ORIGINAL ARTICLE

Associations of Gender and BMI-for-age Status (BAZ) With Nutrient Intake Among Adolescents in Malaysia: Findings From Adolescent Nutrition Survey (ANS) 2017

Lalitha Palaniveloo, Ruhaya Salleh, Azli Baharudin, Cheong Siew Man, Mohamad Hasnan Ahmad, Nur Shahida Abd Aziz, Syafinaz Sallehudin

Center for Nutrition Epidemiology Research, Institute for Public Health, National Institute of Health, Ministry of Health Malaysia, 40170 Shah Alam, Selangor, Malaysia

ABSTRACT

Introduction: Adolescence is an important growth period for individuals. High prevalence of obesity among adolescents in Malaysia in recent years is worrying. This study aims to assess associations of gender and BMI-for-age status (BAZ) with nutrient intake of adolescents between 13-17 years old in Malaysia. **Methods:** Data of 999 respondents were drawn from Adolescent Nutrition Survey 2017; a cross-sectional school-based survey involving adolescents aged 10 to 17 years old. Respondents were selected using multistage stratified cluster sampling from 13 states and three federal territories in Malaysia to ensure nationally representative data. Data collection was undertaken from March until May 2017. Dietary intake was assessed using a single 24-hours dietary recall conducted via face-to-face interview by trained nutritionists. Nutritionist ProTM Diet Analysis Software was used to calculate nutritional intake values. Anthropometric measurements were measured using validated equipment. Nutritional status of the respondents was assessed using BMI-for-Age z-score and categorised based on WHO Growth Reference 2007. **Results:** The mean energy intake of the adolescents was 1972 kcal/day. Majority of the adolescents had normal BMI (74.6%) while overweight, obese and thinness were 12.0%, 7.2% and 6.2% respectively. Boys had significantly higher intakes of energy, carbohydrate, protein, fat, sugar, cholesterol, thiamin, Vitamin A, calcium, iron, sodium and potassium compared to the girls. Obese adolescents had significantly higher energy, carbohydrate, fat, sugar, Vitamin A and calcium intakes compared to other BMI groups. **Conclusion:** The findings highlighted the need for cultivating self-awareness on healthy eating among adolescents.

Keywords: Dietary Intake, Adolescents, BMI, Malaysia

Corresponding Author:
Lalitha Palaniveloo, BSc
Email: lalitha.p@moh.gov.my
Tel: +603-33628727

INTRODUCTION

Adolescence is a key phase of human development for individuals. Between the age of 10-19 years old, rapid physiological, sexual, neurological and behavioral changes occurs, which makes it an important period for laying the foundations of good health to adulthood. In low- and middle-income countries (LMICs), the adolescents who are overweight or obese are increasing while the adolescents are undernourished in developing countries, (1,2). Many LMICs faces double burden of malnutrition as overweight and obesity cases are increasing on top of the existing high burden of undernutrition (2,3). Malaysia as one of the middle-income countries also experiencing the similar trends of double burden of malnutrition among children and adolescents (4,5).

Adolescents who are underweight may suffer from stunted growth, cognitive deficit, delayed puberty, work related productivity reduction later on in life and death in some extreme cases. Whereas, overweight/ obesity in adolescence increases the risk of cardiorespiratory related morbidity, type 2 diabetes, high blood pressure and progression to adulthood obesity (2,6). Compared to underweight, there are more people who are obese worldwide. In 2016, it was reported that nearly 340 million children and adolescents between the age of 5-19 years were overweight or obese globally. Meanwhile, the prevalence of overweight and obesity had increased from 4% (1975) to 18% (2016) among those between the age of 5-19 years (7). In the United States, the prevalence of obesity among the adolescents aged 12-19 years old was 20.6% in 2015-2016 (8). In Canada, the prevalence of obesity among adolescents aged 12-17 years old increased from 10.2% in 2009-2011 to 16.6% in 2012-2013 (9). Recent findings indicated the prevalence of obesity among adolescents aged between 12-17 years old in Malaysia was between 8.3-14.5% (10-12).

Studies have shown that intake of high energy density food, saturated fat, sugar and salt are main causes of obesity besides skipping meals and being sedentary among the adolescents (13-15). Hence, gaining latest data on dietary intake of the adolescents is crucial for formulation of policies and effective interventional programs besides assisting the policy makers in executing the said programs to reduce the prevalence of obesity among the adolescents in Malaysia. In addition, many studies which were conducted over the years on dietary intake among the adolescents in the country are small scaled and concentrated to certain districts, states or region. Thus, this nationwide study aims to assess associations of gender and BMI-for-age status (BAZ) with nutrient intake of adolescents aged between 13-17 years old.

MATERIALS AND METHODS

Participants

Data for this study were drawn from Adolescent Nutrition Survey 2017 (ANS 2017); a cross-sectional survey conducted among 13 to 17 years old students studied in national and private schools in Malaysia. This survey involved all 13 states and three federal territories. A list of secondary schools for the year 2016 which was provided by the Ministry of Education was applied as the sampling frame for this survey. A single proportion formula for estimation of prevalence was used to calculate the sample size (34).

A multistage stratified cluster sampling design was applied in this survey to obtain nationally representative sample of adolescents aged 13-17 year-old (Form 1 to 5 students). The first stage of sampling was a random selection of secondary schools (national and private) from the list of 2688 eligible secondary schools (2016) provided by the Ministry of Education. Next was selection of classes whereby all classes from the selected schools were included in the sampling frame. The classes from the selected schools were identified through systematic random sampling. Finally, students were randomly selected from the identified classes since all the students in the identified classes were eligible to participate in the survey (34). A total of 1,374 students were selected as respondents for this survey. Ethical approvals for the study were obtained from the Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia (KKM/NIHSEC/P16-714) prior to conducting the study. All respondents gave informed consent prior to study enrollment.

Instruments and Procedures

Dietary assessment

The dietary intake of the respondents was assessed using a single 24-hours dietary recall. It was conducted via face-to-face interview by trained nutritionists. Malaysian Food Album (2011) (16) and household measurement tools such as various sizes of plates, bowls, mugs, glasses, spoons and ladles were used to assist the respondents to estimate the portion size of the food and beverages they consumed. The dietary data was analysed using Nutritionist ProTM Diet Analysis Software from Axxya Systems, USA which uses Malaysian Food Composition and United States Department of Agriculture food databases. The nutrients included in this study are macronutrients (total energy intake, carbohydrate, protein and fat), vitamins (thiamin, vitamin A, C and E) and minerals (calcium, iron, sodium and potassium). Sugar and cholesterol intake of the respondents' were also included.

Underreporting of dietary intake was identified and corrected by calculation of a ratio between energy intake (EI) and the predicted basal metabolic rate (EI:BMR). As a first step, Basal Metabolic Rate (BMR) of each respondents was calculated using Poh et al. (2004) equations (17) which are specific for Malaysian adolescents between the ages of 12-18 years (male: 55.8 (weight) + 3187, female: 53.4 (weight) + 2182). The BMR value calculated will be in kj/day which then converted to kcal/day by multiplying with 0.239. The reported energy intake was then divided with the calculated BMR value for each of the respondents. The EI:BMR ratio generated was then compared with the cut-off from Sichert-Hellert et al. (1998) (18) which is gender and age specific (13 years old: male ≥1.04, female ≥1.01 & 14-18 years old: male ≥1.07, female ≥0.97). The EI:BMR ratio values which were lower than the cut-off was deemed as underreporting and excluded from the data analysis.

Physical evaluation

Body weight were measured using digital weighing scale (TANITA HD-319) with an accuracy of 0.1 kg. Height was measured using SECA 213 stadiometer to the nearest 0.1 cm. An average of two measurements was recorded as the final reading for both parameters. The nutritional status of the respondents was assessed using BMI-for-Age z-score and categorised using World Health Organization Growth Reference 2007 (19).

Statistical Analysis

Statistical analysis was performed using the SPSS statistical software package version 22 (SPSS Inc., Chicago, IL, USA). All variables were described using descriptive statistics. Independent-Samples T Test was used to assess associations between gender and nutrient intake of the adolescents. Analysis of Variance (ANOVA) test was used to assess association of BMI-for-age status (BAZ) with nutrient intake of the adolescents. Statistical significance was set at $p < 0.05$.

RESULTS

Out of the 1374 respondents who completed 24-hour dietary recall interview, data from 999 respondents

were included in the final analysis for this study. This was after excluding dietary data from 375 respondents which were categorised as underreporting (27.3%). The characteristics of the 999 respondents are illustrated in Table I. Boys compromised of 44.9% of the total respondents in this study while girls were 55.1%. Tabulation by age shows 62.9% of the adolescents were between the ages of 13-15 years old while 37.1% were between 16-17 years old. Majority of the adolescents were of Malay ethnicity (66.7%) followed by Chinese (14.1%), Bumiputera Sabah (9.1%), Bumiputera Sarawak (4.5%), Indian (4.3%) and Others (1.4%). Adolescents from urban locality were 53.8% while those from rural were 46.2%. Description by BMI shows majority of the adolescents had normal BMI (74.6%) while those categorised as overweight, obese and thinness were 12.0%, 7.2% and 6.2% respectively.

The nutrient intakes of the adolescents by gender were summarized in Table II. The overall mean energy intake of the adolescents in this study was 1972 kcal/d, with mean intake among boys was 2230 kcal/d while 1750 kcal/d among the girls. Boys also consumed significantly higher amount of carbohydrate (284.4g/d), protein (84.8g/d) and fat (83.7g/d) compared to the girls (224.3g/d, 65.9g/d and 65.8g/d respectively). For sugar and cholesterol, the overall mean intake was 51.1g/d and 285.5mg/d with the boys recorded significant higher intake at 55.4g/d and 332.9mg/d respectively compared to girls (47.4g/d and 244.6mg/d). Similar trend was observed for thiamin ($p<0.001$) and Vitamin A ($p<0.001$) while intake of Vitamin C and Vitamin E were not significant between the genders in this study. For minerals, the boys intake of calcium (633.5mg/d), iron (20.6mg/d), sodium (3371.7mg/d) and potassium (1416.1mg/d) were significantly higher compared to the girls (498.6mg/d, 16.6mg/d, 2602.5mg/d and 1170.8mg/d respectively).

Table III outlined the nutritional intake of the adolescents by BMI. It shows obese adolescents consumed significantly higher energy (2258 kcal/d) compared to overweight (1989 kcal/d), normal (1948 kcal/d) and thinness (1802 kcal/d) adolescents ($p<0.001$). Obese adolescents were also found to be consuming significantly higher amount of carbohydrate, 290.6g ($p<0.001$), fat, 85.2g ($p=0.001$) and sugar, 64.7g ($p=0.007$) compared to others. As for vitamins and minerals, obese adolescents recorded significantly higher intake of Vitamin A ($p=0.018$) and calcium ($p=0.022$) compared to other BMI categories.

DISCUSSION

Carbohydrate, fat and protein contributions to total daily energy intake of the adolescents in this study were 51%, 34% and 15% respectively. As in Recommended Nutrient Intakes for Malaysia 2017 (RNI 2017), carbohydrate should contribute 50-65%, fat 25-35% and protein 10-20% to total daily energy intake of adolescents (20).

Table I: Characteristics of adolescents by gender

	Boys (n=449)	Girls (n=550)	Total (n=999)
		n (%)	
Age (years)			
13-15	279 (62.1)	349 (63.5)	628 (62.9)
16-17	170 (37.9)	201 (36.5)	371 (37.1)
Ethnicity			
Malay	300 (66.8)	365 (66.4)	665 (66.6)
Chinese	61 (13.6)	80 (14.5)	141 (14.1)
Indian	17 (3.8)	26 (4.7)	43 (4.3)
Bumiputera Sabah	42 (9.4)	49 (8.9)	91 (9.1)
Bumiputera Sarawak	23 (5.1)	22 (4.0)	45 (4.5)
Others	6 (1.3)	8 (1.5)	14 (1.4)
Locality of School			
Urban	246 (54.8)	291 (52.9)	537 (53.8)
Rural	203 (45.2)	259 (47.1)	462 (46.2)
BMI-for-age status (BAZ)			
Thinness (<-2sd)	33 (7.3)	29 (5.3)	62 (6.2)
Normal (≥-2sd - ≤+1sd)	338 (75.3)	407 (74.0)	745 (74.6)
Overweight (>+1sd - ≤+2sd)	47 (10.5)	73 (13.3)	120 (12.0)
Obese (>+2sd)	31 (6.9)	41 (7.4)	72 (7.2)

Table II: Nutrient intake of adolescents by gender

Macronutrients	Overall	Boys	Girls	*P*-value
	Mean ± 2SD	Mean ± 2SD	Mean ± 2SD	
	n=999	n=449	n=550	
Energy (kcal/d)	1972 ± 626	2230 ± 646	1750 ± 514	<0.001*
Carbohydrate (g/d)	252.1 ± 86.8	284.4 ± 89.2	224.3 ± 74.2	<0.001*
Protein (g/d)	74.6 ± 29.0	84.8 ± 30.5	65.9 ± 24.5	<0.001*
Fat (g/d)	74.1 ± 30.3	83.7 ± 32.0	65.8 ± 26.1	<0.001*
Sugar (g/d)	51.1 ± 45.5	55.4 ± 42.1	47.4 ± 38.0	<0.001*
Cholesterol (mg/d)	285.5 ± 208.0	332.9 ± 235.3	244.6 ± 170.8	<0.001*
Vitamins				
Thiamin (mg/d)	0.8 ± 0.7	0.9 ± 0.5	0.8 ± 0.6	<0.001*
Vitamin A (µg/d)	1557.9 ± 1288.1	1728.1 ± 1253.7	1410.7 ± 1299.2	<0.001*
Vitamin C (mg/d)	73.9 ± 67.5	60.7 ± 51.6	85.3 ± 73.3	0.103
Vitamin E (mg/d)	8.7 ± 7.0	5.8 ± 4.5	11.2 ± 10.6	0.252
Minerals				
Calcium (mg/d)	561.1 ± 345.9	633.5 ± 389.9	498.6 ± 288.5	<0.001*
Iron (mg/d)	18.5 ± 20.7	20.6 ± 15.8	16.6 ± 14.9	<0.001*
Sodium (mg/d)	2959.0 ±1591.1	3371.7 ± 1689.9	2602.5 ± 1406.2	<0.001*
Potassium (mg/d)	1284.5 ± 609.4	1416.1 ± 601.2	1170.8 ± 593.3	<0.001*

*p<0.05

Table III: Nutrient intake of adolescents by BMI-for-age status (BAZ)

Macronutrients	Thinness	Normal	Overweight	Obese	*P*-value
	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	
	n=62	n=745	n=120	n=72	
Energy (kcal/d)	1802 (1656, 1947)	1948 (1902, 1995)	1989 (1900, 2078)	2258 (2115, 2401)	<0.001*
Carbohydrate (g/d)	225.3 (207.6, 243.0)	250.0 (243.4, 256.4)	246.4 (234.0, 258.8)	290.6 (268.8, 312.5)	<0.001*
Protein (g/d)	73.8 (66.8, 80.9)	73.9 (71.8, 76.0)	75.4 (71.0, 79.8)	79.5 (72.5, 86.6)	0.432
Fat (g/d)	67.2 (58.6, 75.8)	72.7 (70.5, 74.9)	78.7 (73.6, 83.8)	85.2 (78.6, 91.7)	0.001*
Sugar (g/d)	40.1 (32.9, 47.3)	49.8 (46.8, 52.7)	48.9 (37.9, 59.9)	64.7 (57.1, 72.3)	0.007*
Cholesterol (mg/d)	297.0 (242.7, 351.3)	284.8 (270.4, 299.2)	287.3 (247.5, 327.0)	315.2 (263.3, 367.1)	0.666
Vitamins					
Thiamin (mg/d)	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)	0.9 (0.8, 1.0)	0.9 (0.8, 1.1)	0.717
Vitamin A (µg/d)	1430.0 (1167.2, 1692.8)	1490.6 (1400.5, 1580.7)	1803.9 (1482.6, 2125.2)	1840.7 (1554.9, 2126.4)	0.018*
Vitamin C (mg/d)	59.9 (44.2, 75.7)	67.0 (53.6, 80.5)	100.5 (22.1, 178.9)	71.3 (55.3, 87.3)	0.472
Vitamin E (mg/d)	6.3 (4.2, 8.4)	5.9 (4.2, 7.5)	18.5 (6.5, 23.5)	5.6 (4.4, 6.8)	0.101
Minerals					
Calcium (mg/d)	517.1 (441.8, 592.4)	534.6 (510.7, 558.4)	596.4 (536.6, 656.1)	639.4 (547.5, 731.3)	0.022*
Iron (mg/d)	16.8 (14.3, 19.3)	19.0 (17.1, 20.9)	17.6 (15.9, 19.3)	20.4 (17.9, 22.9)	0.760
Sodium (mg/d)	2732.7 (2376.2, 3089.1)	2894.7 (2786.5, 3002.8)	3104.3 (2776.1, 3432.4)	3315.9 (2820.2, 3811.5)	0.073
Potassium (mg/d)	1275.3 (1110.6, 1440.1)	1256.8 (1213.9, 1299.7)	1262.7 (1160.7, 1364.8)	1429.1 (1281.5, 1576.6)	0.141

*p<0.05

Based on the findings above, it can be said that the adolescents were consuming the macronutrients within the recommended range.

The significantly higher energy intake among the boys compared to the girls in this study are comparable with results from a population-based study conducted among adolescents aged 12-19 years old in Kelantan, Malaysia where the total mean energy intake of the adolescents was 2238 kcal with boys recorded higher energy intake with 2346 kcal and girls with 2152 kcal (21). Similarly, Abdul Majid et al. (2016) who conducted dietary assessment among adolescents aged 13 years old in schools from central and northern region of Peninsular Malaysia reported a total mean energy intake of 1659 kcal, with higher energy intake observed among the boys (1774 kcal) compared to girls (1595 kcal) (22). Likewise, Teo et al. (2014) reported similar findings in her study (23). Boys also recorded significant higher intake of carbohydrate, fat, protein, sugar and cholesterol than girls. Based on RNI 2017, recommended energy, fat and protein intakes for male adolescents aged between 13-17 years old are higher compared to females (20). This is due to physiological factors of male adolescents where larger frames and bigger muscle mass require them to consume higher calories and nutrients daily than female adolescents (24).

As per micronutrients, intakes of calcium and potassium were low while sodium intake exceeded the recommended levels in RNI 2017 among both the genders. Findings on calcium intake among the adolescents are comparable with a locally conducted study by Abdul Majid et al. (2016) and similar trends were observed in studies conducted in Korea, Brazil, Spain, Saudi Arabia and India (22,25-29). Adequate intake of calcium during adolescence is very crucial because nearly 40% of bone mass is accumulated between the age of 11-17 years old. This is important to avoid occurrence of osteoporosis later in life (26). Findings of high sodium and low potassium intakes among the adolescents in this study concurred with results from studies conducted locally and internationally on the intakes of these two minerals (22,30-31). Excessive intake of sodium and low intake of potassium are worrisome since this situation had been associated with many cardiovascular related diseases across all age groups (32,33). Yet, not much been discussed on sources of high sodium food regularly consumed by the adolescents in Malaysia. Recent findings from ANS 2017 showed nearly 40-47% of the adolescents in the study consumed fast food between one to six days in a week with the top four most consumed fast food were fried chicken, burger, french fries and nuggets (34). Low potassium intake among this group also is not surprising as ANS 2017 showed a very high prevalence of adolescents not meeting the recommended daily serving sizes of fruits and vegetables as stipulated in Malaysian Dietary Guidelines 2010 (MDG 2010). Nearly 70-76% of the adolescents consumed less than 2 servings of fruits daily while 91-94% consumed less than 3 servings of vegetables daily (35). As fruits and vegetables are main sources of potassium, the adolescents need to be encouraged to consume more of these food groups daily (36).

Regardless of gender, intake of Vitamin A was adequate but intake of thiamine (Vitamin B1) was lower than the minimum requirement based on RNI 2017 recommendations. Rezali et al. (2012) also

reported lower thiamin intake among the adolescents in a study conducted locally (37). Severe thiamine deficiency is known to cause the disease beriberi with neurological effects such as confusion, psychosis and severely impaired memory and cognitive function (38). A study conducted among 17 years old adolescents in Australia showed low thiamin intake together with other B-vitamins was significantly associated with mental health and behavioral problems (39). With a constant increase in prevalence of mental health problems among the adolescents in the country (40), consideration should be given in creating awareness on importance of adequate intake of thiamine-rich foods together with other B-vitamins for the adolescents. This in reference to findings from ANS 2017 which indicated that Malaysian adolescents did not meet the recommended daily intake of thiamine rich foods such as fish, seeds, nuts and legumes in their daily diet (34). This may be due to the fact these food groups are not popular among the adolescents who prefers to indulge themselves with carbohydrate-rich and fast foods.

Dietary intake among adolescents by BMI-for-age status
Obese adolescents in this study had higher energy intake compared to overweight, normal and thin adolescents. They consumed 14% and 12% more energy compared to normal and overweight adolescents respectively. Abdul Majid et al. (2016) reported similar findings from his study with a 15.8% more energy consumption by obese adolescents compared to normal weight (22). Results from locally conducted study by Rezali et al. (2012) also concurred to these findings (37). Elliot et al. (2011) reported higher energy intakes were recorded among children and adolescents with higher BMI compared to those who were leaner (41). Obese adolescents in this study also recorded significantly highest consumption of carbohydrate (290.6 g/d) and dietary fat (85.2 g/d) in comparison to other BMI groups. Our findings corroborated with Abdul Majid et al. (2016) who reported obese adolescents had significantly highest intake of carbohydrate and dietary fat with 269.7 g/d and 70.3 g/d respectively compared to other BMI groups in their study (22). Similar trends of carbohydrate and dietary fat intakes among obese respondents was also reported by Yang et al. (2016). All these findings are in line with studies which reported that consumption of energy-densed dan high-fat foods could be an important contributing factor for occurrence of obesity among adolescents (Storey et al., 2011; Sun et al., 2020).

Comparison by BMI groups showed sugar intake is the highest among the obese adolescents who recorded a mean intake of 64.7 g/d, which is equivalent to nearly 13 teaspoons/day. RNI 2017 recommends that sugar intake should be less than 10% of total energy intake (20). Based on this, sugar intake of the obese adolescents in the present study was estimated to be 12%. Thus, the obese adolescents were found to be consuming higher amount of sugar, either from food or beverages. Findings from ANS 2017 showed sugar was the most consumed food item by the adolescents from fat, oil, sugar and salt food group (34). The report also showed malted drinks, ready-to-drink tea, carbonated and cordial drinks of various flavours topped the list of most consumed beverages among the adolescents. All these drinks are known to contain high amount of sugars. Meanwhile, studies had indicated high sugar consumption among obese adolescents is through sugar sweetened beverages (SSB) (42-44). A possible explanation for this scenario is the fact that the intake of liquid carbohydrates causes less satiety than solid carbohydrates, which leads to higher total energy consumed (45).

This study has several strengths. Unlike other studies conducted locally where the respondents will be either from one particular state or district, this study had a nationwide coverage where all the states and federal territories in Malaysia were involved. Data obtained from this study will be very useful to improvise the intervention programmes implemented for the adolescents nationwide. Besides that, formulating health policies for the adolescents based on recent evidence will be more effective in addressing adolescents' health needs. A one-to-one interview session conducted by trained nutritionist to assess the dietary information of the respondents is another strength in this study. An add-on to this was the usage of household measurement tools such as various sizes of plates, bowls, mugs, glasses, spoons and ladles in the interview sessions. This would have helped the respondents in visualising and estimating the portion size of the food and beverages they had actually consumed. Among the limitations noted is the usage of a single 24-hour dietary recall. A single 24-hour dietary recall is not adequate to capture exact dietary information of the respondents. A 3-day period of 24-hour dietary recall that includes weekdays and weekends will provide a more accurate dietary information (46). Respondents in this study were also exposed to recall bias, which is a common occurrence in any age group for dietary recall assessments. Efforts were taken to minimize the bias during the study by engaging qualified nutritionists who were well-versed with dietary interviews to conduct the interview sessions.

CONCLUSION

This study provides the latest insight on dietary intake among adolescents in Malaysia. Although all the adolescents consumed adequate amount of macronutrients daily, their sugar and sodium intakes were high while calcium was low. On the other hand, obese adolescents have higher energy level, carbohydrate and sugar intake compared to other BMI groups. These findings show the need of cultivating self-awareness on healthy eating among the adolescents. Parents, equipped themselves with a good healthy eating knowledge need to guide their children from young on healthy eating habits. Also, joint effort from various organisations are

much needed to provide healthy environments which promotes healthy eating and lifestyle practices for the adolescents. Health policy makers should maximise these latest findings to improvise their current health policies targeting adolescents.

ACKNOWLEDGMENTS

The authors would like to acknowledge the Director General of Health Malaysia for permission to publish this paper and for funding this survey (NMRR-16-698-30042). Appreciation goes to the Department of Statistics, Malaysia in the sampling process. Acknowledgement also goes to Ministry of Education Malaysia and Ministry of Health Malaysia (Nutrition Division, State Health Departments and Liaison Officers) in the preparation and during the data collection. Our sincere appreciation also goes to all participants and data collectors.

REFERENCES

1. World Health Organisation. Health for the World's Adolescents. A second chance in the second decade. 2014.
2. Das JK, Salam RA, Thornburg KL, Prentice AM, Campisi S, Lassi ZS, et al. Nutrition in adolescents: physiology, metabolism and nutritional needs. Ann N Y Acad Sci. 2017;1393(1):21–33.
3. Caleyachetty R, Thomas GN, Kengne AP, Echouffo-Tcheugui JB, Schilsky S, Khodabocus J, et al. The double burden of malnutrition among adolescents: Analysis of data from the Global School-Based Student Health and Health Behavior in School-Aged Children surveys in 57 low- and middle-income countries. Am J Clin Nutr. 2018;108(2):414–24.
4. Khambalia AZ, Lim SS, Gill T, Bulgiba AM. Prevalence and sociodemographic factors of malnutrition among children in Malaysia. Food Nutr Bull. 2012;33(1):31-42.
5. Partap U, Young EH, Allotey P, Sandhu MS, Reidpath DD. The use of different international references to assess child anthropometric status in a Malaysian population. J Pediatr. 2017;190:63-68.e1.
6. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: Systematic review. Int J Obes. 2011;35(7):891–8.
7. World Health Organization Fact sheet on Obesity and overweight. Information tool for policy-makers, and general public Indicators 13-14, target 7, objective 3 (16 Feb 2018) https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
8. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of Obesity Among Adults and Youth: United States, 2015–2016. NCHS data brief, no 288.
9. Rao DP, Kropac E, Do MT, Roberts KC, Jayaraman GC. Childhood overweight and obesity trends in Canada. Heal Promot chronic Dis Prev Canada Res policy Pract. 2016;36(9):194–8.
10. Chew W, Leong P, Yap S, Yasmin A, Choo K, Low G, et al. Risk factors associated with abdominal obesity in suburban adolescents from a Malaysian district. Singapore Med J. 2017;59(2):104–11.
11. Ahmad A, Zulaily N, Abdul Manan NS, Shahril MR, Syed Saadun Tarek Wafa SWW, Mohd Amin R, et al. Body weight status of school adolescents in Terengganu, Malaysia: a population baseline study. BMC Public Health. 2017;17(1):9.
12. Hui Tee JY, Gan WY, Tan KA, Chin YS. Obesity and unhealthy lifestyle associated with poor executive function among Malaysian adolescents. PLoS One. 2018;13(4):1–17.
13. Fisberg M, Maximino P, Kain J, Kovalskys I. Obesogenic environment – intervention opportunities. Jornal de Pediatria. 2016;92(3):30-39.
14. Mushtaq MU, Gull S, Mushtaq K, Shahid U, Shad MA. Dietary behaviors, physical activity and sedentary lifestyle associated with overweight and obesity and their socio-demographic correlates, among Pakistani primary school children. Int J Behav Nutr Phys Act. 2011;8:130.
15. Nasreddine L, Naja F, Akl C, Chamieh MC, Karam S, Sibai A, et al. Dietary, Lifestyle and Socio-Economic Correlates of Overweight, Obesity and Central Adiposity in Lebanese Children and Adolescents. Nutrients. 2014;6:1038-1062.
16. Institute for Public Health. Malaysian Food Album 2011. Ministry of Health, Malaysia. 2011;1-121.
17. Poh BK, Ismail MN, Ong HF, Norimah AK, Safiah MY. BMR predictive equations for Malaysian adolescents aged 12 - 18 years. Final Report for IRPA 06-02-02-0096 Research Project. Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur. 2004.
18. Sichert-Hellert W, Kersting M, Schoch G. Underreporting of energy intake in 1 to 18 year old German children and adolescents. Z ErnΔhrungswiss. 1998;37: 242–251.
19. World Health Organization. Growth Reference Data for 5-19 years old. 2007.https://www.who.int/growthref/en/
20. National Coordinating Committee on Food and Nutrition (NCCFN). Recommended Nutrient Intakes for Malaysia 2017. Ministry of Health Malaysia. 2017;1-523.
21. Nurul-Fadhilah A, Teo PS, Huybrechts I, Foo LH. Infrequent Breakfast Consumption Is Associated with Higher Body Adiposity and Abdominal Obesity in Malaysian School-Aged Adolescents. PLoS One. 2013;8(3):1–6.
22. Majid HA, Ramli L, Ying SP, Su TT, Jalaludin MY. Dietary intake among adolescents in a middle-income country: An outcome from the Malaysian

health and adolescents longitudinal research team study (The MyHearts study). PLoS One. 2016;11(5):1–14.
23. Teo PS, Nurul-Fadhilah A, Aziz ME, Hills AP, Foo LH. Lifestyle practices and obesity in Malaysian adolescents. Int J Environ Res Public Health. 2014;11(6):5828–38.
24. Soliman A, De Sanctis V, Elalaily R. Nutrition and pubertal development. Indian J Endocr Metab. 2014;18, Suppl S1:39-47.
25. Im JG, Kim SH, Lee G, Joung H, Park M. Inadequate calcium intake is highly prevalent in Korean children and adolescents : the Korea National Health and Nutrition Examination Survey (KNHANES) 2007 – 2010. 2013;17(11):2489–95.
26. De Oliveira CF, Da Silveira CR, Beghetto M, De Mello PD, De Mello ED. Assessment of calcium intake by adolescents. Rev Paul Pediatr. 2014;32(2):216-20.
27. Correa-Rodrнguez M, Schmidt-RioValle J, Ramнrez-Vйlez R, Correa-Bautista JE, Gonzбlez-Jimйnez E, Rueda-Medina B. Influence of Calcium and Vitamin D Intakes on Body Composition in Children and Adolescents. Clinical Nursing Research. 2018;1–13.
28. Al-musharaf S, Al-othman A, Moharram O, Yakout S, Sabico S, Chrousos GP. Vitamin D deficiency and calcium intake in reference to increased body mass index in children and adolescents. Eur J Pediatr. 2012;171:1081–1086.
29. Sanwalka NJ, Khadilkar AV, Mughal MZ, Sayyad MG, Khadilkar VV, Shirole SC, Divate UP, Bhandari DR. A study of calcium intake and sources of calcium in adolescent boys and girls from two socioeconomic strata, in Pune, India. Asia Pac J Clin Nutr. 2010;19(3):324-9.
30. Chmielewski J, Bryan MSJ. Dietary sodium, dietary potassium and systolic blood pressure in US adolescents. J Clin Hypertens. 2017;19:904–909.
31. Campanozzi A, Avallone S, Barbato A, Iacone R, Russo O, De Filippo G, et al. High Sodium and Low Potassium Intake among Italian Children: Relationship with Age, Body Mass and Blood Pressure. PLoS ONE. 2015;10(4): e0121183.
32. Lava SAG, Bianchetti MG, Simonetti GD. Salt intake in children and its consequences on blood pressure. Pediatr Nephrol. 2015;30(9):1389–96.
33. D'Elia L, Barba G, Cappuccio FP, Strazzullo P. Potassium intake, stroke, and cardiovascular disease: A meta-analysis of prospective studies. J Am Coll Cardiol. 2011;57(10):1210–9.
34. Institute for Public Health. National Health and Morbidity Survey (NHMS) 2017: Adolescent Nutrition Survey. Ministry of Health, Malaysia. 2017;1-391.
35. National Coordinating Committee on Food and Nutrition (NCCFN). Malaysian Dietary Guidelines 2010. Ministry of Health, Malaysia. 2010;1-220.
36. Loftfield E, Yi S, Curtis CJ, Bartley K, Kansagra SM. Potassium and fruit and vegetable intakes in relation to social determinants and access to produce in New York City. Am J Clin Nutr. 2013;98(5):1282–8.
37. Rezali FW, Chin YS, Yusof BNM. Obesity-related behaviors of Malaysian adolescents: A sample from Kajang district of Selangor state. Nutr Res Pract. 2012;6(5):458–65.
38. Bergeron G, Bettendorff L, Jefferds ME, Mousavi MPS, Cox L, Bourassa MW, et al. Thiamine deficiency disorders: diagnosis, prevalence, and a roadmap for global control programs. Ann N Y Acad Sci. 2018;1430(1):3–43.
39. Herbison CE, Hickling S, Allen KL, O'Sullivan TA, Robinson M, Bremner AP, et al. Low intake of B-vitamins is associated with poor adolescent mental health and behaviour. Prev Med. 2012;55(6):634–8.
40. Ahmad N, Muhdyusoff F, Ratnasingam S, Mohamed F, Nasir NH, Mohdsallehuddin S, et al. Trends and factors associated with mental health problems among children and adolescents in Malaysia. Int J Cult Ment Health. 2015;8(2):125–36.
41. Elliott SA, Truby H, Lee A, Harper C, Abbott RA, Davies PSW. Associations of body mass index and waist circumference with: energy intake and percentage energy from macronutrients, in a cohort of Australian children. 2011;(2001):1–7.
42. Cafй ACC, Lopes CA de O, Novais RLR, Bila WC, Silva DK da, Romano MCC, et al. Intake of sugar-sweetened beverages, milk and its association with body mass index in adolescence: A Systematic Review. Rev Paul Pediatr. 2018;36(1):91–9.
43. Loh DA, Moy FM, Zaharan NL, Jalaludin MY, Mohamed Z. Sugar-sweetened beverage intake and its associations with cardiometabolic risks among adolescents. Pediatr Obes. 2016;12(1):e1–5.
44. Basu S, McKee M, Galea G, Stuckler D. Relationship of Soft Drink Consumption to Global Overweight, Obesity, and Diabetes: A Cross-National Analysis of 75 Countries. Am J Public Health. 2013;103(11):2071–7.
45. Pan A, Hu FB. Effects of carbohydrates on satiety: Differences between liquid and solid food. Curr Opin Clin Nutr Metab Care. 2011;14(4):385–90.
46. Burrows TL, Martin RJ, Collins CE. A Systematic Review of the Validity of Dietary Assessment Methods in Children when Compared with the Method of Doubly Labelled Water. J Am Diet Assoc. 2010;110(10):1501–10.