Original

Factors in Low Prevalence of Child Obesity in Japan

Sayako Aoki[1,] Nobuko Sarukura[1,], Hitomi Takeichi[1,], Ayami Sano[1,],
Noriko Horita[2], Yuko Hisatomi[2], Kenji Kugino[2], Saiko Shikanai[1,]

[1,] *Asian Nutrition and Food Culture Research Cente, Niiza, Saitama, Japan*
[2] *Department of Health and Nutrition Science, Nishikyushu University, Saga, Japan*

ABSTRACT *Background and Objectives:* Sugars, as well as lipids, are tasty and likely to be consumed in excess. Since until recently there was no sugar composition table for Japan, therefore few reports about sugar intake has been existed. Lipid intakes in children are inconsistent. Since a dietary pattern of high sugar and high lipid intakes can become habitual and a factor for life-style-related diseases in adulthood, knowing the facts of dietary intakes of sugars and lipid is important. To determine the sugar and lipid intakes in children as factors in the low obesity prevalence in Japanese children. *Method:* A 3-day nutrition survey was conducted by the weighing and 24-hour recall method at a school in Tokyo, involving 58 children aged 8 and 10 years from average families. Sugars and lipid were calculated using the Japanese sugar composition and food composition tables. *Results and Conclusion:* Sugar and lipid intakes were not different among the ages and genders ($p<0.05$). Average sugar intake was 25.7 g/day was within World Health Organization recommendation (less than 10% of energy; about 45g) for more than 90% of the children and within the newly proposed World Health Organization guideline (less than 5% of energy intake; 22.4g) for almost 43% of them. Lipid and saturated fatty acid intakes were within normal levels for about 75% of the children. Sugar and lipid intakes were normal at a school in Tokyo. Low sugar and lipid intakes may be considered as factors for a low prevalence of obesity.
Key words: Sugar, lipid, obesity, school children, nutrition survey

INTRODUCTION

The principal sugars are sucrose, glucose, fructose, lactose, and maltose. For growing children, such sugars are particularly important as readily absorbed energy sources. However, sugar is tasty and can easily be consumed in excess. According to Japanese school statistics for 2012, the prevalence of obesity in school-age children was 4.1~10% which was relatively low among countries world-wide (1). Since excess sugar intake in childhood can become habitual and play a role in life-style related diseases in adulthood, a dietary habit of low sugar intake is important, especially in childhood. The World Health Organization (WHO) has recommended that sugar (excluding fruits and milk) intake should make up less than 10 % of total energy intake per day. This is based on the idea of chronic diseases prevention; 23 countries use this recommendation as a goal, and various countries use it as a guideline (2). WHO also further suggests that a reduction to below 5 % of total energy intake per day would have additional benefits, even though they have recommended sugar intake should stay at below 10 % of total energy intake a day (3). Until recently a sugar composition for Japan was not available and consequently there have been few reports on sugar intake by Japanese. Likewise, even the annual nation-wide health and nutrition surveys in Japan have not included sugar intakes (4).

In Japanese food composition tables, mono- and di-saccharides are included as carbohydrates and not shown as separate categories (5). The National Health and Nutrition Survey in Japan for 2010 showed a sugar intake of 5.3 g for children 7-10 years old, but this figure was for sugar used in cooking at home only. And for beverages and snacks, only weight was indicated (6). A standard individual bottle of a sweetened beverage contains approximately 50 g of various sugars. Intake of Sugar-Sweetened Beverages (SSBs) increased from 196 g per day in 2001 to 294 g per day in 2007 (7,8). Isomerized sugars are used in many SSBs. Isomerized sugar was developed in 1969 in Japan; it is produced enzymatically from starch to form glucose, part of which is converted to fructose (9). The ratio of the two sugars is approximately 1:1. The taste of isomerized sugar is high in sweetness but not long-lasting; in addition, it is cheaper than sweeteners obtained from other sources. For these reasons isomerized sugar is used in large quantities in beverages, ice cream and chilled snacks. One study regarding the sugar intake of Japanese

* To whom correspondence should be addressed: saiko_shikanai@yahoo.co.jp

children has been conducted by Takeichi et al (17). Its results showed that the sugar intake of Japanese school children was about 25g/d. This is quite low compared to other countries. Given this background, the aim of the current study is to investigate whether sugar intake is a factor for the low prevalence of obesity in elementary school students in metropolitan Tokyo.

According the Japan National Health and Nutrition Survey, in the ten years from 2001 to 2010, seafood consumption decreased from 94.0 g per day to 72.5 g, while meat consumption increased from 76.3 g to 82.5 g (10). Since 2008, consumption of meat has been greater than that of seafood. Since food habits originating in childhood can persist in later life stages, it is crucial to establish healthy habits in the early years. However, with regard to children's lipid intake, interpretations vary. Some maintain that lipid intake has increased because of the Westernizing of the diet, while others claim that it has not changed or has even decreased. However, the proportion of lipids to total energy intake is increasing because of a decrease in carbohydrate intakes (11, 12). Therefore, in addition to sugar intakes, a second purpose of this study was to investigate lipid intakes through a 3-day nutrition survey.

Although informative labeling is important in selecting food products, it is not legally required to list mono- and di-saccharides or fatty acids explicitly on food labels. Because of this, full nutrition information is still not readily available to consumers. It would be preferable to have better information on which mono- and di-saccharides and fatty acids we are consuming and in what quantities in order to assist nutrition professionals in formulating reliable advice. Therefore this study seeks to investigate intakes of sugars and fatty acids by children.

METHODS

Subjects

A nutrition survey was conducted in children of grade 2 (boys 17, girls 14) and grade 5 (boys 15, girl 12) in an elementary school in Tokyo.

Design

The 24-hour recall method on 3 days (2 weekdays and 1 weekend day) was used; however during weekdays, subjects were given school lunch, therefore the school lunch was studied by the weighing method. The subjects were given record forms for three days and all the meals (breakfast, lunch, dinner and snacks such as between meal and bed time snack) were recorded by students' guardians; in some cases, older students did this by themselves. The following day, in the case of incomplete items or unclear descriptions on the form, the investigators confirmed details with the students directly or asked their guardians to fill out the items. Regarding school lunch, their meals were weighed before and after eating by investigators. An investigation of height and weight was used from students' health check-up data.

Estimation of mono- and di-saccharide and lipid intake

Calculations of sucrose, glucose, fructose and lactose intakes from foods were done by using the sugar composition tables that were reported previously (13, 14).

Calculations for the lipid intakes were made in accordance with the data listed in "Standard Tables of Food Composition in Japan, 5 revised and enlarged Version" (5) and "Standard Tables of Lipid Composition in Japan, 5 revised and enlarged Version" (15).

Ethical consideration

These studies were conducted with the approval of the Ethics Committee in the Kagawa Nutrition University in accordance with the Declaration of Helsinki (1964) (revision Tokyo (1975), Venice (1983)): 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. A statement that participation in the research was by free will on the part of the participants was obtained from participants' parents and guardians; explanations were provided 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 Excel Statistics. 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.

RESULTS

Sugar Intake

Table 1 shows that the energy proportion of Protein, Fat and Carbohydrate intake and their percentage against energy (PFC ratio). Total energy were 1596 kcal, 1689 kcal, and PFC ratios were15:30:54, 16:30:53 for the second grade boys and girls respectively, 2050 kcal, 1869 kcal, and PFC ratios were 16:29:53, 15:28:55 for the fifth grade boys and girls respectively. The mean for all was 1792 kcal, and the PFC ratio was16:29:54. Ratios of protein, lipid and carbohydrate against energy intakes (%) in the second grade were 15.8, 29.6, 53.5 and in the fifth grade, 15.6, 29.1, 53.9 %. There was no significant difference among genders and grades ($p>0.05$).

Table 2 shows intakes of sugars (glucose, sucrose, fructose, lactose and the total) by grade. Total sugar intake by grade was 25.9 ± 13.7g (boys 26.8 ± 17.7g, girls 25.1 ± 6.9g) for the second grade, and 25.4 ± 12.9g (boys 27.3 ± 13.9g, girls 23.1 ± 11.8g) for the fifth grade. There were no significant difference among the 4 groups (grade and gender) and total sugar intake of all the children was 25.7 ± 13.2g.

Table 1. Energy and major nutrient intakes

Grade	Gender	Energy (kcal)	Protein (%energy)	Lipid (%energy)	Carbohydrate (%energy)
2	Boy (n=17)	1596±183	15.3±1.4	29.6±3.7	53.8±4.1
	Girl (n=14)	1689±180	16.3±1.4	29.6±2.9	53.1±4.2
	Mean		15.8±1.4	29.6±3.3	53.5±4.1
5	Boy (n=15)	2050±244	15.9±1.5	29.9±3.7	52.9±3.5
	Girl (n=12)	1869±214	15.4±1.5	28.3±2.1	54.9±3.4
	Mean		15.6±1.5	29.1±3.1	53.9±3.5
	All (n=58)	1792±270	15.8±1.5	29.2±3.2	53.8±3.8

Mean±SD, No significant deference was observed among boys and girls in the second and fifth grade children by Turkey (p>0.05).

Table 2. Intake of mono- and di-saccharides

Grade	Gender	Glucose (g)	Sucrose (g)	Fructose (g)	Lactose (g)	Total (g)
2	Boy (n=17)	3.4±4.3	17.5±11.2	3.2±4.0	2.7±3.0	26.8±17.7
	Girl (n=14)	2.6±1.6	17.4±4.2	2.7±1.6	2.4±1.6	25.1±6.9
5	Boy (n=15)	2.9±2.6	19.2±10.5	3.2±3.0	2.0±1.7	27.3±13.9
	Girl (n=12)	2.6±2.8	15.3±8.5	3.0±3.4	2.2±2.2	23.1±11.8
	All (n=58)	2.9±3.0	17.4±9.0	3.0±3.1	2.3±2.2	25.7 ± 13.2

Mean±SD, No statistical differences in 4 subject groups and total sugars were observed among the 4 subject groups by Turkey (p>0.05)

Figure 1 shows that the proportion of mono- and di-saccharide intake for all subjects. Sucrose was 67.8 %, fructose was 11.9 %, glucose was 11.3 %, and lactose was 9.0 %; therefore sucrose was the highest.

Figure 2 shows contributions of 8 food groups to total sugars intake (except sugars for cooking) per day in both the second grade and the fifth grade. The food group contributing the most was dairy snacks such as yoghurt and lactated drinks. The second food group was SSBs such as carbonated drinks and soft drinks. The third food group was baked snacks. In addition from these results sucrose that was using for cooking was 5.9 ±2.6g. Mean sucrose using for cooking by grade was 5.4 ± 2.6g (boys 4.5 ± 1.5g, girls 6.1 ± 2.5g) for the second grade, and 6.6±2.5g (boys 6.8±2.9g, girls 5.8±1.8g) for the fifth grade.

The degree of obesity which is used as a Japanese standard was calculated using the following equation following equation.

Degree of obesity (%) = (Actual measured weight (kg) – Weight for height standards (kg)*) / Weight for height standards (kg)*×100.

*weight for height standards (kg) ＝a × Actual measured weight (kg) －b, “a” is 0.513, 0.508 in 7 year olds, 0.752, 0.730 in 10 year old boys and girls respectively. “b” is 38.878, 38.867 in 7 years old, 70.461, 68.091 in 10 years [no –s] old boys and girls respectively (16).

In addition, the correlation between mono- and di-saccharide intake and body weight was calculated (Fig.3). We could not observe any relationship between sugar intake and body weight.

Lipid intake

The lipid intake of a day (mean ± SD) was 53.6±9.9g (boys 52.0 ± 9.1g, girls 55.6 ± 9.6g） in the second grade, and 65.6 ± 12.1g (boys 71.0 ± 13.0g, girls 58.8 ± 5.0g) in the fifth grade. There was no significant difference among genders and grades (p>0.05). Mean saturated fatty acid intake of total energy a day was 9.8 ± 1.6 %, 9.6 ± 2.0 %, in the second grade and fifth grade, respectively (Table 3).

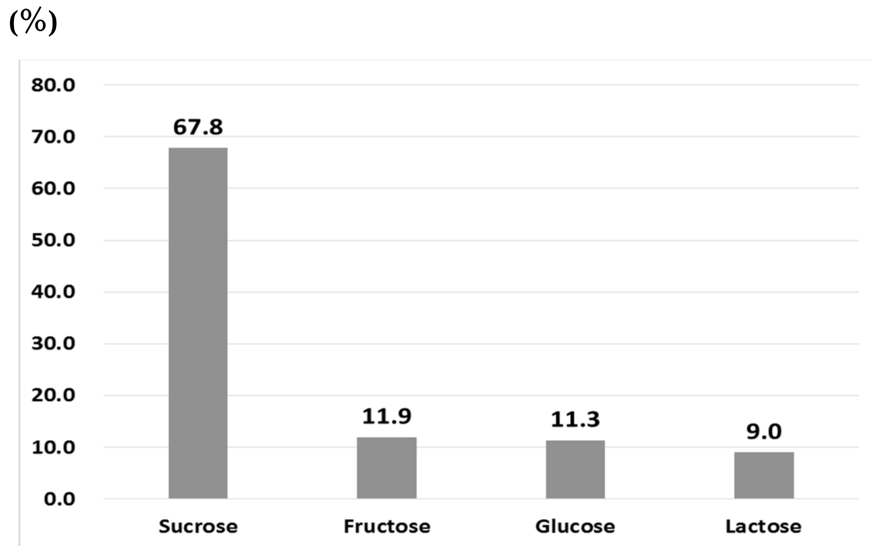

Figure 1. The proportion of mono- and di-saccharide intake for all subjects.

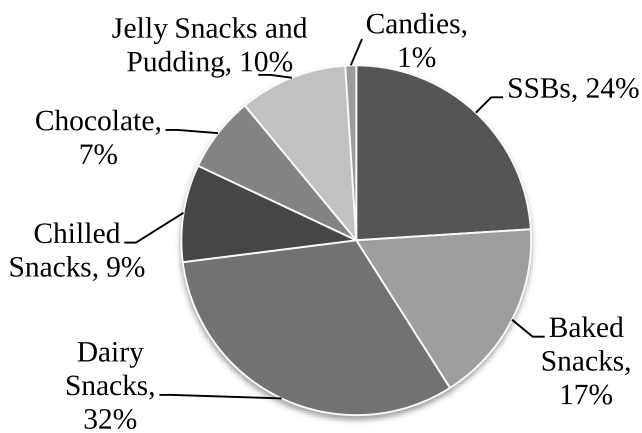

Figure 2. Contribution of various food groups on sugar intake

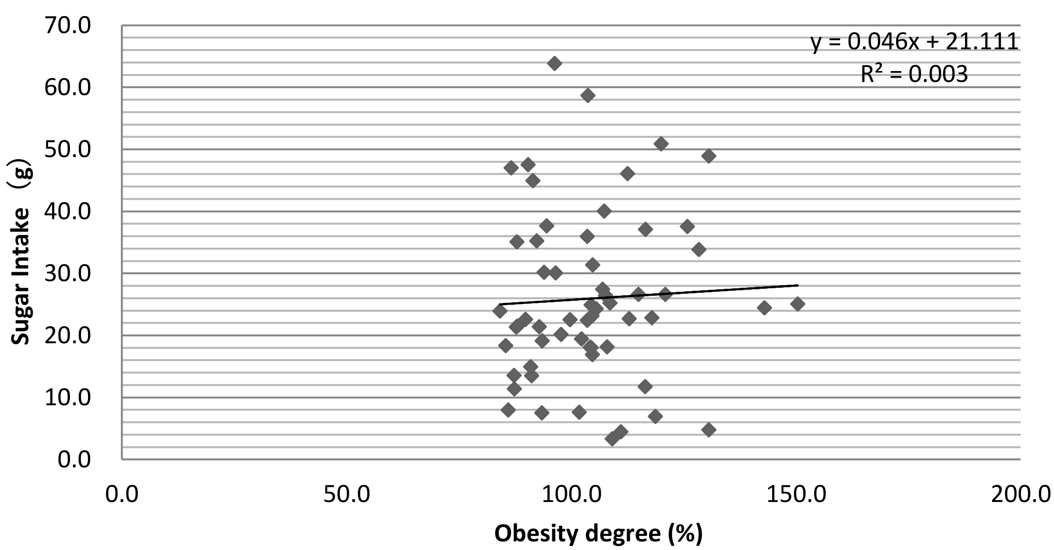

Figure 3. Correlation between body weight and sugar intake

Table 3. Lipid intake (g/d)

Grade	Gender (n)	Lipid (g)	Saturated fatty acid (g)	Mono-Unsaturated fatty acid (g)	n-3 Polyunsaturated fatty acid (g)	n-6 Polyunsaturated fatty acid (g)
2	Boy N=17	52.0±9.8	10.0±1.8	16.8±3.5	1.3±0.4	7.1±0.9
	Girl N=14	55.6±9.6	9.7±1.3	18.7±3.2	1.6±0.4	9.2±2.0
	Mean	53.6±9.9	9.8±1.6	17.2±4.6	1.6±1.0	8.1±1.8
5	Boy N=16	71.0±13.0	10.0±2.1	22.7±4.4	1.8±0.6	10.0±1.7
	Girl N=12	58.5±5.0	9.1±1.9	19.6±2.2	1.8±0.5	10.0±2.1
	Mean	65.6±12.1	9.6±2.0	21.3±3.9	1.8±0.5	10.0±1.9
	All (n=59)	59.2±12.4	9.7±1.8	19.1±4.7	1.7±0.8	9.0±2.1

Mean±SD, No statistical differences in 5 and total lipid intake were observed among the 4 subjects groups by Turkey (p>0.05)

DISCUSSION

We conducted a 3-day nutrition survey in second and fifth grade students at a school in Tokyo and found that sugar and lipid intakes were low compared to those of other countries. The average daily intakes of mono- and di-saccharides by the second grade and the fifth grade children showed no statistical differences; the combined average was 25.7 ± 13.2 g, including sugar used in cooking (5.9 g). WHO recommends that sugars (excluding fruits and milk) intake should make up less than 10 % of total energy intake per day (2). WHO also further suggests that a reduction to below 5 % of total energy intake (3). In the current study, the energy intake of the second grade boys was 1683 ± 361 kcal, for girls 1686 ± 173 kcal, for the fifth grade boys it was 2050 ± 235 kcal and for girls 1869 ± 205 kcal. Ten percent of energy for second grade children was about 169 kcal, which was equivalent to 42 g of sugar; for fifth grade students it was about 197 kcal, which was 49 g of sugar.

Sugar intake of second grade children was 25.9±13.7 g, with the result that mean + 1 SD was 39.6 g and mean + 2SD was 53.3 g. Mean + 1SD covers 84 percent of subjects, while mean+2SD covers 97.5 percent. Ten percent of energy would be equivalent to 42 g of sugar for 2nd grade children and to 49 g for 5th grade children, which falls between 1SD and 2SD. Therefore, about 90 % of subjects were within the range of the WHO recommendation (10% of total energy). The results of the current study were similar to those of the study done in Japanese Children by Takeichi et al (17). Furthermore, sugar intake of 5% of total energy intake would be 22.4g in the case of the current study. Almost 43% of the children were within this WHO new recommendation. Sugar intakes of Japanese children might be one of the lowest among children in the developed world; even given that, fewer than half of these children would be within 5%. In reality, it would be difficult for other countries to meet the new WHO guideline/recommendation.

Sugar intakes in some other countries are: The U.K 85 g (18), Holland135 g (19), and the US 142g (20). Compared to these data, the sugar intake of Japanese children was low.

According to the National Health and Nutrition Examination Survey (NHANES) in the U.S.2005-2008, energy intake from SSBs for 6- to 11-year old children was 125kcal (boys:141 kcal, girls:112 kcal)(21). This mean that sugar intake from SSBs was approximately 30 g in the U.S. To compare to the results of the current survey, sugar intake from SSBs in Japan was 4.9 g for students in grade 2, 5.2 g for students in grade 5. The result of a previous study (Takeich et al (16)) was also 6.7g of sugar in the form of SSBs.

In the current study, fructose intake was 11.9 % of the sugar intake, while glucose was 11.3 %, and the proportion of intakes for both sugars was almost the same, which suggests that these sugars came from isomerized sugar. Isomerized sugar, called high-fructose corn syrup (HFCS) in the U.S., is made from starch and contains roughly equal amount of glucose and fructose. According to Putnam et al (22), use of HFCS went from 0.5 pound per person in 1970 to 62.4 pounds in 1997. In the same year, beverages accounted for 72 percent of total HFCS deliveries for domestic food and beverage use, compared with 36 percent in 1980. The portion of HFCS in the caloric sweetener market in the 1980s was rapidly growing. Commercial products such as SSBs and chilled/frozen snacks use mainly HFCS rather than ordinary sugar because HFCS is cheaper and its taste is more suitable for them. As a result of that, one quarter of the calories available from the 1994 per capita food supply came from sugars (22).

It has been said that mono- and di-saccharide, such as HFCS, intake leads to obesity (23); however the result in the current study did not show such a tendency, nor did the other surveys was there only one other or more in Japan (17). Therefore, childhood obesity in Japan is not caused mainly by sugar intake but the data suggest that other factors may be involved.

Some articles in The Washington Post discussed the Japanese school lunch and commented that the Japanese school lunch helped slow the rise of childhood obesity (26, 27). This is a unique point of view. Actually, it is obvious that sugar intake in Japan has been significantly lower than in the countries such as the U.S. However, in the current study, there are some limitations that we have to mention. Especially when we discuss beverages, we first of all have to consider the season/climate. There is the possibility that the reason for decreased intake of drinks was caused by the weather; in November, when the survey was conducted, the weather typically becomes cooler in Japan. We need further research in different seasons. The second point is the school environment: in the U.S, vending machines are available in most of schools, thus children can have soft drinks anytime they want (21). On the other hand, Japanese public elementary schools do not allow access to any vending machines; in addition, the most public school children are not allowed to bring money when they go to school. They have no chance to have beverages or other snacks, at least until they go home. Therefore to compare Japanese to U.S. children, it seems that U.S. children have easier access to SSBs and other snacks.

Regarding lipid intake, the mean lipid intake as energetic ratio (%) was 29.2 ± 3.2 % a day. While mean lipid intake as energetic ratio (%) is 29.2 ± 3.2%, the value from SD to +1 SD is 32.4 %, to +2 SD is 35.6 %, DRI for lipid is from 20 to 30 %。 From these results, it seems that almost 65 % of [the children took their lipid within the recommendation.

While the mean saturated fatty acid intake as energetic ratio (%) is 9.7 ± 1.8%, the value from SD to +1 SD is 11.5 %, to +2SD is 13.3 %. There is no recommended value for saturated fatty acids in the guidelines in Japan; however in the U.S. it is recommended that should be less than 10 % of total energy intake (24). From these results, almost half of the children consumed lipids within the recommended values.

With regard to such low lipid and sugar intakes, we would like to mention school lunch. As an article of The Washington Post (25, 26) stated, school lunch in Japan may be unique and is definitely unusual for Westerners. In Japan, most of public schools have a school nutrition teacher/dietitian (12,036 school dietitians for whole country) and lunch is provided at 99.3% of elementary schools and 79.3% of junior high schools (27). The school nutrition teacher/dietitian are not only manages the school lunch to provide an interesting menu with the best balance of nutrients and adequate energy, but also learning food culture etc. Therefore meals are often termed useable nutrition education materials, as we discussed above with regard to the environmental differences between the US and Japan, Japanese children have fewer opportunities to have SSBs and empty foods such as high lipid and sugar-containing snacks.

Dietary habits formed in childhood can become permanent and play a role in adulthood. Therefore, a school lunch that provides one third of daily energy and nutrients for school age children is important, and it may help to form children's habits. This may help maintain a/the low rate of obesity in Japan. Low sugar and lipid intake from food with daily habit as a daily habit may be considered as a factor of in the low prevalence of obesity among Japanese school-age children. Hence, school lunch may play a role in particular in controlling the intake of sugar and lipids. However to support this hypothesis, further study is necessary.

In conclusion, sugar and lipid intakes were normal for more than 90 % and 75% of children, respectively, at a school in Tokyo. It is also supported the low prevalence of obesity in Japanese children.

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