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ORIGINAL ARTICLE

ASSOCIATION BETWEEN ADDED SUGAR CONSUMPTION IN FOODS AND BEVERAGES AND BODY MASS INDEX AMONG ADOLESCENTS IN UNIVERSITY SOUTHERN THAILAND: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background. Excessive consumption of added sugar is an essential contributing factor to weight gain in adolescence, leading to non-communicable diseases.

Objective. The aim of this study was to evaluate the added sugar consumption in foods and beverages and determine the association between free sugar consumption and BMI status.

Material and Methods. This cross-sectional study was conducted among 280 adolescents in university (18-22 years) recruited from undergraduate students at different schools. The information was acquired using a 24-hour dietary recall questionnaire. Adjusted binary logistic regression analysis was used to assess the associations between added sugar consumption in foods and beverages and nutritional status.

Results. Half of the participants had a BMI status in the normal range (51.8%). A large percentage of adolescents had eaten staple food only two times and did not have breakfast (49%). Additionally, most of the student did not eat a snack or drink beverages (57.7%). Consumption of vegetables, fruit, meat, and milk was higher in obese subjects than other groups. The results showed that adolescents consumed more added sugar (79.2%) than is recommended by the WHO. The majority of added sugar consumption were beverages (46.5%). The findings revealed that added sugar consumption among undergraduate students did not differ significantly depending on BMI.

Conclusion. This study indicated that added sugar consumption in university students exceeded the WHO recommendation, although there was no discernible difference in BMI status. The results would be useful for further study and may help dietitians provide appropriate nutrition education or campaigns to reduce added sugar consumption in Thai and Southeast Asia university students.

Key words: *added sugar consumption, adolescents in university, body mass index, BMI, food and beverages*

INTRODUCTION

The World Health Organization (WHO) reported that obesity has nearly tripled worldwide since 1975. In individuals 18 years and older, more than 1.9 billion are overweight, and over 650 million are obese. This is expected to increase further due to the fact that in 2019, 38 million children under the age of 5 were overweight or obese in 2020 [1]. This corresponds with sugar consumption statistics. Information on sugar worldwide shows that the global consumption of sugar amounted to 170.82 million metric tons in 2016 and has increased every year to an estimated 177.8 million metric tons by the end of 2021 [2]. Sugar consumption leads to further global health problems, most significantly an overweight and obese population, caused by an energy imbalance between calories consumed and calories expended. Consuming too much sugar more than necessary causes an increased risk of developing non-communicable diseases (NCDs) such as diabetes and cardiovascular diseases [3].

Sugars are divided into two categories: naturally occurring sugars and sugars that have been added.

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Sugars are naturally occurring sugars that can be found in meals such as fruit (fructose) and milk (lactose). Sugars or caloric sweeteners that are added to foods or beverages during processing or preparation, such as sugar in coffee, are referred to as added sugars [4]. Added sugar consumption (ASC) is used to improve the flavor, color, texture, and shelf life of foods and beverages. This form of sugar, in essence, adds calories but has no nutritious value [5]. The recommendation from the WHO is to use ASC as a cut-off point for categorical data, i.e., the WHO recommends ASC less than or equal to 24 g per day or 5% of total energy intake [6]. In 2015, the average person in Thailand consumed approximately 26 teaspoons (104 g) of sugar per day as well as most people received their daily intake mainly from sweet beverages. This makes Thai people more likely to become obese; Thai rank second in ASEAN populations for obesity [7]. In 2016, a report on the situation of sugar consumption in Thailand, from the production Management Centre, Office of Cane and Sugar Board 2016, showed that the average Thai person consumed approximately 122 g of sugar per person per day. This is consistent with a report by the Global Agricultural Information Network (GAIN) 2017 that Thai people continue to consume more sugar every year [8]. In particularly, Thai people 18 years old older have a high body mass index (BMI). Due to decreasing industrial usage, Thai consumers' sugar consumption fell by 7% in the first three months of 2018 compared to the same period in 2017. To evade the new sugar tax, beverage producers began reformulating current goods to include more artificial sweeteners [9].

Thai people aged 18 years have more behavior and more options for eating a variety of foods. Adolescents have been influenced by social factors and ways of life, advances in technology, family life, and the environment. Thus, adolescents have changed eating behaviors. From a study on eating behavior related to food consumption in 2017, the results showed youth aged 15-24 years ate spicy, flavorless, and sweet dishes in a ratio 31.06%, 23.68%, and 19.95%, respectively [10]. Eating sweet foods can cause adverse effects on the body. Thai adolescents prefer to drink soft drinks rather than clean water. In addition, National Statistical Office Thailand found that the favorite beverage of adolescents (15-24 years) is a soft drink, and that the rate of sugar intake has increased almost three times. Overconsumption of sugar in the body is an important reason for changes in body mass index (BMI). Because of the rapid and complete absorption of simple sugars, excess sugar is converted to fat and stored in adipose tissue, especially in the waist and hip areas. This is a risk factor for high blood pressure, heart disease, stroke, and diabetes, as well as having psychological impacts [11].

Adolescents in university spent more than 8 hours attending lectures and completing reading material, leading to low physical activity. Together with home delivery service via online applications in Thailand, these factors may contribute to weight gain during a 4-year curriculum in universities. However, the pattern of sugar consumption and Nutritional status is less well documented in southern Thai university adolescents. Thus, this study aims to determine the amount of added sugar consumption from main meals and beverages using a 24-hour recall method. The results of this study may reflect the harmful effects of added sugar on human health.

MATERIAL AND METHODS

Design, setting, and participants

A cross-sectional design was conducted with enrolment of subjects based on academic year of southern Thai undergraduate students in Tha Sala district of Nakhon Si Thammarat province, Thailand (Latitude: 8° 38' 42.2'' N; Longitude: 99° 53' 47.6'' E). Undergraduate students aged 18-22 years from the different schools of the university with three semesters were recruited to be representative of undergraduate students because of a diversity of students, such as gender, race, religion, and beliefs. Excluded from the study were those aged outside 18-22 years, and individuals with potential memory loss, as participating in the interview relies on the respondent's memory. The G*Power 3.1 calculus program (www.gpower.hhu.de/en.html.3.11.61).21 was used to compute the overall sample size of students. The parameters were as follows: test family = exact; statistical test was correlation; a bivariate normal model was used; $\alpha = 0.05$; power = 0.8. The recommended sample size was 280 students, but it was increased by 10% to accommodate for lost samples. Participants were divided into four groups based on their BMI, which was calculated using self-reported height and body weight as weight in kilograms divided by the square of height in meters (kg/m^2), and categorized into four categories based on Asian-Pacific cut-off points underweight (<18.5 kg/m^2), normal weight (18.5–22. kg/m^2), overweight (23–24.9 kg/m^2), and obese (≥25 kg/m^2) [12,13]. Besides, self-reported height and weight were used to determine BMI.

Data collection

A 24-hour dietary recall questionnaire was used to collect information about ASC on a weekday from the Department of Health, Ministry of Public Health. Asking only on a weekday is appropriate to conduct the dietary recall where usually consumers, both in amount and in variety.

The data were collected by trained research assistants with a manual for data collection. Participants were asked about all their foods and beverages consumed over the previous 24 hours. During the face-to-face interviews, precise recipe components, food photographs, measuring spoons and cups, and calibrated digital food scales were utilized to collect as much information about the portion sizes of meals consumed as feasible.

The protocol was obtained from the Human Research Ethics Committee of Walailak University with a reference number of WUEC-19-173-01. Participants were educated briefly regarding the study protocols. Each participant received a Participant Information Sheet and an Informed Consent Sheet and was asked to read thoroughly before signing to prove their willingness to enroll. Their information was kept confidential. The researcher did not harm the participants and did not benefit from the study at all.

Added sugar determination

The amounts of added sugar consumption of foods and beverages was calculated from its composition using INMUCAL-Nutrients V.4.0 software Institute of Nutrition, Mahidol University, Nakhon Pathom, Thailand) and the data available from Online Thai Food Composition Database 2015 [14]. If this source did not have any food items or recipes, additional sugar was manually introduced based on the nutrition facts labels. The researchers double-checked all of the entries for accuracy.

Data analysis

The ASC results were statistically analyzed by statistical software (IBM SPSS Statistics for Windows Version 20.0, IBM Corp., Armonk, NY, USA). Descriptive statistics, one-way ANOVA, and multiple linear regressions were used for data analysis. Statistical significance of the difference between samples was set at a level of $p<0.05$.

RESULTS

The majority of the participants were female (81.4%), with an average age of 20±3 years. The subjects were generally normal weight (51.8%), followed by underweight (18.5%), obese (17.2%), and overweight (12.5%). The socioeconomic status, such as monthly stipend of study participants, was 4,200-4,800 Baht that influence food choice and BMI. On a daily basis, two-thirds of university students were reported to eat staple food only 2 times. Most of them never had breakfast (49%). Likewise, half of the students did not eat snacks or beverages (57.1%). On average, the university students consumed 4.2-4.6 servings of starchy foods, 1.0-2.6 servings of vegetables, 0.3-0.6 portion of fruit, 3.4-5.9 servings of meat, and 0.2-0.9 glassed of milk. The prevalence of vegetable, fruit, meat, and milk consumption was higher among obese students than among other weight status groups (Table 1).

Overweight university students who exceeded the WHO added sugar recommendation consumed higher quantities of added sugar compared with students in all other BMI categories. However, one-way ANOVA did not indicate significant differences in the quantity of consumption ($p\geq0.05$) across the added sugar groups. Moreover, a majority of the university students who exceeded the WHO recommendation (79%) consumed eight to twelve times more added sugar in foods and beverages than students who did not exceed the WHO added sugar recommendation. The major source of ASC in this study was found in beverages at 45-57 g (Table 2).

Binary logistic regression showed that weight status was not related to ASC in foods and beverages, and only beverages was significantly different among the underweight, overweight, and obese groups ($p\geq0.05$), as shown in Table 3. These variables were analyzed together by using multiple logistic regression analysis while controlling for other variables, such as age, sex, monthly spending, and the number of staple foods per day. Weight status was not related to ASC in foods and beverages of the student population, including underweight, overweight, and obese groups ($p\geq0.05$).

DISCUSSION

According to the Health Systems Research Institute, the prevalence of normal, underweight, overweight, and obese individuals was 55.5%, 19%, 16.1%, and 9.1%, respectively, among adolescents and young adults aged 15 to 29 years [15]. This study also found that the BMI of university students reached a normal BMI, and half of those were underweight, overweight, and obese. In addition, socioeconomic status, such as the monthly spending of study participants, did not differ significantly across the BMI groups nor did it influence food choice. Eating behavior is a key factor in one's health. Most Thai adolescents and youth did not eat breakfast (53.5%). The results of this research demonstrated that half of the university students skipped breakfast (49%). This was in accordance with a previous study showing that breakfast was the most skipped main meal by university students, followed by lunch or dinner/supper [16, 17]. The reason was that in Thai adolescents, three-fourths of males said it was due to lack of time, while one-half of females said the same. In addition, one-fourth of a females who skipped a meal stated the reason was to lose weight [10]. Moreover, Mahfouz et al. reported 83.3% of male and 95.1% of female university students had a habit

Table 1. Nutritional status according to demographic profile of participants

Demographic factor	BMI, kg/m^2			
	Underweight	Normal	Overweight	Obese
Age (Mean=20±2 years)				
Gender, n (%)				
Male	4 (1.4)	27 (9.6)	8 (2.9)	13 (4.7)
Female	48 (17.1)	118 (42.2)	27 (9.6)	35 (12.5)
Monthly stipend (Thai Baht)	4,200	4,800	4,600	4,700
Number of staple food per day, n (%)				
3 times	16 (5.7)	39 (13.9)	10 (3.6)	12 (4.3)
2 times				
Skip breakfast	24 (8.6)	72 (25.7)	17 (6.1)	24 (8.6)
Skip lunch	6 (2.1)	16 (5.7)	4 (1.4)	5 (1.8)
Skip dinner	2 (0.7)	5 (1.8)	1 (0.4)	2(0.7)
1 time	4 (1.4)	13 (4.6)	3 (1.1)	5(1.8)
Number of snack and beverage per day, n (%)				
3 times	5 (1.8)	16 (5.7)	4 (1.4)	5 (1.8)
2 times	9 (3.3)	27 (9.7)	7 (2.5)	9 (3.3)
1 time	9 (3.2)	19 (6.8)	4 (1.4)	6 (2.1)
Not	29 (10.4)	83 (29.6)	20 (7.1)	28 (10.0)
Food group consumption (serving/day)*, Mean±SD				
Starchy foods (rice-serving spoons)	4.4±1.2^a	4.2±1.9^a	4.6±2.2^a	4.2±1.7^a
Vegetable (rice-serving spoons)	1.4±0.9^{ab}	1.0±0.8^b	1.2±1.4^{ab}	2.6±0.9^a
Fruit (portions)	0.3±0.5^b	0.4±0.7^{ab}	0.6±0.9^b	0.6±0.7^{ab}
Meat (spoons)	3.4±1.7^b	3.4±1.7^b	5.5±2.2^a	5.9±2.9^a
Milk (glasses)	0.2±0.3^b	0.3±0.7^b	0.5±0.6^a	0.9±0.6^a
Added sugar consumption in foods and beverages, n (%)				
≤24 g/day	11 (3.9)	30 (10.7)	7 (2.5)	10 (3.6)
>24 g/day	39 (13.9)	116 (41.4)	28 (10.0)	39 (13.9)
Added sugar consumption in beverages, n (%)				
≤24 g/day	26 (9.3)	77 (27.5)	20 (7.1)	27 (9.6)
>24 g/day	24 (8.6)	69 (24.6)	15 (5.4)	22 (7.9)

*Mean difference was calculated using one-way ANOVA significant at $p<0.05$

^{a,b}Different alphabets in the same row for the same factor indicate significant differences (one-way ANOVA) at $p<0.05$

Table 2. Mean difference of added sugar consumption by nutritional status

Added sugar consumption	BMI, kg/m^2					
	Underweight	Normal	Overweight	Obese	F	p-value*
Foods and beverages, Mean±SD						
≤24 g/day	3.2±7.3	1.1±2.9	4.8±8.7	3.1±7.1	1.083	0.364
>24 g/day	51.5±26.6	45.4±16.4	52.6±31.0	50.6±22.7	1.494	0.217
Total	40.9±31.2	36.3±23.2	43.1±34.0	40.9±28.1	0.906	0.438
Beverages, Mean±SD						
≤24 g/day	0.8±4.2	2.5±5.8	0.6±2.5	2.4±6.2	1.225	0.303
>24 g/day	54.5±9.1	46.2±18.4	57.5±37.4	45.7±23.3	1.485	0.222
Total	26.6±33.8	23.2±25.6	24.9±37.4	21.8±27.0	0.271	0.846

*Mean difference was calculated using one-way ANOVA significant at $p<0.05$

Table 3. Binary analysis of added sugar consumption in foods and beverages and nutritional status

BMI, kg/m^2	Crude			Adjusted*		
	OR	95% CI	p-value	OR	95% CI	p-value
Added sugar consumption in foods and beverages						
Underweight	0.66	0.30-1.44	0.298	0.62	0.28-1.40	0.255
Normal	Reference	Reference	Reference	Reference	Reference	Reference
Overweight	0.50	0.21-1.16	0.108	0.50	0.21-1.20	0.122
Obese	0.53	0.25-1.16	0.112	0.47	0.21-1.06	0.071
Added sugar consumption in beverages						
Underweight	0.89	0.47-1.68	0.714	0.86	0.28-1.40	0.659
Normal	Reference	Reference	Reference	Reference	Reference	Reference
Overweight	0.72	0.34-1.52	0.386	0.76	0.21-1.20	0.489
Obese	0.68	0.35-1.33	0.262	0.67	0.21-1.06	0.256

*Adjusted for age, sex, monthly stipend, number of staple foods per day

of snacking throughout the day between meals, often consuming sugar-sweetened beverages [18].

Furthermore, in this study, the average consumption of all food categories among university students was found to be lower than the Department of Health, Ministry of Public Health, Thailand's recommendation. According to the energy need of 2,000 Kcal, Thai adolescents and young adults are advised to eat approximately 10 servings of rice, 5 servings of vegetables, 4 portions of fruit, 9 servings of meat, and 1 glass of milk a day [19]. In addition, vegetable and fruit consumption among university students is also the most important issue identified in this study. Similarly, Hakim et al. found that an inadequate amount of fruits lowers the recommendation in young urban Malaysian adults [20]. The reason for this finding was that university students changed their lifestyle, frequently consuming processed foods and ready-to-eat food.

A national survey reported the taste of the main dish that most adolescents often consume. Most had consumed spicy dishes (31.6%), followed by flavorless (24.1%), sweetness (20.3%), salty (13.7%), sour (7.6%), and other (2.7%). Consistent with what most youth have to consider before choosing the food is taste (19.9%). Additionally, the adolescents were more likely to add seasoning before eating or testing (64.8%) when compared with other ages. Sugar was added to 44.1% less food than fish sauce or soy sauce (63.8%) [10]. This study found the average consumption of added sugar in meals and beverages among university students exceeded the WHO recommendation in all weight categories. The major source of ASC found in this study was beverages, which accounted for 45-55% of total ASC or 80-100 g per person per day. Similarly, Promdee et al. showed that average sugar consumption in Thai undergraduate students was 68±38 g per day or 17 teaspoons of added sugar per day [21]. The results of this study demonstrated that the amount of added sugar consumed per day by southern Thai undergraduate students did not differ significantly between BMI categories. This was in line with a recent study that found no significant differences in added sugar intake among undergraduate students at a South African university based on their BMI [22].

In addition, Gunes et al. also report freshman students in Turkey with a higher BMI (obese and overweight) consumed more foods and beverages than those with other nutritional statuses [23]. On the other hand, Piammongkol et al. found a lower consumption of added sugar level, in the third trimester, greater than 25 g but less than 50 g pregnant Thai-Muslim women in rural southern Thailand [24]. The explanation for this was because a variety of internal and external influences tend to impact university students' food and lifestyle patterns. As a result, it's critical to examine their nutritional consumption and establish the elements that impact their dietary and lifestyle behaviors in order to change these habits [25].

A previous report showed that increased taxes on sugary beverages result in lower consumption of these products [26]. During 2014 and 2015, a case study examining two years of implementation with a sugar-sweetened beverage tax in Mexico found an average reduction of 7.6% in purchases. Households with the fewest resources saw an 11.7% decline in purchases. The survey found a 2.1% rise in untaxed beverage sales, particularly bottled water [27]. Increasing the sugar tax in Thailand has also resulted in a lower sugar consumption rate of Thai people, which can be a guideline for the future prevention of NCDs in the Thai population.

The limitation of this study includes that this study used a single 24-hour dietary recall, which did not provide an accurate estimate of usual intake. Only undergraduate students from a single university

were included in this study; therefore, more research should be undertaken among students from several universities to provide a national perspective on university students' added sugar intake and its impact on their BMI. However, the consistency of the methodology, validated methods, and well-trained field workers used during the data collection and processing phases assured the validity of the data on dietary intake and anthropometric measures, which is an important strength of this study.

CONCLUSION

This study indicated that added sugar consumption in southern Thai university students exceeded the World Health Organization recommendation. Which, the majority source of added sugar consumption was a beverage. The results can use for further study, a reference in research on sugar consumption behavior, and help the dietitians to provide nutrition knowledge or dedicate the information with the general consumer for more understanding about added sugar consumption. That is consistent with the government has intended sugary tax to reduce its consumption among Thai people to prevent overweight, obesity, diet-related non-communicable diseases.

Authors' Note:
J.P, and R.Y. performed the study, analyzed the data, conducted the data interpretation, and drafted the manuscript. B.K, S.M, and W.T performed the study. J.P designed the study and reviewed the manuscript. All authors proofread and approved the final manuscript.

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Conflict of interest
The authors declare no conflict of interest.

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