

Original Article

Sucrose consumption in Thai undergraduate students

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Highly added sugar diets have been associated with various health problems such as dental caries, dyslipidemia, obesity and poor quality of life. Unfortunately, sugar consumption, especially sucrose, has increased continuously worldwide. The purpose of the study was to examine sources of sugar consumption and amount of added sucrose consumed in Thai undergraduate students. This study was carried out at Khon Kaen University, Thailand, between the years 2004-2005. A complete 3-day record of items and amounts of sweet consumption were obtained from 202 individuals - 38 male and 164 female students. Added sucrose content of each sweetened food and drinks referred to in the record was determined by an enzymatic method. Mean intakes of sucrose were calculated from the sucrose content. The average of sucrose consumption in all subjects was 69±38 g/day, ranged from 4 to 182 g/day or 17 teaspoons of added sucrose per day. This amount accounted for 13.8% of total daily energy intake. There was a record of 337 kinds of sweetened foods and drinks found. The major source of added sucrose consumption was sweetened beverage, which was consumed 118 g/day averagely, or 60% of daily sugar consumption. Intake of sucrose per day in both male and female was not statistically difference, neither among different BMI groups. Intake of added sugar in the students was higher than the recommendation of the World Health Organization. These data would be helpful in a health promotion campaign aimed at a reduction of sugar consumption in Thai undergraduate students.

Key Words: dietary sucrose, energy intake, undergraduate students

Introduction

Overweight and obesity are the major health problems.¹ An increasing magnitude of this problem has been documented worldwide. The prevalence of overweight among US adolescents was 15.5%, while 7.3% of Malaysian school children were overweight.²⁻⁴ This problem has been reported not only in children and adolescent, but also in adults. Twenty percent of Japanese age 30 and over were classified as overweight.⁵ Overweight or obesity has been associated with various health problems such as dental caries in pre-school children, dyslipidemia, bone loss and fracture, poor quality of life, and a risk factor of cardiovascular disease and degenerative arthritis.⁶⁻⁸ Higher body weight is associated with an earlier onset of type 1 diabetes in children.⁹ Obesity is known to be a principal accelerator of β -cell destruction leading to type 1 diabetes. It has been documented that consumption of sugar higher than 18% of total daily energy intake resulted in a lower mean intake of micro-nutrients, vitamin A, C, B-12, folate, calcium, phosphorus, magnesium and iron.¹⁰ Furthermore, it has been suggested that diet high in added refined sugar might be associated with an increased risk of colorectal cancer, breast cancer, and pancreatic cancer.¹¹⁻¹³ The possible mechanism is that a diet high in added sugar could affect the level of insulin and insulin-like growth factor.¹⁴

An intake of diet high in added sugar inevitably causes weight gain due to various biochemical changes. Diet high in added sugar has been associated with an increase of obesity in children.¹⁵ A high dietary content of carbohydrate, primarily made up of monosaccharide, is more

problematic for hypertriglyceridemia than those of oligo- and polysaccharide. Added sugar consumption is proven to be associated with an increased body mass index (BMI). It has been reported that an increased BMI, even within non-obese level, could raise a risk for type 2 diabetes in middle aged. Although BMI is affected by multiple factors such as eating behavior, total energy intake, food pattern, an intake of non-basic foods such as added sugar, and sweet snacks is very likely to influence BMI.

It had been reported that BMI of US adolescents age 12-19 years in the year 2000 were higher than those of the year 1988-1994 at the same age group.² Coincidentally, a consumption of added sugar has increase steadily from 27 tsp/person in 1970 to 32 tsp/person in 1996. This represented a consumption of 82 g of carbohydrate, which accounted for 16% of total daily energy intake.¹⁶ The major source of eaten sugar was non-diet soft drink, which increased from 200 ml/day in 1989 to 280 ml/day in 1995. Moreover, it had been found that the prevalence of obesity in adults was different between those who did and did not consume soft drink. The prevalence of obesity in adults who consume and do not consume soft drink ranged from 16-24% and 12-18% respectively.

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Added sugar, exclusively sucrose, is defined as sugar that is eaten separately at a table or used as an ingredient of food such as cake, cookies, soft drink and ice cream. Added sugar includes natural sugar, for instance, white sugar, brown sugar, raw sugar, corn syrup, malt syrup, or lactose also known as milk sugar, fructose, known as fruit sugar.¹⁷ Added refined sugar is defined as sugar added to food or drink in commercial or domestic food preparation. It includes sucrose, lactose, glucose, maltose and fructose. World Health Organization refers free sugar to monosaccharide and disaccharide added to food by manufacturer, cook, or consumer, plus sugar naturally presenting in honey, syrup and fruit juice. The present study focused on added sucrose in food and drink either domestic or processed food. Therefore, only added sucrose was examined. Thus, a term added sucrose would be used throughout this study for more specificity.

Unlike other food groups, a dietary guideline for sugar does not give a certain amount of sugar constituting moderation. However, consumers have been advised to use added sugar sparingly.¹⁸ WHO recommended that an intake of added sugar should not exceed 10% of total daily energy intake.

Even though there is a report of an increased prevalence of overweight and obesity in conjunction with an increasing of added sugar consumption, to the best of author's knowledge, there is no study regarding the magnitude of added sucrose consumption in Thai undergraduate student. The purpose of the present study was to examine sources of sugar consumption and amount of added sucrose consumed in undergraduate students at Khon Kaen University, Thailand, and to compare average amount of added sucrose consumption among different BMI groups.

Materials and methods

Subjects

Two hundred and two undergraduate students of Khon Kaen University, Thailand (164 women and 38 men, age 18-22 years, enrolling between the year 2004 to 2005) volunteered in this study. All volunteers gave their written consent form after the study procedure had been explained orally. Basic data such as weight, height, were collected. Body mass index (BMI) was calculated by dividing body weight (kg) by height² (m). BMI was then grouped into 3 categories according to WHO criteria; low (BMI < 18.5 kg/m²), medium (BMI 18.51 to 24.99 kg/m²), and high (BMI ≥ 25 kg/m²).

Design

Volunteers completed 3-day daily record of items and amount of sweetened foods and drinks consumed. All recorded items were grouped into 5 categories according to their ingredients; candy, snack, bakery, sweetened beverage and traditional Thai sweet. Added sucrose in each and every recorded sample was analyzed as described below. Average amount of sucrose consumption per day was calculated. An overall response rate for 3-day record was of 40%.

Principle of sucrose determination

Sucrose was digested to glucose and fructose by β -fructosidase. Free glucose (tube A) and total glucose

(tube B) were reacted with glucose oxidase and peroxidase. Intensity of quinoneimine dye was measured for optimal density (OD) at the wavelength of 540 nm. Free glucose was subtracted from the total glucose, therefore, the intensity of glucose from added sucrose was $OD_B - OD_A$. Glucose solution of 300 mg% was used as a standard reference. Total amount of sucrose (mg%) in the sample was calculated from $(OD_U/OD_S) \times 300 \text{ mg%} \times (342/180)$. Sucrose content of each recorded item was summarized for 3 days, the average of sucrose consumption per day per person was calculated.

Digestion of the sample by Carez II solution was needed for turbid samples to prepare a clear sample before measurement.

Data analyses

Averages of added sucrose consumption were expressed as mean \pm standard deviation (SD), and range. A one-way analysis of variance (ANOVA) was used to compare averages of sucrose consumption among BMI groups for both genders. For statistical analysis, the statistical package for Social Sciences (SPSS) 12.0 was used. *p* value were two tailed and *p* < 0.05 was considered as statistically significant.

Results

Two hundred and two voluntary Thai undergraduate students participated in this study; 164 of (81.2%) female and 38 (18.8%) of male. Demographic data of the volunteers are described in Table 1. The averaged BMI was $20.3 \pm 6.4 \text{ kg/m}^2$ (mean \pm SD), ranged from 15.2 to 38.9 kg/m². BMI of male and female volunteers were $20.0 \pm 6.2 \text{ kg/m}^2$ and $25.1 \pm 6.0 \text{ kg/m}^2$, respectively.

There were 337 kinds of sweetened foods and drinks (Table 2). After placing each of them in one of five categories; candy, snack, bakery, sweetened beverage, and traditional Thai sweet, we found that ninety-four varieties of sweetened beverage represented the largest source of sugar consumption. They were accounted for 27.8% of a total. An averaged sucrose content of sweetened beverage was 24.0 g/bottle ranged from 0 to 112 g/bottle. Secondly, eighty kinds of bakeries were accounted for 23.7% with an averaged sucrose content of 13 g/piece. Sixty-four kinds of traditional Thai sweets were accounted for 20% of the total. An averaged sucrose content of tradi-

Table 1. Demographic data of the subjects

Type of subjects	All	Male	Female
N	202	38 (18.8%)	164 (81.2%)
Age (years)	20.1 \pm 3.2 (17-29)	20.4 \pm 2.3 (17-29)	20.0 \pm 2.5 (17-28)
Body weight (kg)	53.0 \pm 17.1 (29-110)	59.0 \pm 2.3 (47-110)	51.0 \pm 15 (37-83)
Height (m)	1.6 \pm 0.4 (1.45-1.8)	1.63 \pm 0.4 (1.60-1.8)	1.58 \pm 0.4 (1.45-1.7)
BMI (kg/m ²) [†]	20.3 \pm 6.4 (15.2-38.1)	20.0 \pm 6.2 (15.2-38.1)	25.1 \pm 6.0 (15.6-32.8)

[†]BMI, Body Mass Index, is referred as weight (kg) divided by height (m²)

Table 2. Sugar-sweetened foods and beverages categories and sucrose contents

	Sugar-sweetened food categories (n = 337)	Sucrose contents (g) per pack	
		Range	Mean±SD
Candies (n = 52, 15.4%)	Candies, candy with chocolate, jellies	0.1-24.7	6.0±5.9
Bakery (n = 80, 23.7%)	Cakes, Cookies, pies, doughnuts, crackers, slide bread	0.1-37.3	13.2±9.1
Snacks (n = 43, 12.7%)	Chocolate bar, squid, potato ship, pop corn, grain-based snacks	0.0-52.8	9.5±11.0
Sweet drink (n = 94, 27.8%)	Non-diet soft drink, fruit juices, lemonade,	0.0-111.9	24.0±20.0
Thai sweets (n =68, 20.1%)	Lod chong, roti with egg (banana), sweets topping with coconut milk	0.9-117.3	24.6±25.4

Table 3. Sugar consumption in all subjects

Parameters	BMI	All (n= 202)	Male (n=38)*			Female (n=164)		
			Low** (n=7)	Medium (n=27)	High (n=4)	Low** (n=41)	Medium (n=109)	High (n=14)
Averaged Sucrose consumption (g/day)		69±38 (4-182)	56±31	72±40 72±37 (7-161)	71±32	75±44	60±38 68±39 (4-182)	65±31
Energy intake from sucrose per person/day (kcal)		276		288			282	
Added sucrose in term of dry weight (tsp) ^{††}		17		18			17	
Sucrose consumption according to sweetened food (g/day)								
1.Candy		9		11			9	
2.Bakery		38		31			40	
3.Snacks		7		7			7	
4.Sweetened beverage		118		135			114	
5.Thai sweet		26		22			27	

^{††}1 tsp = 4 grams dry weight. *Not statistically difference between genders; ** not statistically difference in three groups of BMI

tional Thai sweets was 25 g/pack. Fifty-two kinds of candies were accounted for 15.3% with an averaged sucrose content of 6.0 g/piece ranged from 0.1 to 24.7 g. Lastly, forty-three kinds of snacks were accounted for 12.7% with an averaged sucrose content of 9.5 g/piece ranged from 0.0 to 52.8 g.

An averaged amount of daily consumption of added sucrose for all subjects was 69±38 g/day, ranged from 4 to 182 g/day (Table 3). Averaged added sucrose consumption for male volunteers was 72±37 g/day, ranged from 7 to 161 g/day. Meanwhile, female volunteers consumed added sucrose 68±39 g/day, ranged from 4 to 182 g/day. An average of daily energy intake derived from added sucrose of all subjects was 276 kcal/day (1 gram of sucrose = 4 kCal). In average, volunteers consumed 17 tsp/day added sucrose daily (1 tsp equal to 4 g of dry weight).

The data revealed that the largest source of added sucrose consumption was sweetened beverage with an average of 118 g/day, accounting for 59% of daily added sucrose intake (Figure 1). Other sources of added sucrose in ranked order were bakery, contributing 38 g/day, Thai sweets, contributing 26 g/day, candy, contributing 9 g/day, and snack, contributing 7 g/day. Collectively, the last

four categories accounted for only 40% of the total intake of added sucrose consumption.

Although, mean daily added sucrose intake was a little greater in male volunteers, there was no gender difference. Also, there was no difference of average daily added sucrose consumption among groups of low, medium, and high BMI in each gender (Table 3).

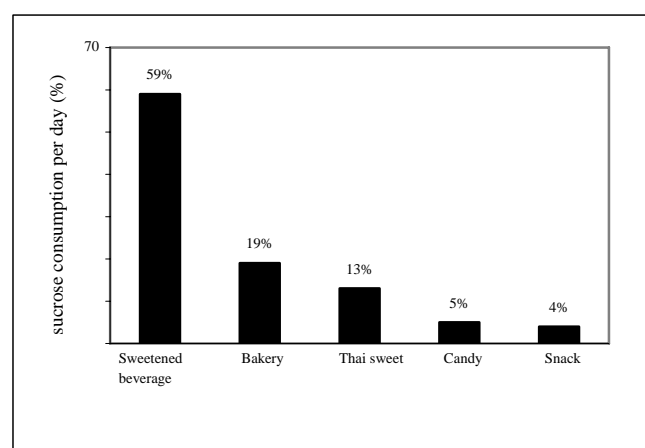


Figure 1. Sources of sucrose consumption per day (%) in the students

Discussion

Our research is the first study determining the intake of sucrose in Thai undergraduate students. The average of added sucrose intake in all volunteers was 69 ± 38 g/day or 17.25 tsp/day. This number is close to averaged sugar consumption of the united state adolescents in the year 1989 to 1996 which was 15.7-20.5 tsp/day.¹⁸ It is also comparable to the refined sugar intake in 18-year old Australian.¹⁹ However, this figure is higher than those found in the children aged 9 to 11 years, which consumed 61 g daily.⁵ Added sucrose consumption in this study is lower than consumption of added sweetener in American, which was 82 g/day between the years 1994 to 1996.¹⁶ However, it should be pointed out that added sucrose consumption in the present study may not reflect the actual amount of sugar intake because only added sucrose was determined in this study. There were other forms of added sugar which were not examined in this study, for example corn syrup and honey. Therefore, it is likely that an actual intake of added sugar consumed in these volunteers would be higher than our result.

The major source of added sucrose intake found in this study was sweetened beverage, which accounted for 59% of total added sucrose intake or 118 g daily. This finding was in accordance with previous studies. Although, we did not categorize the substantial source of sweet drink, presumably, a group of soft drink was the most prominent source.¹⁹ This amount of 118 g daily intake in this study is remarkably higher than those found of 36.2 g in adolescent girls and 57.7 g for boys reported in the year 2000.¹⁶

Although our results showed no difference of added sucrose intake among different BMI groups, highly added sugar intake, especially sugary drink, may promote obesity. Presumably, sugary drink causes excess energy consumption resulting in a lesser intake of subsequent meals and leading to less variety of food groups.¹⁷ Additionally, excess sugar consumption could promote negative changes in bodyweight by involving hunger and rate of metabolism.²¹

The World Health Organization recommends that refined sugar consumption should not exceed 10% of total energy intake per day.¹ In the present study, total energy intake of 2,000 kcal per day recommended by Thai RDI was used for calculation. According to this criterion, energy intake from added sugar should not surpass 200 kcal, or 50 g/day or 12.5 tsp/day. Unfortunately, added sucrose consumption of 69 g/day found in the present study did exceed the WHO recommendation. Furthermore, this amount contributes of 13.8% total daily energy intake, and it is not far different from the report found for adolescent of America and Spain^{8,22-24}.

Strikingly, we found 41 of 164 female subjects with $BMI \leq 18$ kg/m². This was an unexpected result. This result may be an interesting point of the eating habit of Thai undergraduate students. Nowadays, being thin is recognized as a superior body figure. Therefore, this group of our volunteers may control their diet intentionally resulting in a low BMI. Furthermore, life style of these volunteers may affect their BMI. All volunteers were living in university dormitory. It is known that dormitory residents usually skipped their breakfast in order to attend class on time. This result is in accordance

with other study reporting that nibbling or omitting breakfast was associated with lower BMI.²⁵ Only 14 of 164 female subjects (8.5%) fell into overweight category, $BMI \geq 25$ kg/m². This prevalence is higher than those found in Malaysian school children, but lower than those of united state adolescent.²⁴ Although several reports have showed that sugar-sweetened intake is an important contributing factor of body weight gain¹⁵, the present study found that added sucrose consumption was not significantly different among three BMI groups for both genders. Therefore, added sucrose consumption may not play a significant role in weight gain in this population. Other causes such as eating habit, carbohydrate intake, and physical activity may take part in weight gain.

However, our result indicated that added sucrose consumption in Thai undergraduate student exceeded of WHO recommendation. This amount of daily sugar intake is remarkably higher than those found in the year 2000. The major source of added sucrose consumption was sweetened beverage. Knowing of preferred source of added sucrose may help dietitian provide appropriate nutrition education or campaign to reduce added sugar intake in this aged group.

Underreporting of sweet intakes is a serious pervasive problem in dietary survey research. It is possible that the recorded intake of sweetened foods and drinks in this self-report study may be underestimated. We noted that the third day of the daily record generally showed lower sucrose consumption than the first two days. Thus, the amount of added sucrose consumption reported in this study may not truly reflect the actual intake of the subjects. Furthermore, the present study measured only sucrose contents in foods or drinks, omitting other sweeteners added during manufacturing process such as glucose, fructose, or corn syrup. Taken together, it is expected that the actual sugar consumption of our volunteer are underestimated. Even being underestimated, the reported amount of added sucrose consumption was already higher than recommended by WHO.

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