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Influence of School Location within Districts of Terengganu on Body Weight Status among School Adolescents

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Abstract

Rapid development in the urbanisation process is linked to a shift in dietary intake and lifestyle. The locality may also determine the differences in socio-demographic and environmental factors related to nutrition between the rural and urban populations. The present study aimed to determine prevalence of obesity and to compare the body weight status on body weight status among school adolescents aged 10 to 17 years within districts of Terengganu. A cross sectional survey involving school adolescents aged 10 to 17 years from all government school in seven districts in Terengganu were carried out. Anthropometrics data were obtained from National Fitness Standard (SEGAK) assessment which was uploaded into specific developed database Health Monitoring System (HEMS) and BMI were classified using WHO BMI-for-age z-score. A total of 62,567 school adolescents were involved in this study. Girls had significantly higher BMI than boys in age groups of 13 to 15 and 16 to 17 years old. There were significant differences in mean BMI between rural and urban school locations school adolescents in all age groups (P <0.001) among boys and girls. Significant differences were also found between rural and urban school location in 10 to 12 years old in Dungun and Marang, whilst Kemaman and Kuala Terengganu districts had significant difference between rural and urban in 16 to 17 years old age group. Marang had the highest obesity prevalence within urban 15.3% school location whilst rural school location within Kuala Terengganu had the highest prevalence of obesity (14.1%). The obesity prevalence increased substantially regardless of school locations

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compared to previous years. School adolescents in both rural and urban have an equal prevalence of obesity suggesting that intervention and prevention programme should be targeting in both locations. Future studies should look at the association between the potential risk factors to tackle this problem from the origin.

Keywords: Body Weight Status, School Adolescents, Rural, Urban, Terengganu

Introduction

Obesity is often cited as the most pressing health problem among children these days (Reilly and Kelly 2011). Previously, children and adolescents suffered from diseases related to nutrient deficiency, however, the trend has now shifted to overconsumption, poor diet quality and food choices leading to obesity problem. Indeed, obese children and adolescents are at risk of becoming obese during adulthood (Guo et al. 2002) and are predisposed to many negative health outcomes secondary to their childhood obesity including cardiovascular disease, dyslipidaemia, hypertension, diabetes mellitus, and sleep apnoea (Ng et al. 2014).

Obesity development involves multifaceted lifestyle factors. The key contributing factor is the chronic excessive energy intake with reduced energy expenditure. Increased in reliance to outside food intake, higher frequency consumption of sugar-sweetened beverages and energy-dense fast foods and decreased in physical activity levels are known as the lifestyles that contribute to obesity prevalence (Gupta et al. 2012). Indeed, these unhealthy lifestyles were likely to be moderated by obesogenic environment as a result of rapid urbanization and development. Moreover, Willms et al. (2003) suggested that different level of urbanization within geographical and demographical area might have different impact on obesity prevalence especially on children and adolescents. Terengganu is a state that is experiencing urbanization and development despite certain rural part that were least exposed to development as compared to the urban counterpart.

Previous studies had attempted to investigate the difference in body weight status between urban and rural adolescents in Malaysia (Moy et al. 2004). Naidu et al. (2013) and Lee et al. (2014) reported higher BMI among urban adolescents as compared to rural counterpart. However, study exploring the influence of rural and urban school location on body weight status in East Coast region especially in Terengganu is still lacking. A broader understanding of the influence of geographical and demographical on obesity prevalence may provide public health implication especially for Terengganu population. Therefore, the purpose of the present study was therefore to identify influence of school location within districts of Terengganu on body weight status among 10 to 17 years old school adolescents.

Methodology
Study Design and Subjects

The present cross-sectional baseline study was conducted from November 2014 to June 2015 involving 62,567 (92.7%) school adolescents (31,708 boys and 30,859 girls) aged 10 to 17 years, attending 366 primary schools (*n*=35,460) and 146 secondary schools (*n*=27,107) from all seven districts of Terengganu. From a total of 67,519 data collected from school adolescents, 62,567 were included in this study. Subjects were grouped into three school age groups, 10 to 12 years

(Upper Primary), 13 to 15 years (Lower Secondary) and 16 to 17 years (Upper Secondary) based on the standard Malaysian public school staging system. In addition, subjects were also grouped according to school location and area of living district. The classification of schools within districts as rural or urban was based on the Terengganu State Education Department (JPNT). Terengganu is located within the East Coast of Peninsular Malaysia. The seven districts in Terengganu State were Besut, Dungun, Hulu Terengganu, Kemaman, Kuala Terengganu, Marang and Setiu. This study was ethically approved by UniSZA Human Research Ethic (UHREC) and Terengganu State Education Department (JPNT) and was supported by the Ministry of Higher Education (MOHE).

Data Collection

Height, weight, gender, and age data were obtained from the first school term of 2015 National Fitness Standard (SEGAK) assessment test. SEGAK assessment refers to a comprehensive battery of physical fitness assessments devised by Ministry of Education (MOE) in 2005 and was fully implemented nationally in 2008. The SEGAK programme includes primary and secondary school adolescents and is carried out twice a year (i.e. in March and August) by physical/ health education (PE) teacher at schools. Five main components included in the assessments are measurement of BMI, step up, push-ups, partial curl-ups and, sit and reach test. The data of each student that completed the SEGAK test throughout Terengganu state were uploaded according to school by PE teacher into a web portal named Health Monitoring and Surveillance System (HEMS) (Fadzli et al. 2016). The web-based system was developed with an automated data pre-processing and analysis system to aid in SEGAK data collection especially in Terengganu state.

Anthropometry Assessments

Measurements of height and weight were conducted by PE teachers based on measurement protocol stipulated in the SEGAK manual (Ministry of Education, 2008), which took place within the school compound. The completed data of each student were uploaded into the specifically developed database in the HEMS web portal. Height and weight were measured using calibrated analogue health scales to the nearest 0.1 kg and 0.1 cm respectively. Data on height, weight, gender, and age were used to compute the BMI-for-age Z-score using WHO AnthroPlus software (World Health Organisation, 2009). Age of each subjects were calculated to the precise day by subtracting the date of birth from the date of measurement while the BMI were calculated by dividing body weight in kilograms (kg) by height in metre squared (m^2). All subjects were apparently healthy during data collection, and all measurements were taken in light sports attire without shoes during mornings or early afternoons i.e. between 8.30 am to 12.00 pm. BMI categories were defined using age- and sex- specific cut-off points relative to WHO 2007 classifications (World Health Organization, 2007) where z-score > +1SD were classified as overweight, whilst obesity as having z-score > +2SD and thinness as having z-score < -2SD.

Statistical Analyses

Data were analysed using SPSS-IBM (version 22.0) (IBM Corporation, New York, USA). A two-sided *P*-value of less than 0.05 was considered as statistically significant. Due to inappropriate data entry by the PE teachers, data on SEGAK assessment from several schools were not available. For analysis purposes, results which reported BMI value of below -5SD or exceeded +5SD were excluded as these data were the arbitrary cut points by NHMS (Institute of Public Health, 2011). Descriptive statistics were presented as means with their standard deviation or percentage of prevalence. Independent sample *t*-test was used to test the difference in mean of BMI between genders and school locations (rural *vs.* urban).

Results

Table 1 reports subjects' distribution in genders, age groups, school locations and districts. This cross-sectional study was performed among 62,567 school adolescents (50.7% boys and 49.2% girls) living in seven districts in Terengganu, Malaysia, representing 81.1% from total population of school adolescents aged 10 to 17 years in Terengganu. In total, 53.8% of school adolescents were from urban and 46.2% were from the rural schools. The highest number of school adolescents (41.3%) were from the capital district (Kuala Terengganu) followed by Kemaman (13.9%), Besut (12.0%), Dungun (11.0%), Marang (7.4%), Hulu Terengganu (7.3%) and Setiu (7.0%).

In all age groups, the mean BMI of both genders corresponded to the age and gender-specific normal z-score of WHO cut-off points (Table 2). There was a significant correlation between age and BMI among these adolescents ($P < 0.001$). Girls in 13 to 15 and 16 to 17 years old age groups had significantly higher BMI than boys ($P < 0.001$) but no significant difference was found in 10 to 12 years old age group. Significant difference was found in mean BMI of overall subjects between urban and rural school locations ($P < 0.001$). Post-hoc analysis indicated that BMI was higher among both boys and girls age 10 to 12 years in urban (18.2 ± 4.3 kg/m^2 and 18.2 ± 4.2 kg/m^2) compared to rural (17.9 ± 4.2 kg/m^2 and 17.8 ± 4.1 kg/m^2) school locations ($P < 0.001$). There was no significant difference in mean BMI between rural and urban locations in other age groups. Mean BMI within the rural and urban school locations was also significantly different between boys and girls in age groups of 13 to 15 and 16 to 17 years old ($P < 0.001$), however no difference was found in 10 to 12 years old age group.

Overall, by school location within districts, Dungun, Setiu, and Marang showed significant difference in mean BMI between rural and urban ($P < 0.001$) (Table 3). Urban schools in Dungun, Hulu Terengganu, Setiu and Marang reported significant higher mean BMI as compared to rural schools among adolescents age 10 to 12 years old. Whilst, urban schools in Kemaman and Kuala Terengganu reported higher mean BMI as compared to the rural counterpart among 16 to 17 years old adolescents. In addition, boy from urban schools within Hulu Terengganu, Setiu and Kuala Terengganu districts and boys from rural schools within Kemaman reported higher mean BMI that their counterparts among 10 to 12 years old. As for female, girls of 13 to 15 years old from rural schools in Kuala Terengganu reported higher mean BMI than urban schools, while girls of 16 to 17 years old from urban schools were found to have higher mean BMI than the rural schools.

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Table 1: Subjects distribution

Variables	10 – 12 years			13 – 15 years			16 – 17 years			Overall		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
School location												
Rural	8393 (51.0)	8056 (49.0)	16449	4102 (51.3)	3887 (48.7)	7989	2023 (45.1)	2466 (54.9)	4489	14518 (50.2)	14409 (49.8)	28927
Urban	9738 (51.2)	9273 (48.8)	19011	4516 (53.0)	4012 (47.0)	8528	2936 (48.1)	3165 (51.9)	6101	17190 (51.1)	16450 (48.9)	33640
District												
Besut	2124 (50.6)	2075 (49.4)	4199	1167 (51.5)	1099 (48.5)	2266	498 (48.3)	532 (51.7)	1030	3789 (50.6)	3706 (49.4)	7495
Rural	1284 (49.7)	1298 (50.3)	2582	908 (51.2)	866 (48.8)	1774	345 (47.3)	385 (52.7)	730	2537 (49.9)	2549 (50.1)	5086
Urban	840 (51.9)	777 (48.1)	1617	259 (52.6)	233 (47.4)	492	153 (51.0)	147 (49.0)	300	1252 (52.0)	1157 (48.0)	2409
Dungun	1870 (50.5)	1832 (49.5)	3702	992 (50.7)	966 (49.3)	1958	629 (50.2)	624 (49.8)	1253	3491 (50.5)	3422 (49.5)	6913
Rural	911 (51.2)	870 (48.8)	1781	295 (50.4)	290 (49.6)	585	181 (51.4)	171 (48.6)	352	1387 (51.0)	1331 (49.0)	2718
Urban	959 (49.9)	962 (50.1)	1921	697 (50.8)	676 (49.2)	1373	448 (49.7)	453 (50.3)	901	2104 (50.2)	2091 (49.8)	4195
Hulu Terengganu	1111 (52.4)	1009 (47.6)	2120	784 (54.9)	644 (45.1)	1428	532 (50.8)	516 (49.2)	1048	2427 (52.8)	2169 (47.2)	4596
Rural	770 (52.8)	687 (47.2)	1457	574 (54.2)	485 (45.8)	1069	370 (49.1)	383 (50.9)	753	1714 (52.4)	1555 (47.6)	3269
Urban	341 (51.4)	322 (48.6)	663	210 (56.9)	159 (43.1)	369	162 (54.9)	133 (45.1)	295	713 (53.7)	614 (46.3)	1327
Kemaman	2905 (50.8)	2808 (49.2)	5713	904 (49.1)	936 (50.9)	1840	497 (44.5)	621 (55.5)	1118	4306 (49.7)	4365 (50.3)	8671
Rural	1736 (50.4)	1706 (49.6)	3442	542 (46.6)	620 (53.4)	1162	269 (42.6)	363 (57.4)	632	2547 (48.6)	2689 (51.4)	5236
Urban	1169 (51.5)	1102 (48.5)	2271	362 (53.4)	316 (46.6)	678	228 (46.9)	258 (53.1)	486	1759 (51.2)	1676 (48.8)	3435
Kuala Terengganu	7780 (51.0)	7466 (49.0)	15246	3444 (54.4)	2886 (45.6)	6330	1967 (45.8)	2326 (54.2)	4293	13191 (51.0)	12678 (49.0)	25869
Rural	1973 (50.8)	1910 (49.2)	3883	797 (56.8)	606 (43.2)	1403	312 (39.1)	486 (60.9)	798	3082 (50.7)	3002 (49.3)	6084
Urban	5807 (51.1)	5556 (48.9)	11363	2467 (53.7)	2280 (46.3)	4927	1655 (47.4)	1840 (52.6)	3495	10109 (51.1)	9676 (48.9)	19785
Setiu	1222 (51.9)	1132 (48.1)	2354	511 (45.2)	620 (54.8)	1131	426 (46.3)	495 (53.7)	921	2159 (49.0)	2247 (51.0)	4406
Rural	976 (52.0)	901 (48.0)	1877	170 (38.5)	272 (61.5)	442	136 (45.8)	161 (54.2)	297	1282 (49.0)	1334 (51.0)	2616
Urban	246 (51.6)	231 (48.4)	477	341 (49.5)	348 (50.5)	689	290 (46.5)	334 (53.5)	634	877 (49.0)	913 (51.0)	1790
Marang	1119 (52.6)	1007 (47.4)	2126	816 (52.2)	748 (47.8)	1564	410 (44.2)	517 (55.8)	927	2345 (50.8)	2272 (49.2)	4617
Rural	743 (52.1)	684 (47.9)	1427	816 (52.2)	748 (47.8)	1564	410 (44.2)	417 (55.8)	927	1969 (50.3)	1949 (49.7)	3918
Urban	376 (53.8)	323 (46.2)	699	0	0	0	0	0		376 (53.8)	323 (46.2)	699
Total	18131 (51.1)	17329 (48.9)	35460	8618 (52.2)	7899 (47.8)	16517	4959 (46.8)	5631 (53.2)	10590	31708 (50.7)	30859 (49.3)	62567

Data are n (%).

Percentage of BMI categories by age groups within school location in each district are presented in Table 4. Overall, the highest prevalence of obesity in total, boys and girls within urban school location were found in Marang 15.3%, 17.8% and 15.3%, respectively. Contrarily, rural school location within Kuala Terengganu had the highest prevalence of obesity in total, boys and girl subjects were subjected to 14.1%, 16.3% and 11.9% respectively. As for overweight, rural Marang had the highest prevalence (15.2%) while Setiu had the highest prevalence for urban school location (16.1%). Percentage of overweight were found to be higher in girls while boys reported higher percentage of obesity in rural schools in Besut, Hulu Terengganu, Kemaman and Kuala Terengganu districts; and urban schools in Dungun, Kemaman and Kuala Terengganu districts among 10 to 12 years old adolescents. Similar trends were reported among 13 to 15 years old adolescents in rural schools in Besut and Kemaman districts, and in urban schools in Dungun and Kuala Terengganu districts. Besides, girls aged 13 to 15 years from rural schools in Kuala Terengganu and Marang districts reported higher percentage of overweight and obesity as compared to boys. In addition, girls reported higher percentage of overweight while boys reported higher percentage of obesity in rural schools in Hulu Terengganu, Kemaman and Marang districts and urban schools in Kuala Terengganu among adolescents aged 16 to 17 years old.

Table 2: Anthropometric measurements by gender and age groups

	10 – 12 years			13 – 15 years			16 – 17 years			All		
	Boys	**Girls**	**All**	**Boys**	**Girls**	**All**	**Boys**	**Girls**	**All**	**Boys**	**Girls**	**All**
Age (years)										12.7 ± 2.2	12.8 ± 2.3	12.7 ± 2.3
Height (cm)	137.4 ± 8.7	138.8 ± 9.1	138.1 ± 8.9	155.9 ± 9.9	151.9 ± 6.6	154.0 ± 8.8	165.0 ± 7.2	154.9 ± 5.9	159.6 ± 8.2	146.7 ± 14.3	145.1 ± 10.8	145.9 ± 12.7
Weight (kg)	34.5 ± 10.9	35.2 ± 10.8	34.9 ± 10.8	49.3 ± 14.2	48.0 ± 11.9	48.7 ± 13.1	57.9 ± 13.6	51.8 ± 11.7	54.7 ± 13.0	42.2 ± 15.4	41.5 ± 13.4	41.9 ± 14.4
BMI (kg/m²)	18.0 ± 4.3	18.0 ± 4.2	18.0 ± 4.2	20.1 ± 4.6	20.7 ± 4.6 [a]	20.4 ± 4.6	21.2 ± 4.5	21.5 ± 4.4 [a]	21.4 ± 4.5	19.1 ± 4.6	19.3 ± 4.6 [a]	19.2 ± 4.6
School location												
Rural												
Height (cm)	137.2 ± 8.7	138.6 ± 9.1	137.9 ± 8.9	155.9 ± 9.9	151.9 ± 6.6	154.0 ± 8.7	165.7 ± 7.1	154.8 ± 5.9	159.7 ± 8.4	146.5 ± 14.3	145.0 ± 10.8	145.7 ± 12.7
Weight (kg)	34.2 ± 10.8	34.7 ± 10.6	34.5 ± 10.7	49.4 ± 14.0	48.1 ± 11.7	48.7 ± 13.0	58.5 ± 14.0	51.7 ± 11.9	54.8 ± 13.3	41.9 ± 15.4	41.2 ± 13.4	41.6 ± 14.5
BMI (kg/m²)	17.9 ± 4.2 [b]	17.8 ± 4.1 [b]	17.9 ± 4.2	20.1 ± 4.6 [a]	20.7 ± 4.6	20.4 ± 4.6	21.2 ± 4.6 [a]	21.5 ± 4.5	21.4 ± 4.5	19.0 ± 4.6 [ab]	19.2 ± 4.6 [b]	19.1 ± 4.6
Urban												
Height (cm)	137.5 ± 8.7	139.0 ± 9.1	138.2 ± 8.9	155.9 ± 10.0	151.9 ± 6.6	154.0 ± 8.8	164.5 ± 7.3	155.1 ± 5.8	159.6 ± 8.1	146.9 ± 14.2	145.2 ± 10.7	146.1 ± 12.7
Weight (kg)	34.8 ± 11.0	35.6 ± 10.9	35.2 ± 10.9	49.2 ± 14.3	48.0 ± 12.0	48.6 ± 13.3	57.4 ± 13.4	51.9 ± 11.6	54.6 ± 12.8	42.5 ± 15.4	41.8 ± 13.3	42.1 ± 14.4
BMI (kg/m²)	18.2 ± 4.3	18.2 ± 4.2	18.2 ± 4.3	20.1 ± 4.7 [a]	20.7 ± 4.6	20.4 ± 4.7	21.2 ± 4.4 [a]	21.5 ± 4.4	21.4 ± 4.4	19.2 ± 4.6 [a]	19.4 ± 4.6	19.3 ± 4.6

Data are mean ± SD
[a] Significant difference in mean of BMI between genders in age groups (Independent sample t-test)
[b] Significant difference in mean of BMI between school locations within genders in age groups (Independent sample t-test)

Table 3: Mean of BMI between school location within districts and gender within age groups

	10 – 12 years			13 – 15 years			16 – 17 years			All		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
District												
Besut	17.8 ± 4.0	17.9 ± 4.1	17.8 ± 4.0	20.3 ± 4.7	20.7 ± 4.7	20.5 ± 4.7	21.0 ± 4.2	21.4 ± 4.4	21.2 ± 4.3	19.0 ± 4.5	19.2 ± 4.6	19.1 ± 4.5
Rural	17.7 ± 4.2	17.8 ± 4.0	17.8 ± 4.1	20.4 ± 4.6	20.7 ± 4.6	20.5 ± 4.6	21.1 ± 4.3	21.2 ± 4.3	21.2 ± 4.3	19.1 ± 4.6	19.3 ± 4.5	19.2 ± 4.6 [a]
Urban	17.8 ± 3.8	18.1 ± 4.1	18.0 ± 4.0	19.9 ± 5.0	20.9 ± 5.2	20.4 ± 5.1	20.7 ± 3.9	21.9 ± 4.7	21.3 ± 4.4	18.6 ± 4.3	19.2 ± 4.7	18.8 ± 4.5
Dungun	18.0 ± 4.0	18.2 ± 4.1	18.1 ± 4.1	20.2 ± 4.7	21.0 ± 4.6	20.6 ± 4.7	21.4 ± 4.3	21.8 ± 4.1	21.6 ± 4.2	19.2 ± 4.5	19.6 ± 4.5	19.4 ± 4.5
Rural	17.8 ± 3.9	17.9 ± 4.1 [c]	17.8 ± 3.9 [a]	20.2 ± 5.0	20.7 ± 4.6	20.5 ± 4.9	21.3 ± 4.3	21.9 ± 4.2	21.6 ± 4.3	18.8 ± 4.4	19.0 ± 4.5	18.9 ± 4.5 [a]
Urban	18.2 ± 4.1	18.5 ± 4.2	18.4 ± 4.1	20.2 ± 4.5	21.1 ± 4.6	20.6 ± 4.6	21.4 ± 4.3	21.8 ± 4.0	21.6 ± 4.2	19.5 ± 4.5	20.1 ± 4.5	19.8 ± 4.5
Hulu Terengganu	17.5 ± 4.2	17.6 ± 3.9	17.5 ± 4.1	19.9 ± 4.4	20.6 ± 4.3	20.2 ± 4.4	21.3 ± 4.5	21.4 ± 4.6	21.4 ± 4.5	19.1 ± 4.6	19.4 ± 4.5	19.2 ± 4.6
Rural	17.3 ± 4.3 [b]	17.4 ± 3.9	17.4 ± 4.1 [a]	20 ± 4.4	20.6 ± 4.3	20.3 ± 4.3	21.3 ± 4.7	21.4 ± 4.3	21.4 ± 4.5	19.1 ± 4.7	19.4 ± 4.5	19.2 ± 4.6
Urban	17.9 ± 3.9	17.9 ± 3.9	17.9 ± 3.9	19.5 ± 4.5	20.5 ± 4.5	19.9 ± 4.6	21.2 ± 4.1	21.5 ± 5.4	21.3 ± 4.7	19.2 ± 4.4	19.3 ± 4.7	19.2 ± 4.5
Kemaman	18.0 ± 4.3	17.9 ± 4.2	18.0 ± 4.3	20.1 ± 4.8	20.5 ± 4.5	20.3 ± 4.6	21.2 ± 4.8	21.6 ± 4.3	21.4 ± 4.5	18.8 ± 4.6	19.0 ± 4.5	18.9 ± 4.6
Rural	18.2 ± 4.2 [b]	17.8 ± 4.1	18.0 ± 4.2	20.1 ± 4.8	20.3 ± 4.2	20.2 ± 4.5	20.9 ± 5.1	21.3 ± 4.2 [c]	21.2 ± 4.6 [a]	18.9 ± 4.6	18.9 ± 4.4	18.9 ± 4.5
Urban	17.7 ± 4.3	18.1 ± 4.4	17.9 ± 4.3	20.0 ± 4.8	20.7 ± 4.9	20.3 ± 4.8	21.5 ± 4.3	22.1 ± 4.5	21.8 ± 4.4	18.7 ± 4.6	19.2 ± 4.8	18.9 ± 4.7
Kuala Terengganu	18.3 ± 4.5	18.1 ± 4.3	18.2 ± 4.4	20.1 ± 4.7	20.7 ± 4.6	20.4 ± 4.6	21.2 ± 4.6	21.5 ± 4.5	21.4 ± 4.6	19.2 ± 4.7	19.3 ± 4.6	19.3 ± 4.7
Rural	18.4 ± 4.7	18.1 ± 4.4	18.3 ± 4.5	20.1 ± 4.1	21.1 ± 4.8 [c]	20.6 ± 4.4	21.7 ± 5.1	21.9 ± 4.9 [c]	21.9 ± 5.0 [a]	19.2 ± 4.7	19.4 ± 4.8	19.3 ± 4.8
Urban	18.3 ± 4.5	18.2 ± 4.3	18.2 ± 4.4	20.1 ± 4.8	20.6 ± 4.8	20.3 ± 4.7	21.1 ± 4.5	21.3 ± 4.4	21.2 ± 4.5	19.2 ± 4.7	19.3 ± 4.6	19.3 ± 4.7
Setiu	17.7 ± 3.9	17.8 ± 3.9	17.8 ± 3.9	19.8 ± 4.1	20.7 ± 4.4	20.3 ± 4.3	21.0 ± 4.1	21.6 ± 4.0	21.3 ± 4.1	18.9 ± 4.2	19.4 ± 4.4	19.1 ± 4.3
Rural	17.6 ± 3.8 [b]	17.7 ± 3.9	17.6 ± 3.8 [a]	20.2 ± 4.9	20.3 ± 4.3	20.2 ± 4.5	20.9 ± 3.9	21.4 ± 4.0	21.2 ± 4.0	18.3 ± 4.2	18.7 ± 4.2	18.5 ± 4.2 [a]
Urban	18.4 ± 4.0	18.2 ± 4.0	18.3 ± 4.0	19.7 ± 3.7	21.0 ± 4.6	20.3 ± 4.2	21.0 ± 4.2	21.7 ± 3.9	21.4 ± 4.1	19.8 ± 4.1	20.6 ± 4.4	20.2 ± 4.3
Marang	17.8 ± 4.0	17.8 ± 4.0	17.8 ± 4.0	19.8 ± 4.6	21.1 ± 4.8	20.4 ± 4.7	21.3 ± 4.5	21.5 ± 4.7	21.4 ± 4.6	19.1 ± 4.5	19.8 ± 4.8	19.4 ± 4.7
Rural	17.5 ± 3.8 [b]	17.7 ± 3.9 [c]	17.6 ± 3.9 [a]	19.8 ± 4.6	21.1 ± 4.8	20.4 ± 4.8	21.3 ± 4.5	21.5 ± 4.7	21.4 ± 4.6	19.3 ± 4.6	20.0 ± 4.8	19.6 ± 4.7 [a]
Urban	18.3 ± 4.4	18.3 ± 4.1	18.3 ± 4.2	Data not available			Data not available			18.3 ± 4.4	18.3 ± 4.1	18.3 ± 4.2

Data are mean ± SD
[a]Rural vs. urban in district within age groups (independent sample t-test)
[b]Rural vs. urban in boys (independent sample t-test)
[c]Rural vs. urban in girls (independent sample t-test)

Table 4: Percentage of BMI categories by age group within school location

	10 – 12 years				13 – 15 years				16 – 17 years				All			
	Boys	Girls	All	*P*-value[a] (χ)	Boys	Girls	All	*P*-value[a] (χ)	Boys	Girls	All	*P*-value[a] (χ)	Boys	Girls	All	*P*-value[a] (χ)
Besut																
Rural				0.01				0.018				0.286				<0.001
Thin	11.7	9.8	10.7	(16.95)	6.7	5.0	5.9	(10.12)	7.0	4.4	5.6	(3.79)	9.3	7.3	8.3	(30.4)
Normal	59.3	64.8	62.1		63.8	69.6	66.6		73.0	77.4	75.3		62.8	68.3	65.6	
Overweight	14.9	15.9	15.4		15.7	15.5	15.6		12.5	12.7	12.6		14.9	15.3	15.1	
Obese	14.1	9.6	11.8		13.8	9.9	11.9		7.5	5.5	6.4		13.1	9.1	11.1	
Urban				0.502				0.420				0.271				0.305
Thin	7.4	8.0	7.7	(2.35)	8.1	5.2	6.7	(2.82)	7.8	4.1	6.0	(3.92)	7.6	6.9	7.3	(3.62)
Normal	64.9	64.1	64.5		66.0	69.1	67.5		76.5	73.5	75.0		66.5	66.3	66.4	
Overweight	15.1	17.1	16.1		12.7	15.0	13.8		6.5	10.9	8.7		13.6	15.9	14.7	
Obese	12.6	10.8	11.8		13.1	10.7	12.0		9.2	11.6	10.3		12.3	10.9	11.6	
Dungun																
Rural				0.111				0.623				0.754				0.269
Thin	10.5	9.9	10.2	(6.01)	5.1	5.2	5.1	(1.76)	2.2	2.3	2.3	(1.19)	8.3	7.9	8.1	(3.93)
Normal	59.9	64.9	62.4		69.5	69.0	69.2		80.1	75.4	77.8		64.6	67.2	65.9	
Overweight	16.9	15.5	16.2		13.2	16.2	14.7		11.0	13.5	12.2		15.4	15.4	15.4	
Obese	12.6	9.7	11.2		12.2	9.7	10.9		6.6	8.8	7.7		11.8	9.5	10.7	
Urban				0.009				0.001				0.094				<0.001
Thin	9.0	6.5	7.8	(11.62)	4.6	4.3	4.4	(16.64)	4.2	1.8	3.0	(6.4)	6.5	4.8	5.6	(27.69)
Normal	58.9	61.7	60.3		69.6	66.1	67.9		75.2	77.0	76.1		65.9	66.5	66.2	
Overweight	14.5	17.8	16.1		12.9	20.4	16.6		12.5	14.8	13.7		13.5	18.0	15.8	
Obese	17.6	13.9	15.8		12.9	9.2	11.1		8.0	6.4	7.2		14.0	10.8	12.4	
Hulu Terengganu																
Rural				0.001				0.104				0.049				<0.001
Thin	15.2	11.5	13.5	(21.31)	6.8	6.2	6.5	(6.16)	7.0	3.7	5.3	(7.83)	10.6	7.9	9.3	(32.47)
Normal	62.3	67.4	64.7		65.3	67.4	66.3		73.2	78.9	76.1		65.7	70.2	67.8	
Overweight	10.0	14.1	11.9		15.3	18.1	16.6		9.7	11.0	10.4		11.7	14.6	13.1	
Obese	12.5	7.0	9.9		12.5	8.2	10.6		10.0	6.5	8.2		12.0	7.3	9.7	
Urban				0.499				0.275				0.3				0.853
Thin	8.2	9.0	8.6	(2.37)	12.4	6.3	9.8	(3.87)	5.6	8.3	6.8	(3.66)	8.8	8.1	8.5	(0.78)
Normal	62.2	65.2	63.7		64.3	69.8	66.7		80.9	71.4	76.6		67.0	67.8	67.4	
Overweight	14.1	14.3	14.2		13.3	13.8	13.6		7.4	10.5	8.8		12.3	13.4	12.8	
Obese	15.5	11.5	13.6		10.0	10.1	10.0		6.2	9.8	7.8		11.8	10.7	11.3	
Kemaman																
Rural				<0.001				0.04				<0.001				<0.001
Thin	9.2	11.4	10.3	(38.35)	9.2	7.1	8.1	(8.29)	10.8	5.8	7.9	(18.68)	9.4	9.7	9.5	(53.25)
Normal	60.3	63.0	61.6		61.6	66.8	64.4		70.6	72.7	71.8		61.6	65.2	63.4	
Overweight	13.5	15.5	14.5		15.7	17.1	16.4		9.3	17.4	13.9		13.5	16.1	14.9	
Obese	17.1	10.1	13.6		13.5	9.0	11.1		9.3	4.1	6.3		15.5	9.0	12.2	

[a] BMI categories versus genders in age groups (Pearson's chi-square test)

Table 4: (*continued*)

	10 – 12 years				13 - 15 years				16 – 17 years				All			
	Boys	Girls	All	*P*-value[a] (χ)	Boys	Girls	All	*P*-value[a] (χ)	Boys	Girls	All	*P*-value[a] (χ)	Boys	Girls	All	*P*-value[a] (χ)
Kemaman																
Urban				<0.001				0.84				0.151				<0.001
Thin	16.3	10.8	13.6	(23.32)	7.2	6.0	6.6	(0.84)	5.7	3.1	4.3	(5.31)	13.0	8.7	10.9	(27.3)
Normal	53.5	59.8	56.5		65.7	66.1	65.9		73.2	73.3	73.3		58.6	63.1	60.8	
Overweight	14.5	17.0	15.7		14.4	16.1	15.2		11.4	16.7	14.2		14.0	16.8	15.4	
Obese	15.8	12.4	14.2		12.7	11.7	12.2		9.6	7.0	8.2		14.4	11.5	13.0	
Kuala Terengganu																
Rural				<0.001				0.04				0.283				<0.001
Thin	10.8	9.7	10.2	(44.76)	5.8	4.5	5.2	(8.31)	6.1	3.5	4.5	(3.81)	9.0	7.6	8.3	(31.7)
Normal	55.9	62.3	59.0		68.4	62.9	66.0		70.8	75.5	73.7		60.6	64.5	62.6	
Overweight	13.3	15.5	14.4		15.9	20.0	17.7		14.1	12.6	13.2		14.0	16.0	15.0	
Obese	20.0	12.5	16.3		9.9	12.7	11.1		9.0	8.4	8.6		16.3	11.9	14.1	
Urban				<0.001				<0.001				0.01				<0.001
Thin	10.2	10.3	10.3	(83.7)	8.1	6.0	7.1	(22.81)	7.1	5.3	6.2	(11.4)	9.2	8.4	8.8	(109.5)
Normal	56.7	61.2	58.9		64.0	68.3	66.0		73.0	75.1	74.1		61.3	65.5	63.4	
Overweight	15.0	16.6	15.8		15.5	16.4	15.9		11.3	12.9	12.2		14.5	15.9	15.2	
Obese	18.0	11.9	15.0		12.4	9.3	10.9		8.6	6.6	7.6		15.0	10.3	12.7	
Setiu																
Rural				0.404				0.310				0.777				0.108
Thin	8.9	8.4	8.7	(2.92)	7.1	7.7	7.5	(3.59)	2.9	3.7	3.4	(1.1)	8.0	7.7	7.9	(6.07)
Normal	66.1	68.7	67.3		62.4	65.4	64.3		76.5	75.8	76.1		66.7	68.9	67.8	
Overweight	14.1	14.2	14.2		16.5	18.4	17.6		13.2	15.5	14.5		14.4	15.2	14.8	
Obese	10.9	8.7	9.8		14.1	8.5	10.6		7.4	5.0	6.1		10.9	8.2	9.5	
Urban				0.253				0.425				0.063				0.324
Thin	4.1	6.1	5.0	(4.07)	7.6	5.5	6.5	(2.79)	4.5	3.3	3.8	(7.30)	5.6	4.8	5.2	(3.48)
Normal	63.8	66.7	65.2		70.7	68.7	69.7		80.3	74.6	77.2		71.9	70.3	71.1	
Overweight	20.3	20.3	20.3		15.0	17.0	16.0		9.3	16.5	13.1		14.6	17.6	16.1	
Obese	11.8	6.9	9.4		6.7	8.9	7.8		5.9	5.7	5.8		7.9	7.2	7.5	
Marang																
Rural				0.071				0.03				0.025				0.001
Thin	10.5	8.8	9.7	(7.03)	8.7	5.1	7.0	(8.94)	7.3	3.3	5.1	(9.31)	9.1	5.9	7.5	(17.33)
Normal	61.5	67.5	64.4		64.8	65.1	65.0		69.8	76.0	73.2		64.6	68.9	66.7	
Overweight	16.3	15.2	15.8		15.1	17.2	16.1		12.9	12.4	12.6		15.1	15.2	15.2	
Obese	11.7	8.5	10.2		11.4	12.6	12.0		10.0	8.3	9.1		11.2	10.0	10.6	
Urban				0.071												0.071
Thin	8.8	5.9	7.4	(7.02)									8.8	5.9	7.4	(7.02)
Normal	58.0	65.6	61.5										58.0	65.6	61.5	
Overweight	15.4	16.1	15.7										15.4	16.1	15.7	
Obese	17.8	12.4	15.3										17.8	12.4	15.3	

[a] BMI categories versus genders in age groups (Pearson's chi-square test)

Discussion

The mean of BMI was significantly higher among boys within school locations in primary schools (*P* <0.05). Finding from this study was also in line with previous studies conducted in Malaysia which reported higher mean BMI in girls than in boys (Adeyemi et al. 2014; Teo et al. 2014). This may be due to physiological (hormonal) and psychological (cognitive and emotional) changes that accompany the adolescents' growth spurt. Spear (2002) reported that, on average, girls begin their adolescent growth spurt at 10 years and grow at peak velocity at about 12 years old. However, these ages vary from country to country, being the lowest in

developed countries and the highest in poor countries (Parent et al. 2003). However, in boys, the adolescent growth spurt starts around 12 years of age and will overtake the growth in girls in one or two years (World Health Organisation, 2006). Besides, the degree of pubertal maturation in girls could negatively influence the level of physical activity (PA). The level of physical activity during adolescents also decreases with increasing age as the probability to be inactive increase 1.5 times per year of age thus correlate with increase in body weight (Finne et al. 2011).

In agreement with the SEANUT and NHMS 2011 studies, for boys and girls, the mean BMI was higher for boys and girls in the urban compared to rural particularly in 10 to 12 years old age group (Institute of Public Health, 2011; Poh et al. 2013). Urbanization and development do not only change the environment and physical landscapes but also cause socioeconomic and nutritional trajectories leading to obesogenic lifestyle change. Different socioeconomic and occupational status might have also changed the dietary intake pattern to higher consumption of sugar-sweetened beverages, processed fast foods and higher calories-outside foods (Gupta et al. 2012). In addition, previous studies showed that, urbanised school adolescents particularly in Malaysia were also physically inactive compared to their rural counterpart (Lee et al. 2014; Wong and Parikh, 2016). Difference in built environment and security level in urban areas offer limited opportunities to engage with physical activities (Sjöberg et al. 2011). Interestingly, a recent review and meta-analysis on rural-urban difference of obesity among American children and adolescent found that rural population were 26% at higher risk of becoming obese compared to the urban population (Johnson, 2015). Nevertheless, the review also found that, obese adolescents in rural were more physically active than obese adolescents in urban population.

Based on the z-score BMI categories, the highest prevalence of obesity were from urban Marang (15.3%) and followed by rural Kuala Terengganu (14.1%) which were higher than the national prevalence and Terengganu state for 2015 (Institute of Public Health, 2015). Compared to the prevalence of obesity in Terengganu in 2015, the prevalence had increased by almost 50% in both rural and urban school locations. Finding from current study showed that prevalence of thinness was lower compared to NHMS 2015. Majority of the rural schools within districts reported higher prevalence of thinness compared to urban location except for Kemaman and Kuala Terengganu districts. The findings indicated contradicting trend compared to the national study in the prevalence of thinness which was higher in urban compared to the rural area (8.0% *vs*. 7.2%). Both prevalence of thinness and obesity decreased with advancing age in all districts within school location except for Besut and Hulu Terengganu districts.

This study covered all adolescents from all government schools in Terengganu. It shows the real trend in this population, thus reducing the risk of under- or over-estimation of prevalence. The fact that this study covered all students from all government schools in Terengganu, it had produced the actual prevalence of obesity and thinness among this population in each district in Terengganu. The data presented in this study were cross-sectional by nature thus casual relationships cannot be inferred from the associations presented. Anthropometric measurements conducted by PE teachers in each school may had introduced an inter-researcher variability and inaccuracy. However, since the PE teachers conducted the

anthropometry measurements during SEGAK assessment at regular basis, they were fully trained with accurate method and validated tools.

Conclusion

In summary, this school-based cross sectional study on 62,567 school adolescents in whole Terengganu had indicated a substantial increment of obesity prevalence regardless of school locations compared to previous years. The prevalence of obesity was found to be highest in urban schools in Marang district and rural schools in Kuala Terengganu district. The rapid increase in prevalence of obesity and overweight in both urban and rural locations warrant equal public health attention in both locations. In addition, this finding also suggest, obesity might show further increase as urbanisation progresses, thus broader understanding regarding underlying factors related to obesity among this population should be explored.

Acknowledgments

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