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Sugar Intakes from Snacks and Beverages in Japanese Children

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Summary While sugar intake is an important factor for obesity, diabetes and dental caries, sugars are also important energy sources, especially for rapidly growing children. Children like sugar-rich sweet foods. However, intake for Japanese children is not known due to a lack of studies and sugar, composition data. This study was designed to determine sugar intakes from snacks and beverages in Japanese school children. A nutrition survey was conducted for 3 weekdays for 283 Japanese school children (7, 10 and 13 y old) in 8 prefectures from different areas of Japan. The methods for the survey were the weighing method for school lunches and the 24 h recall method for other foods. To estimate sugar intakes, the sugar composition table that was recently compiled by us for 135 beverages, cakes and other sweets was used. Height and weight were measured. They were similar to Japanese averages. Energy intakes were also similar to the results of the Japanese National Health and Nutrition Surveys. Sugar eaten outside meals was 24.7±15.5 g/d. From the National Health and Nutrition Surveys conducted in 2009, the mean sucrose intake from meals including some home-made cookies for 7–14-y-old children was 5.5 g/d, suggesting the mean total sugar intake of these children was about 30 g/d. This was within the range of FAO/WHO recommendation (less than 10% of energy intake, 49 g for these children. Mean intakes among age groups were not significantly different ($p>0.05$), but the intake for girls was lower than for boys in the oldest age group ($p<0.05$). Contributions of each sugar to total intake were sucrose 64%, fructose 14%, glucose 13% and lactose 9%. Fructose and glucose were mainly from isomerized sugar. Contributions of food groups to total intake were beverages 25%, baked goods 19% and ice cream 17%, respectively, covering 61% of all. In conclusion, we revealed that the average sugar intake of Japanese children was within the range of the FAO/WHO recommendation, though the effects of the kind of sugars on health remain to be clarified.

Key Words Japanese children, sucrose, fructose, glucose, lactose, energy

Major sugars are sucrose, glucose, fructose and lactose. They convert to glucose, which plays an important role as the brain's energy source. Sugars are tasty and pleasurable, especially for growing children. Such characteristics easily induce people to consume more sugars than necessary and they can become a major factor in obesity, diabetes and dental caries. Sugars are also an important energy source, especially for rapidly growing children. However, intakes for Japanese children are not known due to the lack of a sugar composition table other than one in which foreign data are used (*1*). Japanese traditional foods and their sugar concentrations are quite different from those in other countries. We therefore recognized the importance of a sugar composition table for Japanese food. We have measured concentrations of sugars (sucrose, glucose, fructose and lactose) in 135 sugar-rich foods (42 commercial beverages and chilled snacks, 29 home-made cookies, and 64 commercial cakes and cookies). More than 5 samples from different manufacturers and home recipes of each food were analyzed and the average values were calculated and published (*2*, *3*).

FAO/WHO recommend less than 10% of energy (about 50 g sugar), which is intended for the prevention of life-style related diseases and is used in 23 countries (*4*). Sheiham (5) recommends less than 40 g to prevent dental caries. The FAO/WHO definition of sugar is free sugar (sugars plus concentrated sugars in honey, syrups and fruit juices); the intrinsic sugars or milk sugars

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(lactose, galactose) are not included because they are not considered to have adverse health outcomes (*4*).

In this study we conducted a nutrition survey covering various areas of Japan and tried to estimate children's sugar intake.

METHODS

Subjects. The survey was conducted in about 350 children of 7, 10 and 13 y old in 8 prefectures from north to south in Japan. The final available number was for 283. We tried random sampling as much as possible in selecting areas, schools and classes so that the subjects would be close to representative for the country as a whole.

Survey. The nutrition survey was conducted for 3 weekdays. An investigation of height and weight was conducted before the commencement of the survey. Regarding the intake of school lunches, researchers measured the actual amount of each student's portion, while that of the other meals, including in-between snacks, was measured by the 24-h recall method with the cooperation of the students' guardians. In the case of incomplete items or unclear descriptions on the form, the researchers confirmed details directly with the students or asked their guardians to fill out the items.

Estimation of sugar and energy intakes. Calculations of energy intake were made in accordance with the data listed in "Standard Tables of Food Composition in Japan, 5 revised and enlarged ed" and the table of processed foods data (*6–8*). Sucrose, glucose, fructose and lactose intakes from foods other than meals were calculated by using the sugar composition table constructed by us previously (*2*, *3*).

Ethical considerations. This study was conducted with the approval of the Ethics Committee of Ochanomizu University, and 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. Analysis of the data was carried out with SPSS (version 17.0) statistical software. Data were assessed by one-way ANOVA and then Tukey's multiple comparison test and p values less than 0.05 were considered statistically significant. Correlation between body weight and sugar intake was assessed by Pearson's correlation coefficient test.

RESULTS

Table 1 shows the height, weight and energy intake of the children in this study. All values were similar between our subjects and the Japanese average (*9*), indicating that our subjects were similar to the country representative. Energy intakes were higher in boys than in girls in all the age groups and increased by age except for girls of 13 y old.

Table 2 shows sugar intakes. Sugar intakes in both sexes in all the age groups were similar except the low intake in 13-y-old girls. The average intake for all the children was 24.7±15.5 g/d.

Table 1. Characteristics of the subjects and energy intake.

Age (y)	Gender	*n*	Height (cm)	Weight (kg)	Energy/d (kcal)
7	boy	33	122.5±5.4[a]	23.6±3.7[a]	1,843±310[a]
	girl	42	120.9±5.2[a]	22.8±3.5[a]	1,668±238[a]
10	boy	64	139.8±6.1[b]	34.8±8.4[b]	2,081±385[b]
	girl	64	140.4±6.9[b]	32.6±6.1[b]	1,896±282[a]
13	boy	42	162.2±8.4[c]	52.5±11.5[c]	2,340±446[c]
	girl	38	156.2±5.3[d]	47.7±7.4[d]	1,871±287[a]

Values are mean±SD.
Figures with different superscript letters in the same column are significantly different as assessed by one-way ANOVA and then TukeyÅfs multiple comparison test ($p<0.05$).

Table 2. Sugar intakes of Japanese children (g/d).

Age (y)	Gender	*n*	Glucose (A)	Fructose (B)	Sucrose (C)	Lactose (D)	Total sugar (A+B+C+D)
7	boy	33	3.1±2.6[abc]	3.5±3.3[abc]	15.9±9.4	2.5±2.3	25.1±14.6[ab]
	girl	42	3.5±3.0[abc]	3.8±3.6[abc]	17.7±11.7	2.4±1.6	27.4±15.9[a]
10	boy	64	3.2±3.4[abc]	3.4±3.7[abc]	16.8±9.8	2.2±1.9	25.7±14.2[ab]
	girl	64	3.4±2.4[abc]	3.6±2.8[abc]	16.6±9.5	2.4±1.9	26.0±12.7[ab]
13	boy	42	4.0±4.2[b]	4.4±4.6[b]	14.6±12.7	2.1±3.1	25.0±20.7[ab]
	girl	38	2.0±2.4[c]	2.1±2.7[c]	12.0±11.2	1.4±1.7	17.5±14.3[b]
Average			3.2±3.1	3.5±3.5	15.8±10.7	2.2±2.1	24.7±15.5

Values are mean SD.
Figures with different superscript letters in the same column are significantly different as assessed by one-way ANOVA and then Tukey's multiple comparison test ($p<0.05$).

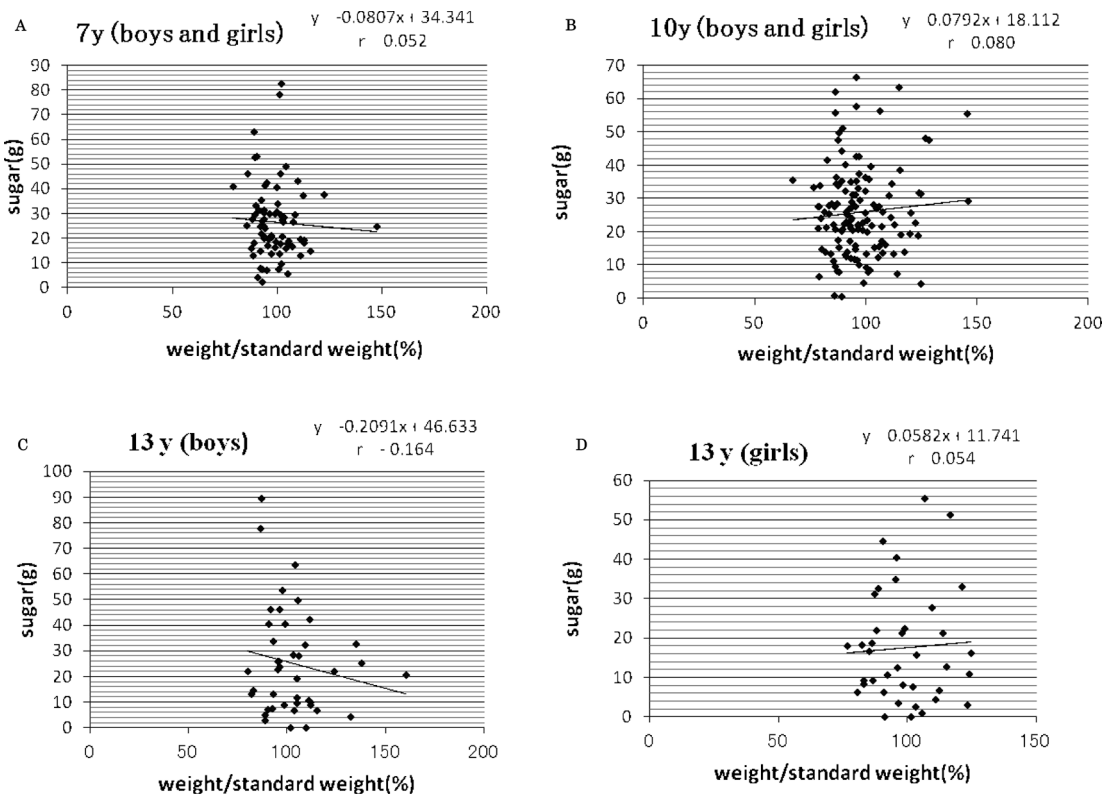

Fig. 1. Relationships between body weight and sugar intake for 7-(A) and 10-(B) y-old children and 13-y-old boys (C) and girls (D).

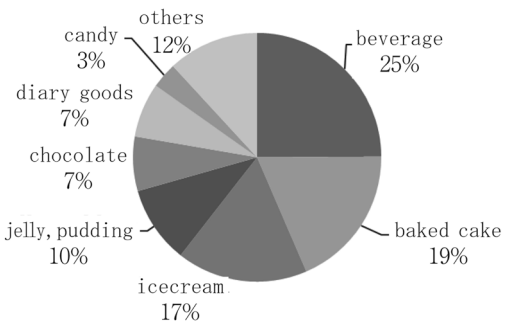

Fig. 2. Contributions of various food groups to total sugar intake.

As shown in Fig. 1, no significant relationship was observed between body weight and sugar intakes in 3 age groups. The data for 13-y-olds were separated into boys and girls because only in this age group the height, weight and sugar intake were different in the two genders. The standard weight was established from the health statistics of school children in 2000 (*10*).

Figure 2 shows the contribution of major foods to sugar intake. Sugars from beverages contributed about 25% and baked goods and ice cream each about 19% and 17%, respectively. These 3 items contributed about 61% of the sugar intake.

DISCUSSION

We found in this study that average sugar intake of Japanese children from snacks and beverages was about 25 g. To our knowledge, this is the first study to estimate sugar intake in Japanese children. The limitation of this study was that the sugar intake from meals could not be estimated, because for estimating sugar content of a meal, another study in which the amount of sugar used before cooking world have to be measured. However, in Japan, luckily the nationwide Health and Nutrition Survey has been conducted every year since 1946 and the amount of sugar used in meals and some homemade cakes were estimated, although sugar-rich snacks and beverages are shown only by weight but not by their sugar content. According to the most recent survey in 2009 (*9*), mean sugar intake from meals in children aged 7–14 y was reported to be 5.5 g/d. From the result of the present study and that of Japanese Health and Nutrition Survey, the sum of sugar intake was estimated as 30 g. However, the sugar from some homemade cakes is doubly calculated in both studies, suggesting the sugar intake may be less than 30 g/d.

The FAO/WHO recommendation of sugar intake is less than 10% of energy (*4*). In this study we also measured the energy intake. It was 1,960 kcal/d and 10% of it (196 kcal) was equivalent to 49 g of sugar. The standard deviation of sugar intake was about 15 g. Thus the mean sugar intake+1SD is about 45 g which is smaller than 49 g. When the distribution is normal, mean+1SD covers about 85% of the age population. Therefore, sugar intake for most of the Japanese children may be within a desirable level.

There are reports about sugar intake from various countries: American male children of 6–12 y old consume 124 g/d (*11*), English 84 g/d (*12*), Dutch 135 g/d

(*13*), South African 43 g/d (*14*) and Filipino 60 g/d (*15*). These data are much higher than our present result. Nutrition surveys often underestimate intakes (*16*). To prevent such problems, in this study we used the weighing method for school lunches and carefully checked other meals and foods. There are seasonal variations in the intakes; however, this study was conducted in summer and in this season sugar intake from beverages is thought to be usually higher than in other seasons because people drink more cold sweet beverages, which decreases the underestimation problem. To verify the reliability of the present nutrition survey, we compared the energy intakes in the present subjects with those reported by the National Health and Nutrition Survey (*9*). Energy intake was 1,960±388 kcal in our subjects and 1,936 kcal in the children reported in the nationwide nutrition survey (*9*). Both sets of data were similar.

Our present result is also supported by the FAO report on sugar intakes by countries estimated from each country's annual supply of sugar (*17*). From the reports, the sugar intakes per person (g/d) were 48.8 g for Japanese, 84.5 g for Americans, 139.4 g for Cubans, 138.6 g for Brazilians, 100.4 g for British, 96.2 g for Germans, 47.1 g for Koreans, 17.2 g for Chinese, 79.6 g for Thais, 31.7 g for Vietnamese, and 66.0 g for Filipinos.

The contribution of each sugar to the total sugar intake (about 24.7 g) in the present study was 64% for sucrose, 14% for fructose, 13% for glucose and 9% for lactose (Table 2). From the data shown in Fig. 2, sugar from beverages was 25% and the highest. These results indicate that fructose and glucose (total 27%) were mainly from beverages. From our finding, most of the beverages contain isomerized sugar, commonly called high-fructose corn syrup. It is produced by the hydrolysis of corn starch and other starches and is cheaper than sucrose. It is in soluble form and is usually used in beverages. The different physiological effecs of glucose and fructose are known. For example, fructose increases blood triglyceride concentration and causes obesity more than glucose (*18–21*). Therefore, we may have to determine what kind of sugar we are taking and the effects of them on health.

The lower sugar intake by 13-y-old girls was perhaps due to over-concerns about body weight.Å@In Japan most adolescent girls think that a slim body is beautiful. Such an image on the part of Japanese girls seems to be more serious than for girls in other countries (*22*).

In conclusion, the sugar intake of most Japanese children is supposed to be within the proper range.

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