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Short Communication

Dietary intake and weight status of urban Thai preadolescents in the context of food environment

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ABSTRACT

Little attention has been devoted to the importance of understanding the association between dietary intake and childhood obesity in Thailand. This study aimed to explore food types affecting the weight status of preadolescents in urban settings, where obesity is remarkably prevalent. This study was conducted in 2015–2016 and assessed the dietary intake of 263 children aged 10–12 years from Bangkok Metropolitan Regions through three- nonconsecutive-day 24 h recall. Lifestyle and sociodemographic information was obtained using questionnaires. Participants were classified into non-obese and overweight/obese groups based on the WHO child growth standard curve. Foods were categorized into 13 groups based on Thailand's dietary guidelines and food environment context regarding two eating occasions (main and between meals) of children, which resulted in the newly classified "street-side snacks". Data were examined using analysis of covariance and multiple linear regression analysis. After adjusting for sex and energy misreporting, overweight/obese participants had higher energy and macronutrient intake and consumed more cereal grains, meat/fish, flavored milk, and sugar-sweetened beverages during main meals and street-side snacks and confectioneries during between meals than non-obese participants. The consumption of street-side snacks had the highest beta coefficient on BMI z-scores among the food types in the model, adjusted further for energy intakes. Street-side snacks may be an important predictor of obesity in Thai children. A prospective investigation of the impact of accessibility and availability of this food item is needed.

1. Introduction

The prevalence of overweight and obesity is growing rapidly among the children in Thailand (Chavasit et al., 2013). According to Thailand's National Health and Examination Survey, the prevalence of overweight/obesity among children and preadolescents aged 6–14 years rose from approximately 5.4% to 9.7% between 2003 and 2008 based on the weight-for-height percentile provided in the Thai growth reference. Additionally, the urban–rural differences on this issue are striking, and the highest prevalence of both overweight and obesity was found in Bangkok (Mo-suwan, 2010). The prevalence of either overweight or obesity was even higher when the weight status was assessed based on BMI-for-age z-scores (BAZ) provided in the World Health Organization (WHO) growth reference charts, which showed prevalence rates of 24.2% and 18.2% in the urban and rural areas, respectively (Rojroongwasinkul et al., 2013).

Along with the continuing economic growth, the food environment and lifestyle have also changed as a consequence of rising income. This situation is likely to happen in many low-to-middle-income countries, including Thailand (Popkin et al., 2012). An increase in food access and availability has been accompanied by changes in diet composition (Herforth and Ahmed, 2015). Given such environment, the Thais are currently undergoing nutritional transition, regardless of age and sex (Kosulwat, 2002). Preadolescence is a life period where an individual is easily influenced by the surrounding and relatively easy access to less healthy diet available in the school neighborhood food environment.

To our knowledge, no study to date has addressed the role of diet in the etiology of childhood obesity in Thailand. In particular, comprehensive scientific evidences that demonstrate the effect of food type on weight status are lacking. Determining the food group consumption patterns can provide us with information on the food types that are related to obesity, which could be important in planning the dietary guidelines specific for school-aged children and developing effective nutritional education program.

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Taken together, remarkable changes in food environment are likely to occur in urbanized areas. Therefore, this study aimed to explore the food types that can contribute to an increased BAZ of an urban Thai preadolescent sample, with a focus on the food types consumed during different eating occasions: main and between meals.

2. Methods

2.1. Study design and measurement

This cross-sectional pilot study was conducted in a convenience sample of 294 grade 5 and 6 school-aged children (10–12 years old) in August–September 2015 and September 2016 within the six public schools of Bangkok Metropolitan Regions in Thailand. The height, weight, and birth date of the participants were collected from the school records, which was considered as a physical examination record that was completed within the past one month prior to the performance of the research, and used to calculate BAZ using the WHO AnthroPlus (WHO AnthroPlus for personal computers Manual, 2009). BAZ was classified into two categories based on the WHO child growth standard curve: overweight/obese ($> +1$ BAZ) and non-obese (between -3 and $+1$ BAZ). The exclusion criteria were as follows: incomplete three-day dietary assessment, age ≥ 13 years, failure to return the questionnaire on sociodemographic parameters, and < -3 BAZ. The final sample size included 263 children. The Human Research Ethics Committee of Kagawa Nutrition University and Ethics Committee of Thailand's Department of Health approved the study protocol. Informed consent was obtained from the parents and each child prior to their participation in the study.

The parents or caregivers of each child were asked to complete a short questionnaire prior to the interviews to obtain information on the caregiver and household characteristics.

The food consumption data of each child were collected through three-nonconsecutive-day semi-weighted, interactive 24 h dietary recall (Gibson and Ferguson, 2008) by trained staff. The interviews were conducted in the school within a two-week period.

Each child was asked to list all the foods and drinks they have consumed for 24 h using household measures with the corresponding timing. To obtain as much detail as possible regarding the portion sizes of the foods consumed, a three-dimensional food model was used during the interviews.

The food consumption data were categorized based on Thailand's food-based dietary guidelines and school-aged children's eating context, in which sauces and condiments were not included. The classification system is initially developed and described as follows.

We first categorized the foods based on eating occasion: main and between meals (see Supplementary 1). Foods eaten during the main meal time period were divided into two main groups: "foods recommended on Thailand's food-based dietary guidelines" and "others." The former were disaggregated based on the main ingredients and then designated into each main food group, which included cereal grains, fruits, vegetables, meat/fish, eggs, cooking fats and oils, and unflavored milk. The latter included convenience foods, packaged snacks, confectioneries, sugar-sweetened beverages (SSB), and flavored milk (see Supplementary 2).

Foods consumed in between the main meals or those that are not self-defined as regular meal were categorized as between meals, which included street-side and packaged snacks, fruits, confectioneries, unflavored and flavored milk, and SSB. "Street-side snacks" is defined as a light meal, local mixed dish, or local/Western fast food that is mostly sold by street-side vendors and road-side shop and does not have food/nutritional label (see Supplementary 2).

This proposed classification system was approved by the nutrition experts from the Bureau of Nutrition, Department of Health, and Ministry of Public Health prior to data analysis.

The total energy intake and percent energy from macronutrients and micronutrients were assessed using INMUCAL-Nutrients V.3 (Institute of Nutrition, Mahidol University, Thailand) based on Thai food composition tables. All entries were checked for accuracy by a second technician.

To identify inaccurate energy intake reports, the ratio of reported energy intake (rEI) to basal metabolic rate (BMR) was calculated to determine whether rEI was consistent with energy requirement. The BMR was estimated using the age- and sex-specific Schofield's equations (Schofield, 1985).

Under- and over-reporting were detected using the upper and lower cutoff limits of the 95% confidence level between rEI and BMR and physical activity level (PAL), which were determined using the Goldberg equation (Goldberg et al., 1991).

2.2. Statistical analysis

The descriptive data were presented as means with standard deviation or frequency distribution using Student's *t*-test or the chi-square test. The total energy intake and nutrients in each food group were checked for normality using skewed distribution. Analysis of covariance was performed to determine the differences in dietary intake between the two groups after controlling for sex and rEI–BMR ratio because these variables were found to contribute to the differences in weight status. Multiple linear regression analysis was used to identify the food groups that could serve as predictors of BAZ. Subsequently, two models were fitted: model 1, which was adjusted for sex and rEI–BMR ratio, and model 2, which was additionally adjusted for energy intake. All analyses were performed using SPSS, version 23 (SPSS Inc., Chicago, IL, USA), and $p < 0.05$ was considered statistically significant.

3. Results

Participants who were overweight/obese account for 33.5% of the 263 children included in the study. Furthermore, overweight/obese participants were more likely to be boys (51.1%) and to misreport their diets (43.2%) than non-obese participants.

After adjusting for energy intake misreporting, participants who were overweight/obese had higher daily energy intake and macronutrient consumption than those who were non-obese. The percentage energy from carbohydrate, protein, and fat did not differ between groups. Additionally, all the selected micronutrient intakes of overweight/obese participants were higher than those of non-obese participants (Table 1).

Overweight/obese participants reported significantly higher consumption of cereal grains, meat/fish, flavored milk, and SSB during main meals than non-obese participants. Furthermore, the former also consumed more street-side snacks and fewer confectioneries during between meals than the latter. No difference in the energy intake during the main and between meals was observed.

In the regression model adjusted for rEI-BMR ratio and sex, main meals and between meal foods were found to be positively associated with BAZ. Furthermore, street-side snacks had the most significant effect on BMI z-scores ($\beta = 0.390$, $p < 0.001$), even after controlling further for energy intake ($\beta = 0.094$, $p = 0.018$) (Table 2).

4. Discussion

This study is the first to explore the food types that contributed to the weight status of urban Thai preadolescents, especially by clarifying the relatively precise classification of food eaten between meals. Overweight/obese preadolescents consumed more cereal grains, meat/fish, flavored milk, and SSB during main meals and more street-side snacks and confectioneries during between meals than non-obese participants. With our novel food group classification system clarifying the snack types, we primarily demonstrated that street-side snack consumption was associated with increased BAZ. This approach contributes

Table 1
Descriptive characteristics and dietary intake of the participant based on weight status categories in Bangkok Metropolitan Regions from 2015 to 2016.

		Overweight/obese		Non-obese		*p*-Value
		n = 88		n = 175		
Child						
Age (year)	Mean, SD	11.3	0.6	11.4	0.6	0.162
Anthropometry						
Body weight (kg)	Mean, SD	52.6	9.8	35.8	6.6	**< 0.001**
Height (cm)	Mean, SD	149.4	8.1	146.4	7.8	**0.004**
BMI (kg/m^2)	Mean, SD	23.4	3.1	16.6	1.8	**< 0.001**
BMI z-score	Mean, SD	1.9	0.7	− 0.5	1.0	**< 0.001**
Physical activity level[a]						0.877
Least active	n, %	14	25.5	28	22	
Moderately active	n, %	31	56.4	77	60.6	
Highly active	n, %	10	18.2	22	17.3	
Screen time[b]						0.859
< 2 h/day	n, %	15	26.8	37	29.1	
> 2 h/day	n, %	41	73.2	90	70.9	
Sex						**0.034**
Boys	n, %	45	51.1	65	37.1	
Girls	n, %	43	48.9	110	62.9	
Family background						
Household composition						0.375
Lives with both parents	n, %	68	77.3	125	71.4	
Lives either with parents or without parents	n, %	20	22.7	50	28.6	
Caregiver's educational level[a]						0.774
≤ Junior high school	n, %	34	38.6	59	33.9	
≥ Junior high school	n, %	53	60.2	113	64.9	
Others	n, %	1	1.1	2	1.1	
Household income (baht/month)						0.591
< 10,000	n, %	19	21.6	49	28.2	
10,000–20,000	n, %	33	37.5	67	38.5	
20,000–40,000	n, %	26	29.5	42	24.1	
> 40,000	n, %	10	11.4	16	9.2	
Accuracy of energy reporting						**< 0.001**
Under-reporters	n, %	38	43.2	26	14.9	
Plausible reporters	n, %	50	56.8	148	84.6	
Over-reporters	n, %	0	0	1	0.6	
rEI–BMR ratio	n, %	1.06	0.28	1.33	0.32	**< 0.001**
Snack environment[c]						
Availability at home	n, %	11	19.6	21	16.5	0.674
Buys around home's neighborhood	n, %	43	76.8	106	83.5	0.306
Buys from school or shop/stalls around school	n, %	31	55.4	63	49.6	0.523
Nutrient intake[d]						
Energy (kcal)	Mean, SD	1764.5	15.5	1510.0	10.7	**< 0.001**
Carbohydrate (g)	Mean, SD	235.1	3.3	205.3	2.3	**< 0.001**
%Energy from carbohydrate	Mean, SD	53.2	0.6	54.4	0.4	0.145
Protein (g)	Mean, SD	64.9	1.1	54.7	0.7	**< 0.001**
%Energy from protein	Mean, SD	14.8	0.2	14.5	0.2	0.327
Fat (g)	Mean, SD	63.1	1.1	52.5	0.7	**< 0.001**
%Energy from fat	Mean, SD	32.1	0.5	31.3	0.4	0.209
Saturated fat (g)	Mean, SD	21.6	0.5	18.7	0.4	**< 0.001**
Protein (g/kg body weight)	Mean, SD	1.4	0.0	1.5	0.0	**0.025**
Animal protein (g/kg body weight)	Mean, SD	1.0	0.0	1.1	0.0	0.138
Calcium (mg/day)	Mean, SD	547.0	18.9	491.0	13.1	**0.02**
Iron (mg/day)	Mean, SD	8.57	0.22	7.39	0.15	**< 0.001**
Vitamin A (μg RAE/day)[e]	Mean, SD	352.4	1.1	302.0	1.0	**0.019**
Dietary fiber (mg/day)	Mean, SD	6.33	0.26	5.39	0.18	**0.005**

Continuous and categorical variables were presented as mean with standard deviation and number with percentages, respectively. Continuous variables included the child's age, anthropometric variables, and rEI–BMR ratio; the rest were classified as categorical variables. Chi-square test or Fisher's exact test was used for categorical variables, whereas Student's *t*-test was utilized for continuous variables. Bold values indicate statistical significance.

[a] Physical activity level: assessed using two-item, self-report recall questionnaire on the frequency and duration of both moderate-intensity and vigorous-intensity activities.
[b] Screen time: time spent on TV and computer.
[c] Snack environment: assessed using the multiple-choice question "where do you usually buy snack?"
[d] Values were presented as mean with standard error after adjusting for rEI–BMR and sex (girls/boys).
[e] Values were log-transformed prior to the analysis and values presented are back-transformed units.

to evidences demonstrating the snack types affecting the changes in weight status among Thai preadolescents.

It is important to note that comparing our result with those of previous studies using different snack terms is difficult because our unique classification of the snack types is based on the commonly consumed food among school children in Thailand. Street-side snack, which was defined in Section 2.1, is a term that mostly refers to foods that the participants purchased at school or from the school neighborhood. Thus, our result suggests that school food environment may influence children's weight through the availability of street-side snacks. The issue on "street-side snacks" would be an interesting topic to study in the context of determining obesogenic environment among school-aged children. One recent study on food environments in schools suggested that food availability in and around school are associated with

Table 2
Association between food group consumption and weight status in Bangkok Metropolitan Regions from 2015 to 2016.

		ANCOVA[a]				*p*-Value	Regression[b]					
		Overweight/obese		Non-obese			Model 1			Model 2		
		Mean	SE	Mean	SE		β	95% CI		β	95% CI	
Main meals												
Recommended food[e]	Cereal grains (g)	376.61	10.3	341.88	7.11	**0.008**	0.315	0.003	0.006	− 0.088	− 0.003	0.000
	Vegetables[c] (g)	77.87	5.89	66.53	4.07	0.23	0.034	− 0.265	0.526	− 0.058	− 0.509	0.059
	Fruits (g)	79.54	8.5	65.69	5.87	NA	0.143	0.093	0.475	0.064	− 0.009	0.265
	Meat/fish (g)	140.12	5.58	118.5	3.86	**0.002**	0.337	0.006	0.012	− 0.025	− 0.003	0.002
	Eggs (g)	52.57	3.66	43.6	2.53	0.052	0.227	0.005	0.015	0.072	0.000	0.007
	Unflavored milk[c] (g)	118.57	14.29	122.28	9.87	0.826	0.118	0.033	0.301	0.021	− 0.067	0.126
	Cooking fats and oils[c] (g)	13.04	0.97	11.76	0.67	0.154	0.081	− 0.086	0.850	0.055	− 0.073	0.591
Others[f]	Packaged snacks[c] (g)	6.61	0.99	4.6	0.68	NA	0.058	− 0.100	0.418	− 0.023	− 0.249	0.122
	SSB (g)	129.05	11.58	95.77	8	**0.023**	0.19	0.001	0.004	0.023	− 0.001	0.001
	Confectioneries[c] (g)	30.56	4.26	23.32	2.94	0.706	0.165	0.115	0.501	− 0.069	− 0.276	0.018
	Flavored milk (g)	65.62	7.19	42.69	4.97	**0.012**	0.14	0.062	0.375	0.001	− 0.113	0.116
	Convenience foods[c] (g)	20.97	3.09	21.61	2.13	0.724	0.099	0.005	0.380	− 0.026	− 0.188	0.085
Between meals												
Recommended food[e]	Fruits[c] (g)	10.06	3.13	12.79	2.16	0.496	0.054	− 0.075	0.304	0.013	− 0.108	0.161
	Unflavored milk (g)	157.01	13.05	159.33	9.01	0.888	0.143	0.001	0.003	− 0.015	− 0.001	0.001
Others[f]	Street-side snacks[d] (g)	59.36	4.81	37.7	3.32	**< 0.001**	0.39	0.009	0.016	0.094	0.001	0.006
	Packaged snacks[c] (g)	4.77	0.82	3.86	0.57	0.276	0.113	0.044	0.606	0.014	− 0.161	0.244
	SSB (g)	79.35	9.88	85.45	6.83	0.624	0.009	− 0.001	0.002	− 0.044	− 0.002	0.000
	Confectioneries[c] (g)	9.91	2.47	13.79	1.71	**0.035**	0.073	− 0.062	0.367	− 0.01	− 0.173	0.133
	Flavored milk[c] (g)	32.97	5.3	20.49	3.66	0.149	0.071	− 0.041	0.284	0.023	− 0.076	0.155
							Adjusted R^2	0.489		**Adjusted R^2**	0.744	
	%Energy from between meals	19.06	1.02	18.44	0.71	0.63						
	%Energy from main meals	76.06	1.02	76.85	0.71	0.54						

Bold values indicate statistical significance. Original data of mean and standard error (SE) were presented in the ANCOVA. NA; Not applicable, SSB; sugar-sweetened beverages, β; beta coefficient, 95% CI; 95% confidence interval.

[a] Adjusted for rEI–BMR ratio and sex.

[b] Dependent variables included BAZ, adjustments for rEI–BMR ratio, and sex for model 1 and rEI–BMR ratio, sex, and energy intake for model 2.

[d] Weight of the street-side snack was calculated based on the food consumed, rather than its individual ingredients. For example, the weight of a crispy wonton was calculated as a whole, instead of wonton, vegetable oil, and salt.

[c] Non-normally distributed variables were log-transformed prior to the analysis.

[e] Foods included in Thailand's food-based dietary guidelines.

[f] Foods not included in Thailand's food-based dietary guidelines.

high unhealthy food consumption (Azeredo et al., 2016). Another study showed a positive association between the presence of fast-food outlets around school and body weight (Gilliland et al., 2012).

Interestingly, by assessing two occasions of consumption of SSB and flavored milk, it was observed that overweight/obese preadolescents consumed these sugary drinks during meals rather than between meals. Since according to the 3-day dietary assessment, most main meals were consumed with family, it may be assumed that sugary drink consumption by children during meals were acknowledged or prepared by the parents. Family or parents play an important role for controlling the diet of children (Birch and Fisher, 1998). Therefore, educational approach to assist parents prepares healthy meals for their children are necessary to improve dietary status of overweight or obese Thai children.

A meta-analysis of cohort studies and RCTs has reported evidence demonstrating that SSB consumption promoted weight gain in children and adults. However, a cross-sectional study showed mixed results (Malik et al., 2013). One previous study reported that overweight/obese children who consumed flavored milk (142 g/day) had greater weight gain than those who did not (0 g/day) (Noel et al., 2013). Contrastingly, the recent reviewed literature revealed that flavored milk consumption was not associated with high BMI or weight status (Fayet-Moore, 2016). However, evidence regarding the relationship between the consumption of these foods during different eating occasions and weight status are insufficient. Hence, further investigation is needed on this subject.

This study has some limitations that should be noted. First, this study has a cross-sectional design, which limits the determination of causal relationships. Second, we also acknowledged the limitation of using 24 h dietary recall, which is subject to recall bias. Third, the generalizability of our finding could be limited due to its small sample size and the use of convenience sampling. Fourth, we were unable to collect information on physical activity and screening time from all participants, which could have also limited the results of this study. Lastly, the food group classification system was initially developed for this study, and its unique definition may partly lead to inconsistent results when compared with those of other studies.

Our results demonstrated that street-side snack was consumed more frequently by overweight and obese preadolescents than by normal weight preadolescents, and this was found to be the single most important obesity-related food item. A prospective study of the impact of accessibility and availability of this food item in the development of obesity is needed.

Conflicts of interest

None.

Transparency document

The Transparency document associated with this article can be found, in the online version.

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Appendix A. Supplementary data

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