FFQ) which consisted of 136 commonly consumed food items in Malaysia. It took 30-45 minutes to complete depending on the literacy of the respondents. The same FFQ had been pre-tested and used in the Malaysia School-Based Nutrition Survey in 2012 (IPH, 2012), but it has not been tested for its validity and reliability. This FFQ aimed to describe the habitual food intake among adolescents studying in Primary 4 to Secondary 5 in Malaysian schools. The FFQ was integrated into the Survey Creating System (SCS), which is an automated data collection system (installed in a tablet) to ensure more effective data collection and data processing work.

The FFQ was used to evaluate the habitual intake of SSB. Following is the list of SSBs included in the questionnaire – fruit drinks, regular carbonated flavoured drinks, isotonic drinks, soft drink bases, syrups, botanical beverage mixes, soybean milk/drinks, cow's milk, cultured milk, sweetened tea, instant coffee, and malted drinks, in accordance with the Malaysian Food Regulation

(1985) and the Malaysian Adults Nutrition Survey 2014 (IPH, 2014). The amount of SSB consumption per day was based on household measurement (1 glass = 250mL, 1 can = 325mL, and 1 bottle = 500mL).

Adolescents were asked to recall the frequency and amount of any types of SSB drinks that they usually consume during one month prior to the interview. The question asked was "How often (times either per day or per week or per month) did you drink the following types of beverages during the past one month? If yes, how many servings did you take each time?". Respondents should choose only one option – either times per day or per week or per month. Dietary assessment aids such as household measurement tools and the Malaysian Food Album (IPH, 2011) were used to facilitate the respondents in quantifying the portion size of the foods and beverages consumed.

Data analysis

Data analysis was done using IBM SPSS version 21. Complex samples analysis procedures were used in the analysis and was carried out at 95% confidence interval. The WHO Anthroplus software was used to enter and determine the BMI-for-age status for the respondents. Weight, height, and age data were used to calculate BMI-for-age z-score and categorise subjects into thinness, normal, overweight, and obese based on the WHO growth reference (WHO, 2017). Thinness was defined as low BMI-for-age at <-2 standard deviation (SD), overweight at >+1 SD to ≤+2 SD, and obese at >+2 SD.

All the different types of SSB were recategorised into a new variable called SSB. The amount of any drinks taken was recorded either in cups or glasses and all measurements were converted into millilitres (mL). All frequency of intakes were converted into number of times SSB was taken per day. If the respondent answered in the per week column, the frequency was divided by seven days (frequency per week/7); if the respondent answered in the per month column, the frequency was divided by 30 days (frequency per month/30). The total amount of SSB taken was calculated by multiplying the frequency of intake (now all converted into per day) with the amount taken each time. Volume (mL/day) = (*n* of days x total amount of beverages consumed)/7 days. Data were presented as median (25^{th} percentile; 75^{th} percentile) as none had a normal distribution.

Mann-Whitney and Kruskal-Wallis tests were used in this paper because the data were not normally distributed. Mann-Whitney U test was used to assess if there were any differences in consumption between urban and rural, between male and female, and between primary and secondary school adolescents. Kruskal-Wallis test was used to assess if there were any differences in consumption between the ethnic groups and BMI-for-age groups. Kruskal-Wallis post-hoc test was done to determine which of the ethnic groups and which of the BMI-for-age groups had significant differences in SSB consumption.

RESULTS

Socio-demographic characteristics

A total of 2,096 school children were eligible for this study, and 2,021 completed the food frequency questionnaire on food intake. However, 2,017 had complete data on SSB intake to be analysed. Table 1 shows the distribution according to sociodemographic characteristics. Almost 55% of the subjects were from the urban area, and there were similar proportion of males and females. Malays comprised the largest proportion in this survey (65.1%), followed by Chinese

(17.0%) and Indians (4.0%). Sixty-eight percent of subjects were in secondary schools.

Intake of SSB

Overall, the prevalence for intake of any SSB during the one-month period before the survey was 98.2% (95% CI 97.4 – 98.8). Table 2 shows the SSB intake by sociodemographic status and BMI-for-age categories. The median SSB intake for overall adolescent population was 345.1mL/day (95% CI 187.2 – 545.3), which was about 1.4 cups (250mL/cup). The highest intake of SSB was found among Bumiputra Sarawak at 455.1mL/day (95% CI 261.3 – 737.1), which was about 1.8 cups. The second highest was among Indian adolescents at 382.8mL/day (95% CI 225.4 – 553.6), which was about 1.5 cups. Chinese adolescents had the lowest intake of SSB at 276.4 mL/day (95% CI 127.9 – 448.5). In the BMI-for-age categories, overweight adolescents had the highest SSB consumption (371 mL/day (95% CI 205.9 – 534.0).

Factors associated with SSB consumption

Rural children had a significantly higher SSB consumption compared to urban children (p=0.01), while males had a significantly higher intake than females (p<0.01). There was no difference in SSB consumption between primary (younger) and secondary school (older) adolescents. After post-hoc tests, there were significant differences in SSB consumption between Chinese and

Table 1. Sociodemographic characteristics of subjects (n=2,021)

Characteristics	*n*	*%*
Location		
Urban	1106	54.7
Rural	915	45.3
Sex		
Male	1011	50.0
Female	1010	50.0
Ethnicity		
Malay	1315	65.1
Chinese	344	17.0
Indian	80	4.0
Bumiputra Sabah	142	7.0
Bumiputra Sarawak	94	4.7
Others	46	2.3
School category		
Primary	647	32.0
Secondary	1374	68.0
SSB consumption on a daily basis		
Yes	916	96.4
No	34	3.6
SSB consumption on a weekly basis		
Yes	1735	99.9
No	1	0.1
SSB consumption on a monthly basis		
Yes	1993	98.7
No	26	1.3

Malays (p<0.01), between Chinese and Indians (p<0.01), and between Chinese and Bumiputra Sarawak adolescents (p<0.01), as shown in Table 3. There were no significant differences in SSB consumption between thin, normal, overweight, and obese adolescents (Table 2).

DISCUSSION

Our survey showed that almost all (98.0%) Malaysian adolescents nationwide consumed some types of SSB. The average taken among consumers was about 1.4 cups/day. However, there were no differences in SSB intake between different BMI-for-age status. Other studies have found that lack of physical activity, poor dietary habits, and low quality diet such as high energy-dense foods and SSBs, which are low in micronutrients, contribute to excess body weight in adolescents (Kroker-Lobos *et al.*, 2014; Al-Domi *et al.*, 2019). Our adolescents had low physical activity level as reported elsewhere (IPH, 2017).

Table 2. Factors associated with SSB consumption among Malaysian adolescents (n=1,993)

Socio-demography	*n*	*Estimated population*	*Median (mL/day)*	*95% Confidence Interval*		*x^2 (df) or z* stats*	*p value*
				25th percentile	*75th percentile*		
OVERALL	1993	3,430,696	345.1	187.2	545.3		
Location†							
Urban	1092	1,924,426	326.6	180.2	519.6	-2.46	0.01
Rural	901	1,506,271	364.2	199.5	612.7		
Sex†							
Male	996	1,718,174	370.2	211.8	593.5	-5.07	<0.00
Female	997	1,712,522	312.8	165.8	508.6		
Ethnicity‡							
Malay	1305	2,221,678	348.1	199.3	572.2	48.74 (5)	<0.01
Chinese	333	612,394	276.4	127.9	448.5		
Indian	80	156,360	382.8	225.4	553.6		
Bumiputera Sabah	138	191,663	350.0	206.7	601.0		
Bumiputera Sarawak	93	167,987	455.1	261.3	737.1		
Others	44	80,614	279.6	154.9	692.4		
School category†							
Primary	635	1,313,502	345.9	191.2	550.0	-0.66	0.51
Secondary	1358	2,117,194	343.1	184.5	542.4		
BMI categories							
Thinness	111	204,076	348.8	207.5	578.6	3.55 (3)	0.31
Normal	1277	2,150,939	337.4	188.6	535.7		
Overweight	316	570,961	371.8	205.9	534.0		
Obese	285	502,372	330.4	156.9	609.5		

†Mann-Whitney U test
‡Kruskal-Wallis test

Table 3. Differences in SSB intake between ethnicities among Malaysian adolescents

Sample1 – Sample2	*Test Statistic*	*Std. Error*	*Std. test statistic*	*Sig*	*Adj. Sig.*
Chinese-Bumiputera Sabah	-164.82	58.26	-2.83	0.01	0.07
Chinese-Others	-165.95	92.31	-1.79	0.07	1.00
Chinese-Malays	217.89	35.33	6.17	<0.00	<0.00*
Chinese-Indian	-254.89	71.65	-3.56	0.00	0.01*
Chinese-Bumiputera Sarawak	-360.58	67.49	-5.34	0.00	0.00*
Bumiputera Sabah-Others	-1.14	99.63	-0.01	0.99	1.00
Bumiputera Sabah-Malays	53.07	51.51	1.03	0.30	1.00
Bumiputera Sabah-Indian	90.08	80.87	1.11	0.27	1.00
Bumiputera Sabah-Bumiputera Sarawak	-195.77	77.21	-2.54	0.01	0.17
Others-Malays	51.94	88.21	0.59	0.56	1.00
Others-Indian	88.95	108.01	0.82	0.41	1.00
Others-Bumiputera Sarawak	194.63	105.29	1.85	0.07	0.97
Malays-Indian	-37.01	66.28	-0.56	0.58	1.00
Malays-Bumiputera Sarawak	-142.70	61.76	-2.31	0.02	0.31
Indian-Bumiputera Sarawak	-105.69	87.75	-1.20	0.23	1.00

Notes:
1. Each node shows the sample average rank of Ethnicity
2. Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same
3. Asymptotic significances (2-sided tests) are displayed
4. Significant values have been adjusted by the Bonferroni correction for multiple test

*p<0.05

Many studies have shown an association between SSB intake and overweight/obesity (Malik *et al.*, 2013; Luger *et al.*, 2017). The lack of association between SSB and BMI-for-age z-score in our study could be due to several reasons. In this study, we did not adjust for under- or over-reporting, and as most children had high intakes of SSB, no association could be detected (Hasnain *et al.* 2014). Aside from that, obese children could have reduced their SSB intake in order to lose weight (Park *et al.*, 2012b), which would further weaken the association expected.

Studies have shown that SSBs contribute between 10% to 15% of youth's caloric intake and are the primary source of added sugar in the diet of children and adolescents (Hu & Malik, 2010). In a national survey among Malaysian adolescents, it was found that obese adolescents had the highest energy intake (2,232kcal/day) and the highest fat intake (88.75g/day), whereas thin adolescents had the lowest at 1,853kcal/day and 60.58g/day, respectively (IPH, 2017). The energy intake of these obese adolescents was 107.64% above the Malaysian recommended nutrient intake (MOH Malaysia, 2017) and their fat intake was 105.42% of the Recommended Nutrients Intake (RNI). Overweight and obese children had a high intake of added sugar, which were 34.50g/day and

58.31g/day, respectively. Other sources of added sugar besides SSB include confectionaries and snacks. Thus, in that study, obese children may have had an excess calorie not only from SSBs, but also from confectionaries, snacks, as well as fat. This could be the reason why we could not detect any significant association between SSB consumption and BMI-for-age status among our subjects.

As stated earlier, the strength of this study was its large nationwide representative sample, which allowed for its reliable inference to Malaysian adolescents in general within the same age group. For nutritional assessment, we applied a semi-quantitative FFQ that has demonstrated to be a practical and affordable technique, thus widely used to measure nutrient intakes in epidemiological studies. One of the limitations of this study was the lack of data on physical activity levels, which could have affected SSB intake and weight status. FFQ has been found to underestimate the frequency of beverages consumed and overestimate the quantity of beverages consumed (Cock *et al.*, 2016). Furthermore, the FFQ used in this study has not been tested for its validity and its reliability. Thus, we acknowledge that the assessment of SSB intake may have had measurement errors such as misclassification of subjects that could lead to bias in the results. Nevertheless, Hu (2008) commented that using food frequency questionnaire reflects longer-term dietary habits, although quantitatively imprecise.

CONCLUSION

Nearly all Malaysian adolescents reported that they had consumed SSB during the last one month and the average amount consumed was 1.4 cups/day. Our study indicated that locality, sex, and ethnicity contributed to differences in SSB consumption among adolescents. BMI-for-age status did not show any association with SSB consumption. This could be due to other factors such as excess energy intake from fat, other sources of sugar, and low energy expenditure from physical activity.

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Availability of data and materials

The dataset of this article belongs to the ANS project. At present, the data are not publicly available but can be obtained from the authors upon reasonable request and with the permission from the Director General of Health, Malaysia.

Authors' contributions

RS, principal investigator, conceptualised, drafted and reviewed the manuscript; AAZ, assisted in drafting of the manuscript, data analysis, reviewed the manuscript; SMY, prepared the draft of the manuscript and reviewed the manuscript; CSM, MHA, NSAA, LP, AB, assisted in drafting of the manuscript, reviewed the manuscript, conducted data collection; NIW conducted data analysis and interpretation, and reviewed the manuscript.

Conflict of interest

The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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