ORIGINAL

Sugar Intake and Body Weight in Cambodian and Japanese Children

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Abstract : Because of the tastiness of sugars, it is easy to consume more than an adequate amount. There are many research reports that excess sugar intake contributes to dental decay, obesity, diabetes etc. Continuing economic development in Cambodia has made it easier than before for people to consume sugars in their daily life. Currently, isomerized sugar (a mixture of glucose and fructose) made from starches is commonly used in commercial beverages because of its low price. However, in Cambodia and Japan, sugar composition tables that include not only sucrose but also glucose, fructose, lactose and maltose have not been available. Prior to the present nutrition surveys, we made sugar composition tables for both countries. In this study we tried to estimate the intakes of various sugars by children in Cambodia and Japan and to determine the relationship between intake and body weight. Nutrition surveys of children aged 7, 10 and 13 years old were conducted for 3 nonconsecutive days by the 24 h recall method in 89 Cambodian children living in the capital city of Cambodia, Phnom Penh, and 151 Japanese children living in 3 prefectures from north to south. Height and weight of children in Cambodia and Japan were similar until 10 years old but at 13 years old, the Cambodians were shorter and lighter than the Japanese. We could not observe any differences in BMI in either country. The sugar intakes from beverages and snacks were not different among the different gender and age. Thus we combined the mean total sugar intake for Cambodian and Japanese, 28.42 ± 25.28 g and 25.69 ± 16.16 g respectively. These were within the range of WHO recommendations (less than 10% of energy intakes). Cambodian children consumed about 46% of sugars from commercial beverages and snacks and Japanese children 26%. This means that for Cambodians half of the sugars came from isomerized sugar made from starches. Relationships between sugar intake and body weight were not observed in both countries. In conclusion, the Cambodian children consumed about 46% of sugar from glucose and fructose (probably in the form of isomerized sugar), while the Japanese children took 26% ; however, the intakes in both countries met the WHO recommendation and there was no relationship to body weight. J. Med. Invest. 61 : 72-78, February, 2014

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INTRODUCTION

Sugar is important as an easily absorbed energy source, especially for rapidly growing children with high physical activity. This may account for why we

find sugar tasty. However, the pleasing taste makes it easy to consume more than an adequate amount. There are many reports that excess sugar intake contributes to dental decay, obesity, diabetes etc. The rising prevalence of obesity in children in the US has been reported to be linked in part to the consumption of sugar-sweetened drinks (1). From 1994 to 1996, Americans aged 2 years and older (n= 15,010) consumed the equivalent of 82 g carbohydrate per day from added sweeteners, which accounted for 16% of total energy intake (2). The WHO recommendation is less than 10% of energy from sugars (3), which is about 40-50 g/d for children.

Continuing economic development in Asian countries, including Cambodia, has made it easier than before for people to consume sugars in their daily life. Childhood is important in establishing life-long food habits ; therefore we must be concerned with sugar intakes and possible health problems in children.

Sugars are defined as mono- and di-saccharides. They include glucose, fructose and sucrose, lactose and maltose. Fructose is also called fruit sugar because it is found in fruits. It is a mono-saccharide, with the special characteristic that it has a 1.73 times stronger taste than sucrose when it is cooled (4).

Since the 1970s, fructose has been a component of isomerized sugar made from starches. Starch is digested into glucose by enzymes and then about half of it is converted into fructose by the isomerize-enzyme (5). The consumption of foods containing isomerized sugar (a mixture of glucose and fructose) is increasing world-wide because it is cheap, and in addition it is in a liquid form which is easy to use in commercial beverages and chilled or frozen snacks. In the U.S, isomerized sugar is called High Fructose Corn Syrup (HFCS), because it is produced from hydrolyzed corn starch.

As mentioned above, at present not only is sucrose readily available, but other sugars are also available, making it necessary to devise a new sugar composition table to estimate sugar intakes. For this reason, we have constructed sugar composition tables for Japan (6, 7) as well as for Vietnam and Cambodia (8). In this study we tried to estimate the sugar intakes in Cambodian and Japanese children to determine the intakes and their relation to body weight.

METHODS

Subjects

The survey was conducted in children of 7, 10 and 13 years old in several schools in Phnom Penh, the capital city of Cambodia, and finally the reliable data from 89 children were obtained. In Japan survey was conducted in 3 prefectures from north to south and finally 151 reliable samples were chosen. Despite various limitations, we used random sampling as much as possible in selecting areas, schools and classes.

Survey

The nutrition survey in each country was conducted on 3 days (2 weekdays and 1 weekend day), using the 24 hour-recall method. Height and weight were measured.

Estimation of sugar and energy intakes

Calculations of energy intake in Cambodia were made in accordance with the Standard Tables of Food Composition in Vietnam in "Vietnam EIYO-KUN" (10), and "ASEAN Food Composition Table" (11). Sucrose, glucose, fructose, lactose and maltose intakes from foods other than meals were calculated by using the sugar composition tables that was constructed by us previously for Japan (6, 7), Cambodia and Vietnam constructed by us previously (8). We analyzed commercial beverages and snacks which sold in both Vietnam and Cambodia, because products are common to sell in both countries by easy export and import. Calculations of energy intake in Japan were made in accordance with the data listed in "Standard Tables of Food Composition in Japan, 5 revised and enlarged Version" (12) and the table of processed foods data (13).

Degree of obesity

Degree of obesity was derived by the following equation (14).

The degree of obesity= (Actual measured weight-Weight for height standards)/Weight for height standards $\times$100.

Ethical consideration

These studies were conducted with the approval of the Ethics Committee in the Ministry of Health in Cambodia and Ochanomizu University in accordance with the Declaration of Helsinki : Ethical principles for research involving human subjects with special attention paid to the following : to prevent

the identification of individuals each subject's personal information was carefully coded and obtained data were strictly managed. We obtained a statement that participation in the research was by free will on the part of the participants and their guardians by providing explanations about the objectives and details of the investigation and the intention to use the results for oral and written presentations. Even after commencement, explanations were provided whenever subjects dropped out of the study, either of their own volition or at the guardian's behest ; no subjects were penalized in any way.

Statistical analysis

Statistical analysis of the data was carried out with Microsoft Excel. Data were assessed by unpaired Student *t*-test and *p* values less than 0.05 were considered statistically significant. Correlation between body weight and sugar intake was also assessed.

RESULT

Table 1 shows the body characteristics of Cambodian and Japanese children aged 7, 10 and 13 years old. Height and weight of children in both countries of the same age and gender were similar ; except Japanese children became much larger at the age of 13 years old in height (cm) : 149.6 vs 163.4 for boys and 153.1 vs 156.7 for girls and in body weight (kg) : 40.2 vs 52.6 for boys and 43.4 vs 45.7 for girls. BMI was not different between the two countries.

Table 2 shows the energy intakes of children in both countries. Energy intake of 13 years old children was higher in Japan than in Cambodia ($p< 0.0001$).

Table 3 shows the intakes of glucose, fructose, sucrose, lactose, maltose and total sugars for children of different ages and gender in Cambodia and Japan. Intake of maltose in both countries was low. Lactose intake of Japanese children was about 2 times higher than that of Cambodian children, which may suggest that milk consumption in Cambodia is lower than in Japan. Intakes of glucose and fructose were equal in each country, which may suggest that these two sugars came from isomerized sugars made from starch.

Fig. 1 show percentages of each sugar against total intake in Cambodian (upper) and Japanese (lower) children. The intake of glucose + fructose was about 50% of total sugar intake in Cambodia, while it was about 26% in Japan.

Fig. 2 shows the correlation between body weight and sugar intake in both genders at 7, 10 and 13 years old in Cambodia and Japan. No relationships were observed.

Table 1 : Body Characteristics of Cambodian and Japanese subjects

Measurement	Age	Gender	Cambodia	Japanese
Height (cm)	7y	Boy	126.3± 10.2	121.0± 4.5
		Girl	124.2± 6.1	121.4± 4.9
	10y	Boy	135.7± 4.0	140.9± 6.9*
		Girl	138.8± 7.8	139.6± 6.7*
	13y	Boy	149.6± 8.7	163.4± 7.8
		Girl	153.1± 6.2	156.7± 3.6*
Weight (kg)	7y	Boy	22.26± 5.01	22.18± 2.37
		Girl	24.28± 4.04	22.39± 3.20
	10y	Boy	34.76± 10.86	36.48± 10.57
		Girl	30.34± 4.54	31.71± 6.66
	13y	Boy	40.24± 7.50	52.58± 9.76
		Girl	43.44± 8.50	45.74± 5.07
BMI (kg)	7y	Boy	14.1± 3.4	15.1± 1.1
		Girl	15.7± 2.3	15.1± 1.2
	10y	Boy	18.7± 4.7	18.1± 3.9
		Girl	15.7± 2.3	16.1± 15.8
	13y	Boy	17.9± 2.1	19.6± 2.8*
		Girl	18.4± 2.5	18.6± 2.1

Means± SD
Number of subjects in Cambodia and Japan were 23 (boy 10, girl 13) and 43 (boy 19, girl 24) for 7 years old, 26 (boy 16, girl 10) and 58 (boy 28, girl 30) for 10 years and 40 (boy 21, girl 19) and 50 (boy 29, girl 21) for 13 years old, respectively.
Statistical analysis was conducted between Cambodian and Japanese groups by unpaired Student t-test. *$p< 0.05$

Table 2 : Energy Intakes of Cambodian and Japanese subjects (kcal/d)

Age	Gender	Cambodian	Japanese
7y	Boy	1787± 292	1727± 237
	Girl	1524± 158	1617± 210
10y	Boy	1852± 235	2060± 364
	Girl	1792± 484	1816± 235
13y	Boy	1643± 150	2424± 454***
	Girl	1557± 243	1921± 285***

Means± SD
Number of subjects in Cambodia and Japan were 23 (boy 10, girl 13) and 43 (boy 19, girl 24) for 7 years old, 26 (boy 16, girl 10) and 58 (boy 28, girl 30) for 10 years and 40 (boy 21, girl 19) and 50 (boy 29, girl 21) for 13 years old, respectively.
Statistical analysis was conducted between Cambodian and Japanese groups by unpaired Student t-test. ***$p< 0.0001$

Table 3 : Sugar intakes of Cambodian and Japanese subjects by age and gender

(g/d)

		Glucose		Fructose		Sucrose		Lactose		Maltose		Total	
Age	Gender	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese
7y	Boy	7.81±8.34	2.79±2.52*	8.68±8.44	2.86±2.59*	26.65±13.26	16.84±8.07*	1.24±1.24	2.76±2.22*	0.22±0.37	Tr	43.4±26.68	25.24±11.85*
	Girl	3.67±5.95	3.68±3.44*	4.39±6.21	4.19±4.20*	16.92±19.01	16.58±9.51*	1.64±1.73	2.18±1.58*	Tr	Tr	24.12±20.38	26.63±15.23*
10y	Boy	4.03±3.77	2.98±3.19*	4.42±4.13	3.11±3.50*	20.28±16.91	19.26±11.08*	0.93±1.23	2.63±1.09*	Tr	Tr	26.85±19.94	27.98±15.18*
	Girl	6.27±10.60	3.23±2.49*	7.42±11.49	2.86±2.49*	12.15±8.08	17.45±9.34*	1.10±1.40	2.72±2.25*	0.10±0.24	Tr	24.37±25.20	26.25±13.21*
13y	Boy	6.98±7.26	4.30±4.52*	7.71±8.06	4.74±5.01*	6.45±5.46	16.59±13.96**	0.62±0.85	1.79±2.49*	Tr	Tr	20.00±18.51	27.41±22.81*
	Girl	10.50±12.58	2.16±2.19**	11.58±13.66	2.19±2.70**	14.61±14.66	12.72±11.46*	0.51±0.07	1.70±1.94*	0.20±0.59	Tr	36.27±34.12	18.77±14.46*
Mean		6.73±8.73	3.25±3.24	7.53±9.42	3.38±3.65	15.12±14.54	16.75±10.87	0.93±1.20	2.30±2.14	0.10±0.32	Tr	28.42±25.28	25.69±16.16

Means± SD
Tr : trace amount
Number of subjects in Cambodia and Japan were 23 (boy 10, girl 13) and 43 (boy 19, girl 24) for 7 years old, 26 (boy 16, girl 10) and 58 (boy 28, girl 30) for 10 years and 40 (boy 21, girl 19) and 50 (boy 29, girl 21) for 13 years old, respectively.
Statistical analysis was conducted between Cambodian and Japanese groups by unpaired Student t-test. *p< 0.05, **p< 0.01

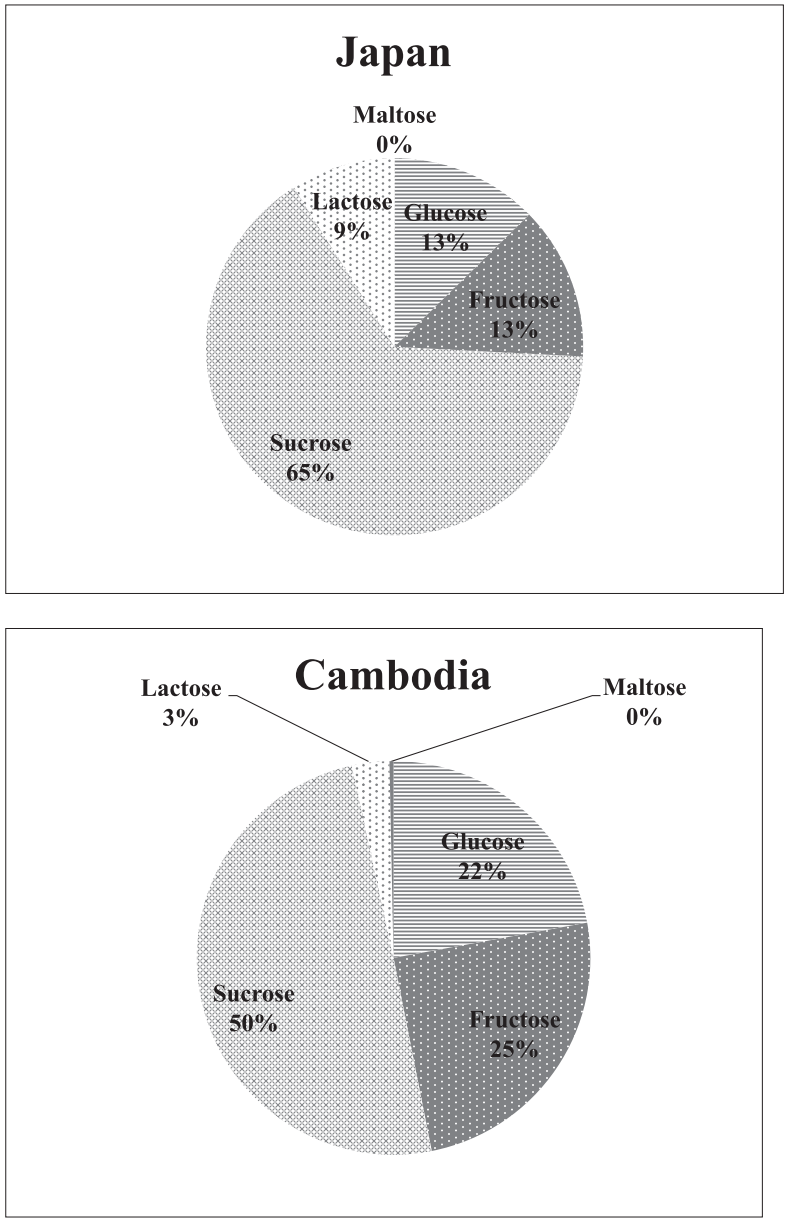

Fig 1. Percentage of sugar against total intake in Cambodian (upper) and Japanese (lower) Children

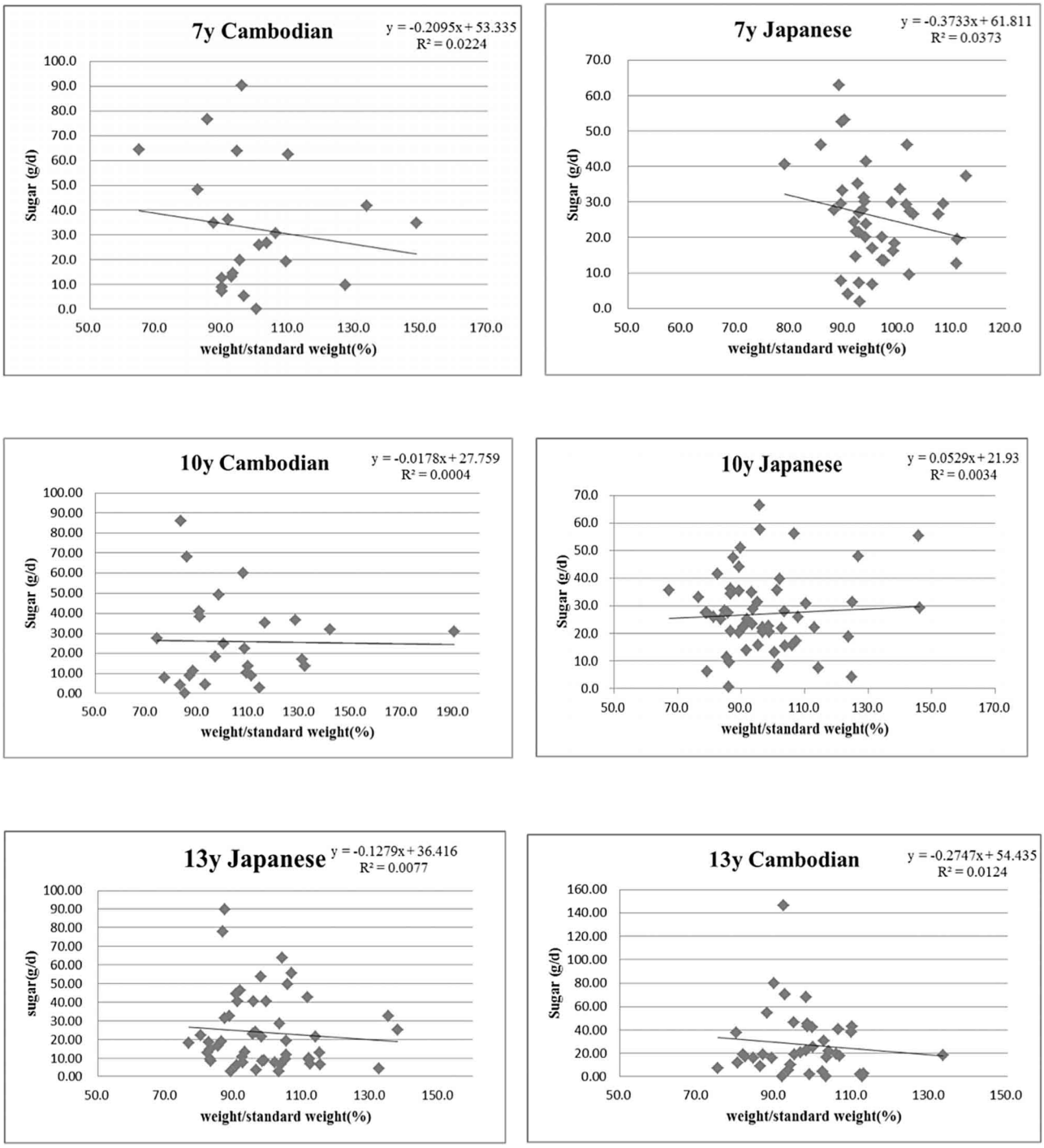

Fig. 2 Correlation between body weight and sugar intake was also assessed by Microsoft excel

DISCUSSION

We found in this study that Cambodian children take about 46% of sugar from glucose and fructose probably in the form of isomerized sugar, while Japanese children take 26%. ; however, the intakes in both countries met the WHO recommendation (3). Our present results were similar as our previous study in different Japanese children (9).

As the primary cause of high sugar intake, the tropical climate could be considered crucial. People drink more cold beverages in hot weather. However, our survey was done in summer, which in Japan is as hot as it is in Phnom Penh. Thus we can consider climate not to be the primary factor in higher consumption in Cambodia than in Japan.

School lunch may be a major cause of the big difference in sugar intake. Japanese schools do not install soft-drink vending machines and soft drinks are not available in schools. There is a nutrition teacher

or school dietitian basically in every school. From various information about the school lunch program in Japan, most children enjoy it and are satisfied. On the other hand, in Cambodia, there is neither a school lunch program nor school dietitians ; therefore, children become hungry at school and buy food for themselves. The most available and favorite energy source for children is fast food and beverages. In items of this sort, sugar and lipids are usually abundant and they are often called empty foods, meaning that they contain energy but few nutrients. Furthermore, an early and light breakfast which is typical in Cambodia makes children very hungry while they are in school.

Although the average energy intake from sugar was within the WHO recommendation level (3), the fact that about 50% of the intake was from isomerized sugar may lead to health problems. About half of isomerized sugar is fructose. Fructose does not require insulin, which is an advantage ; however, fructose easily becomes fatty acids, which may cause other problems (15-18). In any case, the nutritional behavior of Cambodian children may need to be changed. In Japanese schools, various types of nutrition related laws and regulations help to improve the school meal programs. The school meal law was established in 1954 (19), basically there is a licensed dietitian at each school and from 2007 they became a nutrition teacher by the new law and at present about half of them are the nutrition teachers (19). Basic Law of Nutrition Education was established in 2006 which supports the improvement of school lunch program (19). For example, school order the products to specific reliable food producers including farmers, fish men etc. Most of the school knows the producers and producers supply foods with the responsibility, by this system there are strong reliability between the school and food producers. If proper lunch is served at adequate time for children in schools in Cambodia like Japan, perhaps sugar intake could be reduced, especially sugars from soft-drinks and sweetened beverages. This could be confirmed on a small scale and if successful, a broader school meal program should be seriously considered.

In this study, we could not observe a relationship between sugar intake and body weight. Average BMI was also within the normal range. This also indicates that the energy balance was good. However, if a high percentage of energy intake is from isomerized sugar in commercial beverages, children may not form good dietary habits for their later life, since such habits are usually established in childhood.

There are some limitations to this study. First, there is the question of how much the present sample represents the larger communities. In both countries, studies in school children were quite difficult and many schools did not want to participate in the study. As a result, it is not a fully random sampling of the communities and the data may be biased. We need further studies.

In this study, we did not include sugars from whole fruits and fresh milk but only sugars from snacks and beverages, because this follows the definition by WHO (20). Fresh milk and fruits are usually rich in sugar ; however, if the definition is followed, sugar from them are not included in total sugar intake. In Western countries, people usually drink large quantities of milk, while in ASEAN countries people consume large amounts of fresh fruit. Sugars from these sources should be included in total intake. We did not include the meal sugar in the total intake. From the annual Japanese Nutrition Survey, sugar used in the meal is about 6 g/day (21). For a fair comparison, this should be included, too. However, even considering these sources, total sugar intake would not exceed 50 g a day for Cambodian and Japanese, which is within the WHO recommendation (3).

In conclusion, Cambodian children take about 50% of sugar from glucose and fructose, probably in the form of isomerized sugar, while Japanese children take 26% ; however, the intakes in both countries met the WHO recommendation.

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