

Prevalence of Malnutrition and its Association with Socio-demographic Characteristics among Malaysian Adolescents Living in Day-school Hostels

Lai SC¹, Chin YS^{1,2}, Chan YM^{1,3} & Mohd Nasir MT^{1,2}

¹ Department of Nutrition and Dietetics, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Malaysia

² Research Centre of Excellence, Nutrition and Communicable Diseases, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Malaysia

³ National Research Institute on Ageing, Universiti Putra Malaysia, 43400 UPM Serdang Malaysia

ABSTRACT

Introduction: The life of an adolescent in a school hostel is well-managed with respect to daily food intake and physical activity. These adolescents are likely to be physically active and are assumed to consume nutritious food. However, little is known about malnutrition and factors related to it. Thus, this study determined the association between malnutrition (thinness & overweight) and socio-demographic characteristics of these adolescents living in day-school hostels. **Methods:** Data from *Program Cara Hidup Sihat* (Healthy Lifestyle Program), comprising a total of 4189 13-year-old school-going adolescents were used. A multi-stage stratified cluster sampling method was applied. Information on socio-demographic characteristics was collected using self-administered questionnaires. Body weights and heights were measured. Body mass index (BMI)-for-age (z-score), or BAZ, was determined using the World Health Organization's (WHO) Growth Reference **Results:** The prevalence of overweight (23.3%, 95% CI: 22.1, 24.7) was about six times higher than thinness (4.3%, 95% CI: 3.7, 5.0). Males had higher prevalence of thinness (5.6%, 95% CI: 4.6, 6.9) compared to females (3.4%, 95% CI: 3.7, 4.2). A higher prevalence of overweight was observed in the central zone than in the other five zones. Complex samples logistic regression showed that adolescents from the central zone and those with monthly parental incomes \geq RM 5000 were 2.5 times (adjusted odds ratio [OR]=2.5, 95% confidence interval [CI]: 1.6, 3.9) and 2.0 times (adjusted OR=2.0, 95% CI: 1.3, 2.9), respectively, more likely to be at risk of overweight compared to adolescents from the other five zones and with parents whose monthly incomes were less than RM 5000. Conversely, male adolescents were 1.7 times more likely to be at risk of thinness (adjusted OR=1.7, 95% CI: 1.2, 2.3) compared to female adolescents. **Conclusion:** The dual forms of malnutrition co-existed, with over-nutrition being more prevalent than under-nutrition. Future healthy body weight intervention programs should consider sex, monthly parental incomes and geographic zones of adolescents living in day-school hostels.

Key words: Adolescents, day-school hostels, Malaysian, overweight, thinness

INTRODUCTION

Malnutrition remains one of the major public health problems and is among the most common causes of morbidity and mortality resulting from non-communicable diseases throughout the world. Global transitions in economic development and urbanisation have seen changes to people's diets and lifestyles, and has seen them consume energy-dense food while lowering their levels of physical activity (Ramachandran *et al.*, 2012). This concomitant transition in nutrition has contributed to nutritional and health problems in which thinness and obesity co-exist. Both conditions pose an emerging public health problem in many developing countries, and recent trends seem to predict a further increase in the future (Khambalia *et al.*, 2012; Poh *et al.*, 2013).

Malnutrition can be categorised as under-nutrition (severe thinness and thinness) and over-nutrition (overweight and obesity) while body weight status is one of the indicators of malnutrition. Among Asian countries, the prevalence of under-nutrition and over-nutrition vary and are assessed using different standards. For example, Tang *et al.* (2010) used the International Obesity Task Force (IOTF) classification to show that the prevalence of overweight (14.7%) and obesity (18.9%) among Vietnamese adolescents aged 6-19 years was higher than the prevalence of underweight (7.6%). In India, Gupta *et al.* (2011), using the IOTF classification, found a decline in the prevalence of underweight (11.3% to 3.9%) accompanied by an increase in the prevalence of obesity (9.8% to 11.7%) from 2006 to 2009 among urbanite adolescents aged 14 to 17-years old in New Delhi (North India), reflecting the consequences of nutrition transition. Gupta & Wang (2009) report that China, one of the world's fastest growing economies, had escalating proportions of overweight and obesity among children and adolescents aged 7 to 18 years old from 1985 to 2010

by using the Working Group on Obesity in China (WGO) standard (Zhang & Wang, 2012). The proportion of overweight and obesity among males and females in the age range studied were 20.2% to 33.2%, and 2.3% to 19.1%, respectively.

Malaysia, as one of the fast developing countries, is also experiencing the dual burdens of malnutrition. Using data from the National Health and Morbidity Survey (NHMS) III in 2006, which is based on the CDC growth charts (Centers for Disease Control and Prevention, National Center for Health Statistics., 2000) (weight-for-age), the Institute for Public Health (IPH) (2008) reports that the prevalence of underweight (weight-for-age < -2SD) and overweight (weight-for-age > +2SD) among Malaysian adolescents aged less than 18-years old were 13.2% and 5.4%, respectively. Subsequently, the NHMS IV in 2011 (IPH, 2011) revealed that the prevalence of thinness (BMI-for-age < -2SD) and obesity (BMI-for-age > +2SD) among Malaysian adolescents aged less than 18-years old were 12.2% and 6.1%, respectively (IPH, 2011). As such, this observation is of importance to public health as obesity is a fore warning risk factor of non-communicable diseases, especially among adolescents.

Adolescence is a period that involves dramatic physical, psychological, and cognitive changes in young people. To achieve optimal growth and development during adolescence, the nutritional requirements during this period are the highest across the lifespan (National Coordinating Committee on Food and Nutrition [NCCFN], 2010). However, immature cognitive abilities, increasing autonomy in making decisions, and susceptibility to environmental influences during this stage may contribute to unhealthy nutritional and lifestyle choices among adolescents (Stang & Story, 2005) which in turn, may become risk factors for malnutrition (de Jong *et al.*, 2013; Law, Mohd Nasir & Hazizi, 2013; O'Dea & Amy, 2011).

Previous studies found that malnutrition during adolescence has important short and long-term implications. Over-nutrition among adolescents is associated with several adverse outcomes in adulthood including cardiovascular diseases (Alp *et al.*, 2014), metabolic syndromes (Steinberger & Kelly, 2014), and poor psychological health outcomes (Brixval *et al.*, 2012). Additionally, under-nutrition during adolescence has been linked to psychiatric disorders (Bühren *et al.*, 2013), delayed growth and pubertal development (Ferrari & Olds, 2010).

It is also noteworthy that childhood and adolescent obesity may persist into adulthood and increase the likelihood of adult morbidity and mortality (Reilly & Kelly, 2011). Regardless of the reference cut-off points used for body weight status, the increasing epidemic of malnutrition among adolescents is worrying. Treatment of malnutrition in adolescents is challenging, and prevention is the only feasible option to curb this public health problem. Thus, a better knowledge of the prevalence of under and over-nutrition, and the risk factors associated with them, is a pre-requirement for setting up effective health promotion programs.

Both under and over-nutrition among adolescents are multifactorial conditions. Many previous studies show that the prevalence of underweight, overweight and obesity among adolescents appears to be associated with socio-demographic characteristics (Aboshkair *et al.*, 2011; Andegiorgish *et al.*, 2012; Khambalia *et al.*, 2012; Rampal *et al.*, 2007a; Yen *et al.*, 2010). Other studies identify risk factors for unhealthy body weight status among school-aged adolescents in Malaysia. Baharudin *et al.* (2013) examined 4304 Malaysian adolescents aged 10 to 17-years and found that the prevalence of thinness was the highest in Sabah/Labuan and was higher in urban areas than in rural areas. They also found that the prevalence of

obesity is highest in urbanite adolescents in Perak. Subsequently, Rampal *et al.* (2007b) reported a significantly higher prevalence of obesity in Malay adolescents, followed by Indian and Chinese adolescents, among 3333 adolescents aged 13 to 17-years old in the Klang district studied using BMI greater than the 95th percentile as an indicator of overweight. Comparing by sex in the Malaysian state of Selangor, higher prevalence of overweight and obesity were found in males compared to females aged 13 to 16-years old (Aboshkair *et al.*, 2011).

There are two types of government-financed residential schools in Malaysia, namely, fully residential schools (*sekolah berasrama penuh*) and day-schools with hostels facilities (*sekolah berasrama harian*) (Ministry of Education Malaysia [MoE], 2012). Fully residential schools nurture outstanding students to excel academically as well as in extra-curricular activities, and require them to live in the school hostels provided. On the other hand, day-schools with hostel facilities provide a conducive and safe accommodation for less advantaged students whose homes are far from school. Many Malaysian studies relating to body weight status have been conducted in school-aged adolescents (Baharudin *et al.*, 2013; IPH, 2008; IPH, 2011), but they have not focused on adolescents attending and living in day-school hostels.

According to the MoE (2012), the diet and physical activity of adolescents who live in day-school hostels are managed by the day hostels' management teams. Standardised healthy menus planned by the Ministry of Health (MoH) are provided to all adolescents living in school hostels while their leisure and extra-curricular activities are scheduled into days by the school authorities. Since students at these facilities were likely to consume nutritious food and be physically active, this study hypothesised that the prevalence of malnutrition would be low among them.

Given that the current trend of under and over-nutrition among adolescents is prevalent in Malaysia, and studies on the nutritional status among adolescents living in day-school hostels are limited, it was timely to confirm whether the dual forms of malnutrition was prevalent among the adolescents studied.

In order to fill the identified gap in knowledge, this study assessed the prevalence of malnutrition, namely under-nutrition (severe thinness and thinness) and over-nutrition (overweight and obesity) among a representative sample of Malaysian adolescents living in day-school hostels. It also aimed to investigate the possible association between socio-demographic characteristics with malnutrition among these adolescents.

METHOD

Study setting and subjects

This study was a baseline study for a three-year national intervention program (2012-2014) entitled *Program Cara Hidup Sihat* (Healthy Lifestyle Program), focusing on adolescents living in day-school hostels in Malaysia. A multi-stage stratified cluster sampling of adolescents aged 13 years from a random sample with probability proportionate selection of day-school, stratified by geographical location, was carried out. This study was carried out using a zone-based sample. All states in Malaysia are classified by geographical location into six zones, namely northern (Pulau Pinang, Perak, Kedah and Perlis), east-coast (Pahang, Kelantan, Terengganu), southern (Negeri Sembilan, Malacca, Johor) and central (Kuala Lumpur, Selangor), Sabah, and Sarawak. There are a total of 721 day-schools in Malaysia, of which 169 schools are located in the northern zone, 64 in the southern zone, 74 in the central zone, 203 in the east-coast zone, 110 in Sabah, and 101 in Sarawak. From the total of 721 day-schools, 100 schools were randomly selected using probability proportional

sampling according to the urban and rural proportions in each zone.

By using the cluster sampling design, all form one (or first year of high school) adolescents attending and living in the 100 selected day-school hostels were invited to participate in the study. The sample size was calculated using the equation by Daniel (1999) as shown below:

$$n = \frac{Z^2 P (1-P)}{d^2}$$

where n is the estimated required sample size, Z is the Z-statistic for a level of confidence, p is the estimated prevalence, and d is the precision.

A minimum sample size for one zone was calculated using the expected prevalence of 19.5% for overweight and obesity as reported by Fara Wahida, Chin & Barakatun Nisak (2012) with a confidence level of 95% and a precision of 0.05. The sample was then multiplied by two to take into consideration the urban and rural stratification of the schools (Lu Ann & Llewellyn, 1996) and then multiplied by six to take into account the six geographical zones considered. By considering a possible non-response rate of 20%, a sample of 3619 form one adolescents attending and living in day-school hostels was needed for this study.

The inclusion criteria were students attending form one and living in day-school hostels. Students with learning and/or physical disabilities, as confirmed by their teachers and school records, were excluded from this study. Approvals to conduct the study were obtained from the University Ethics Committee for Research Involving Humans, Universiti Putra Malaysia (UPM), MoE and State Education Departments from the six zones in Malaysia. Permission to conduct this study was also obtained from the respective school principals prior to data collection. Written information sheets about the study and consent forms were distributed to a total 5186 adolescents. Of

these, 4277 adolescents gave their consent to participate in the study (response rate: 82.5%).

Data collection procedure

A day before data collection, school wardens were informed by the research team members to convey the message to the adolescents about the time when data collection would be carried out. The students were also reminded to dress in a sports uniform, usually comprising a T-shirt and a pair of shorts or track pants. On the day of data collection, the adolescents were briefed by researchers and trained enumerators on ways to fill in a self-administered questionnaires used in the study. Then, their body weights and heights were measured. All adolescents who completed the study were given a token of appreciation at the end of data collection.

Anthropometric measurements

Body weight was measured in light clothes without shoes to the nearest 0.1 kg using a TANITA HD-319 digital weighing scale. Height was measured without shoes and in a standing position with shoulders in a normal position to the nearest 0.1 cm using an SECA body meter 206. The weighing scale and body meter were routinely calibrated to ensure accuracy. The BMI-for-age (z-score), or BAZ, was determined using AnthroPlus software (WHO, 2009). The BAZ was then categorised based on the WHO Growth Reference 2007 (de Onis *et al.*, 2007). The BAZ scores were classified into thinness (including severe thinness) (BAZ < -2SD) and overweight (including obesity) (BAZ > 1SD).

Socio-demographic characteristics

A questionnaire was used to obtain information on socio-demographic data such as sex, date of birth, ethnicity, parental education level, and monthly parental income. The age of the adolescents were obtained from their reported dates of birth.

The urban-rural classification was based on the location of the school as defined by the MoE.

Statistical analysis

Data were analysed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). All analyses were based on the complex sampling design to ensure that sample weights and study design were accounted for. Descriptive statistics was used to describe the estimated prevalence of thinness and overweight among Malaysian adolescents and their socio-demographic characteristics. Simple logistic and multivariate logistic regression analyses were done. The findings were presented as crude and adjusted odds ratios (OR) with 95% confidence intervals (CI). The level of statistical significance was set at $p < 0.05$.

RESULTS

Socio-demographic characteristics of Malaysian adolescents living in day-school hostels

Of the total of 38,119 Malaysian adolescents, 4189 adolescents participated in the study, representing an estimated population totalling 37,170 Malaysian adolescents aged 13-years old attending and living in day-school hostels (97.5%). The number of adolescents on whom measurements were carried out, and the estimated weighted population represented by the survey are shown in Table 1. Approximately two-thirds of the adolescents (70.2%) were from rural schools, and the remaining 29.8% from urban schools. Three in five adolescents (59.5%) were females. A large majority of the adolescents were Malay (70.4%), whereas 29.6% were of other ethnicities including Chinese, Indian, indigenous Sabahans, indigenous Sarawakians, and *Orang Asli* (aborigines). It was observed that one in four of the adolescents (25.7%) were from the east-coast zone. About two in five adolescents' fathers (38.8%) and mothers (38.6%) had completed secondary

Table 1. Characteristics of adolescents (n=4189)

<i>Characteristics</i>	<i>Estimated population (N)</i>	<i>n (%)</i>
Total	37 170	4189 (100.0)
Area		
Urban	11 070	1397 (29.8)
Rural	26 100	2792 (70.2)
Sex		
Male	15 050	1667 (40.5)
Female	21 120	2522 (59.5)
Ethnicity		
Malay	26 182	3015 (70.4)
Others	11 988	1174 (29.6)
Malaysia zone		
Sabah	5 427	538 (14.6)
Sarawak	7 193	778 (19.4)
Southern	3 045	427 (8.2)
Central	3383	402 (9.1)
East-coast	9 556	1086 (25.7)
Northern	8 566	959 (23.0)
Father's education level		
No formal education/Primary	4808	522 (12.9)
Secondary school	14438	1618 (38.8)
Higher institution	5330	610 (14.4)
No information available	12594	1439 (33.9)
Mother's education level		
No formal education/Primary	5577	600 (15.0)
Secondary school	14358	1609 (38.6)
Higher institution	4666	546 (12.6)
No information available	12569	1434 (33.8)
Monthly parental income		
≤ RM 499	4281	452 (11.5)
RM 500-999	6079	672 (16.4)
RM 1000-1499	2465	278 (6.6)
RM 1500-1999	2157	248 (5.8)
RM 2000-2499	473	57 (1.3)
RM 2500-2999	1449	166 (3.9)
RM 3000-3499	553	65 (1.5)
RM 3500-3999	733	86 (2.0)
RM 4000-4499	312	40 (0.8)
RM 4500-4999	591	70 (1.6)
≥ RM 5000	3301	395 (8.8)
No information available	14776	1660 (39.8)

Note: No information available (adolescents were not able to provide data)

school. It was observed that the parents of one in four of the adolescents (27.9%) had monthly incomes of less than RM 1000, and only 8.8% of the adolescents had parents earning more than RM 5000 per month.

Prevalence of thinness among Malaysian adolescents living in day-school hostels

The overall national prevalence of thinness among Malaysian adolescents living in day-school hostels was 4.3% (severe

Table 2. Prevalence of thinness by socio-demographic characteristics (n=4189)

<i>Characteristics</i>	<i>Prevalence (95% CI)</i>	<i>Crude OR (95% CI)</i>	<i>Adjusted OR#(95% CI)</i>
Area			
Rural	4.3 (3.5, 5.1)	1.0 (0.7, 1.4)	0.9 (0.6, 1.2)
Urban	4.3 (3.3, 5.6)	1.0	1.0
Sex			
Male	5.6 (4.5, 6.9)	1.7 (1.2, 2.4)	1.7 (1.2, 2.3)
Female	3.4 (2.7, 4.2)	1.0	1.0
Ethnicity			
Malay	4.5 (3.8, 5.3)	1.2 (0.8, 1.8)	1.5 (0.9, 2.6)
Others	3.7 (2.7, 5.2)	1.0	1.0
Malaysia zone			
Sarawak	5.7 (4.3, 7.7)	1.8 (0.9, 3.5)	1.7 (0.8, 3.6)
Southern	3.6 (2.1, 6.1)	1.1 (0.5, 2.4)	0.7 (0.3, 2.0)
Central	4.5 (2.8, 7.2)	1.4 (0.6, 3.0)	0.9 (0.3, 2.5)
East-coast	3.8 (2.7, 5.1)	1.1 (0.6, 2.2)	0.8 (0.3, 2.0)
Northern	4.3 (3.2, 5.8)	1.3 (0.7, 2.6)	0.9 (0.4, 2.2)
Sabah	3.3 (1.9, 5.9)	1.0	1.0
Father's education level			
No formal education/ Primary	3.3 (1.9, 5.7)	1.0	1.0
Secondary school	4.4 (3.4, 5.6)	1.3 (0.7, 2.5)	1.2 (0.6, 2.5)
Higher institution	4.9 (3.4, 7.0)	1.5 (0.8, 2.9)	1.6 (0.7, 3.8)
No information available	4.2 (3.2, 5.4)	1.3 (0.7, 2.4)	1.0 (0.4, 2.4)
Mother's education level			
No formal education/ Primary	3.6 (2.4, 5.5)	1.0	1.0
Secondary school	4.7 (3.7, 6.0)	1.3 (0.8, 2.2)	1.1 (0.6, 2.1)
Higher institution	3.7 (2.4, 5.7)	1.1 (0.6, 1.9)	0.8 (0.4, 1.8)
No information available	4.3 (3.3, 5.5)	1.2 (0.7, 2.0)	1.1 (0.5, 2.6)
Monthly parental income			
≤ RM 499	3.1 (1.8, 5.2)	1.0	1.0
RM 500-999	4.1 (2.8, 6.0)	1.4 (0.7, 2.7)	1.3 (0.6, 2.6)
RM 1000-1499	5.1 (3.0, 8.4)	1.7 (0.8, 3.6)	1.7 (0.7, 3.8)
RM 1500-1999	3.3 (1.7, 6.6)	1.1 (0.4, 2.7)	1.1 (0.4, 2.6)
RM 2000-2499	5.4 (1.8, 15.6)	1.8 (0.5, 6.6)	1.8 (0.5, 6.8)
RM 2500-2999	1.3 (0.3, 5.1)	0.4 (0.1, 1.9)	0.4 (0.1, 1.8)
RM 3000-3499	5.4 (1.7, 15.8)	1.8 (0.5, 6.7)	1.6 (0.4, 6.2)
RM 3500-3999	6.6 (3.0, 14.2)	2.2 (0.8, 6.1)	2.1 (0.7, 6.2)
RM 4000-4499	2.8 (0.4, 17.5)	0.9 (0.1, 7.2)	1.0 (0.1, 8.3)
RM 4500-4999	4.5 (1.4, 13.7)	1.5 (0.4, 5.7)	1.3 (0.3, 5.5)
≥ RM 5000	2.8 (1.5, 5.0)	0.9 (0.4, 2.1)	0.8 (0.3, 2.1)
No information available	5.1 (4.1, 6.4)	1.7 (0.9, 3.1)	1.7 (0.9, 3.5)

Note: No information available (adolescents were not able to provide data)

Adjusted for all other variables

thinness: 0.7%, thinness: 3.6%) as shown in Table 2. The prevalence of thinness in both urban and rural areas was similar. With regards to sex, the prevalence of thinness was higher in males (5.6%) than

in females (3.4%) (OR: 1.7, 95% CI: 1.2, 2.3). By ethnicity, the prevalence among Malay adolescents and other ethnicities were 4.5% and 3.7%, respectively. By geographic zones, the prevalence of

thinness ranged from 3.3% to 5.7%. When education levels of the fathers increased, the prevalence of thinness increased and ranged from 3.3% to 4.9%. Moreover, the prevalence of thinness increased steadily with the mothers' education level until secondary school level, after which the prevalence declined. By monthly parental income, the prevalence of thinness ranged from 1.3% to 6.6%. Sex was the only socio-demographic characteristic associated with the prevalence of thinness in this study.

Prevalence of overweight among Malaysian adolescents living in day-school hostels

The overall national prevalence of overweight among Malaysian adolescents living in day-school hostels was 23.3% (overweight: 15.1%, obesity: 8.2%) as shown in Table 3. About one in four urban adolescents (24.9%) and 22.7% of rural adolescents were overweight. By sex, about one in four females (24.5%) and one in five males (21.7%) were overweight. With regard to ethnicity, about one in four Malay adolescents (24.3%) and one in five adolescents from other ethnic groups (21.0%) were overweight. However, there were no significant associations between area, sex, and ethnicity with overweight. Conversely, geographical zone was associated with overweight, whereby the central zone (28.2%) (OR: 2.5, 95% CI: 1.6, 3.9) had the highest prevalence compared to Sabah which had the lowest prevalence rate. The prevalence of overweight was found to increase when the education levels of the parents increased. However, no significant difference was found. With regards to monthly parental income, the lowest prevalence of overweight (17.3%) was found in adolescents whose parents' monthly incomes were less than RM 499, followed by those with parental incomes between RM 1000 to RM 1499 (17.7%), RM 500 to RM 999 (21.7%), RM 1500 to RM 1999 (23.0%), RM 4500 to RM 4999 (24.9%), RM 3000 to RM 3499 (25.0%), RM

2000 to RM 2499 (27.8%), RM 2500 to RM 2999 (28.3%), RM 3500 to RM 3999 (29.5%), RM 4000 to RM 4499 (30.1%) and parental total monthly income of more than RM 5000 (36.3%). However, monthly parental incomes of more than RM 5000 were found to be associated with a higher prevalence of overweight.

DISCUSSION

More than one in four Malaysian adolescents living in day-school hostels faced malnutrition problems. Overweight (23.3%) was more prevalent than thinness (4.3%). The most recent NHMS found that among 10 to 14-year-old adolescents, the prevalence of thinness was 8.7% while the prevalence of obesity was 6.3% (IPH, 2011). The Malaysian School-based Nutrition Survey (MSNS) comprising a nationally representative sample of 10 to 17-year-old school-going adolescents reports that 28.0% of the adolescents are overweight and obese, while 7.0% are underweight based on the WHO Growth Reference 2007 (Baharudin *et al.*, 2014). The differences in the prevalence between the NHMS (2011) and MSNS with this study might be due to different standards used in classifying the body weight status, as well as the wider age range of adolescents in the previous studies.

In the present study, the prevalence of thinness was higher in males than females. A similar finding was reported by Baharudin *et al.* (2013) among 4303 Malaysian adolescents. The difference in the prevalence of thinness between the sexes could be due to the difference in timing and tempo of their respective growth spurts (Jeffery *et al.*, 2012). Due to the later onset of puberty, in early and mid-adolescence, males have less fat compared to females (Anuradha *et al.*, 2011; Staiano & Katzmarzyk, 2012). This partially explains why more male adolescents were thinner compared to females, who may have started to experience rapid pubertal changes. In contrast with the findings of

Table 3. Prevalence of overweight by socio-demographic characteristics (n=4189)

Characteristics	Prevalence (95% CI)	Crude OR (95% CI)	Adjusted OR#(95% CI)
Area			
Urban	24.9 (22.7, 27.3)	1.1 (1.0, 1.3)	0.9 (0.8, 1.1)
Rural	22.7 (21.2, 24.3)	1.0	1.0
Sex			
Female	24.5 (22.8, 26.2)	1.2 (1.0, 1.4)	1.2 (1.0, 1.3)
Male	21.7 (19.8, 23.8)	1.0	1.0
Ethnicity			
Malay	24.3 (22.8, 26.0)	1.2 (1.0, 1.4)	0.7 (0.5, 1.0)
Others	21.0 (18.6, 23.5)	1.0	1.0
Malaysia zone			
Sarawak	22.8 (19.9, 25.9)	1.7 (1.3, 2.4)	1.8 (1.3, 2.6)
Southern	25.5 (21.4, 30.0)	2.0 (1.4, 2.8)	2.4 (1.5, 3.7)
Central	28.2 (23.9, 32.9)	2.3 (1.6, 3.3)	2.5 (1.6, 3.9)
East-coast	23.9 (21.3, 26.6)	1.8 (1.4, 2.5)	2.3 (1.6, 3.4)
Northern	26.2 (23.4, 29.1)	2.1 (1.5, 2.8)	2.4 (1.7, 3.7)
Sabah	14.6 (11.6, 18.3)	1.0	1.0
Father's education level			
No formal education/ Primary	18.1 (15.1, 21.7)	1.0	1.0
Secondary school	22.9 (20.8, 25.1)	1.3 (1.0, 1.7)	1.2 (0.9, 1.6)
Higher institution	32.3 (28.6, 36.3)	2.2 (1.6, 2.9)	1.5 (1.0, 2.2)
No information available	22.1 (20.0, 24.4)	1.3 (1.0, 1.7)	1.0 (0.7, 1.6)
Mother's education level			
No formal education/ Primary	18.4 (15.4, 21.8)	1.0	1.0
Secondary school	23.5 (21.4, 25.7)	1.4 (1.1, 1.7)	1.1 (0.9, 1.5)
Higher institution	31.7 (27.8, 35.8)	2.1 (1.6, 2.7)	1.1 (0.7, 1.6)
No information available	22.3 (20.1, 24.6)	1.3 (1.0, 1.6)	1.1 (0.7, 1.6)
Parental monthly income			
≤ RM 499	17.3 (14.1, 21.2)	1.0	1.0
RM 500-999	21.7 (18.7, 25.1)	1.3 (1.0, 1.8)	1.2 (0.9, 1.6)
RM 1000-1499	17.7 (13.6, 22.7)	1.0 (0.7, 1.5)	0.9 (0.6, 1.3)
RM 1500-1999	23.0 (18.1, 28.8)	1.4 (1.0, 2.1)	1.2 (0.8, 1.8)
RM 2000-2499	27.8 (17.6, 40.9)	1.8 (1.0, 3.5)	1.7 (0.8, 3.1)
RM 2500-2999	28.3 (21.8, 35.7)	1.9 (1.2, 2.9)	1.5 (1.0, 2.4)
RM 3000-3499	25.0 (15.9, 36.9)	1.6 (0.9, 2.9)	1.2 (0.6, 2.3)
RM 3500-3999	29.5 (20.6, 40.2)	2.0 (1.2, 3.4)	1.5 (0.9, 2.8)
RM 4000-4499	30.1 (17.8, 46.0)	2.1 (1.0, 4.3)	1.6 (0.8, 3.4)
RM 4500-4999	24.9 (15.9, 36.6)	1.6 (0.9, 2.9)	1.3 (0.7, 2.4)
≥ RM 5000	36.3 (31.6, 41.3)	2.7 (2.0, 3.8)	2.0 (1.3, 2.9)
No information available	22.7 (20.6, 24.9)	1.4 (1.1, 1.8)	1.2 (0.9, 1.6)

Note: No information available (adolescents were not able to provide data)

Adjusted for all other variables

this study, Aboshkair *et al.* (2011) and Naidu *et al.* (2013) found a higher prevalence of overweight (including obesity) among male adolescents than female adolescents. Although there were no obvious reasons

for this divergence, the same living environments between the sexes might have played a role in the development of obesity in this sample.

There were no statistically significant differences in the prevalence of thinness or overweight, regardless of ethnicity. However, the findings of this study contrasted with studies by Boyd *et al.* (2011) and Rampal *et al.* (2007b). Boyd *et al.* (2011) state that ethnicity increases the susceptibility of adolescent girls to conform to the mainstream culture's ideal body size. Rampal *et al.* (2007b) state that the prevalence of overweight and obesity was higher among Malay adolescents than adolescents of other ethnicities. A likely explanation is that the adolescents living in school hostels spend a great deal of their time in school and the hostel after school and are exposed to the same culture and environment negating the influence of their ethnicities.

This study found that the location of geographic zones appeared to be associated with the prevalence of overweight, but not thinness. The highest prevalence of overweight was observed in the central zone. Sabah was found to have both the lowest prevalence of overweight and thinness compared to the other zones in Malaysia. These findings were in line with a nationwide study among Malaysian adolescents, whereby the prevalence of overweight was the lowest in Sabah (Baharudin *et al.*, 2013). However, data on the association between zone and malnutrition in Malaysia are scarce, particularly among Malaysian adolescents living in day-school hostels. Further research, such as a prospective study, is needed to examine this association in greater detail.

The current study found that there was no association between the prevalence of overweight and thinness with the location of the day-school hostels. In contrast, Poh *et al.* (2013) state that children from urban areas show a lower prevalence of thinness, but a higher prevalence of overweight compared to children from rural areas. Adolescents in this study lived in day-

school hostels with a more urbanised concept of living without clear borders between urban and rural areas. Meals and snacks were prepared and served during specific times resulting in regular food accessibility regardless of the locations of the day-school hostels.

Educated parents generally transmit their knowledge and skills to their children on better weight-related choices, and are likely to engage with medical professionals with regard to their child's weight (Martin *et al.*, 2012). In contrast, less educated parents tend to underestimate the incidence of overweight and obesity (Li *et al.*, 2014). This study failed to find any significant association between the education levels of parents with the prevalence of thinness and overweight in adolescents. In general, the influence of parents is lesser in adolescence than in childhood, but peers and schoolmates may play a more influential role during this period (Chen, Martin & Matthews, 2006). During the academic year, adolescents living in day-school hostels spent the majority of their days at school as well as at school-hostels with their peers compared with the limited time spent with their parents. This might account for the non-significant association between parents' education levels and body weight status among those adolescents.

This study found that monthly parental incomes of more than RM 5000 were significantly associated with the prevalence of overweight in adolescents. This agreed with the findings of Le *et al.* (2013) who state that overweight and obese adolescents came from families with higher incomes. Adolescents with higher purchasing power, exposure to unhealthy food, and labour saving devices have an increased risk of overweight and obesity (Doustmohammadian Jr *et al.*, 2009). Further prospective studies are needed to understand the association between monthly parental incomes and the weight

status among adolescents living in day-school hostels.

This study found that malnutrition remained a problem for specific zones and demographics in Malaysia. Given the co-existence of thinness and overweight among adolescents living in day-school hostels, relevant authorities should address the problem by implementing intervention programs focusing on a healthy lifestyle in the school setting. Even though well-planned meals and snacks are being prepared by day-school hostels' caterers, healthy eating behaviour and physical activity should be promoted among adolescent residents of those hostels. These measures should be implemented as adolescent health is essential since they will make up a large population of future contributors to Malaysia. Moreover, both under and over-nutrition may contribute to the disease burden in the future.

The strength of this study includes the objective measures of the weights and heights taken, the relatively large sample size, and the high response rate. This study used stratified sampling to ensure adequate representative recruitment of participants from all zones as well as capturing the influences of both urban and rural areas in Malaysia.

This study had several limitations that should be taken into consideration. Due to its cross-sectional nature, this study was not able to draw conclusions about the causal relationship between socio-demographic characteristics and prevalence of malnutrition. It is recommended that cohort studies be conducted to determine the causal relationships between socio-demographic characteristics and body weight status. Besides, the adolescent subjects were not able to provide actual data on their parents' education levels and monthly incomes, and they most probably considered their parents' information confidential. Future studies should ascertain this information directly from the

parents. Moreover, adolescents studying and living in public secondary schools may be predominantly from a single ethnic group. Thus, these students may not be truly representative of the population of school-aged adolescents in general. Future studies should include all types of public schools to better represent the different ethnicities of the target age groups in Malaysia.

CONCLUSION

Dual forms of malnutrition co-exist, with over-nutrition being more prevalent than under-nutrition. Despite the supportive environment of the day-school hostels in promoting a healthy lifestyle, without intervention programs to fully utilise that environment, both under and over-nutrition would be expected to continue to co-exist. Thus, a comprehensive nutrition intervention program to combat malnutrition, considering the socio-demographic variances in Malaysian adolescents living in day-school hostels, is required.

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