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Changes in the intake of dietary fibre derived from rice among Japanese people based on the National Health and Nutrition Survey during 2018-2019

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Abstract

Dietary fibre intake among Japanese people in the National Health and Nutrition Survey in Japan has been almost flat for the past 20 years but has increased remarkably in 2019. Thus far, no study has reported the reason for this increase. Therefore, we conducted a study focusing on dietary fibre derived from rice, the intake of which increased significantly in 2019, and performed a comparison of the intake between the 2018 and 2019 data. We used data of nutrient intake by food groups over the past 20 years that were reported in the 2018 and 2019 national health and nutrition surveys. Until 2018, dietary fibre intake was estimated using the modified Prosky method, and in 2019, dietary fibre intake was estimated using the modified Prosky method and the AOAC 2011.25 method. The proportion of increase in total dietary fibre intake to increase in rice-derived dietary fibre intake was 86.8%, which could explain the change in dietary fibre intake from 2018 to 2019. When dietary fibre intake was estimated using the same method as that used in 2018, the change in dietary fibre derived from rice was -0.1 g, and almost no change was observed. The increase in dietary fibre intake from 2018 to 2019 was not an increase in actual dietary fibre intake, but an apparent increase due to the revision of the Standard Tables of Food Composition in Japan used to estimate dietary fibre intake.

Introduction

A wide range of non-chronic diseases have been examined for their association with dietary fibre intake. Several studies have shown that dietary fibre intake is significantly inversely associated with the development of and death from myocardial infarction [1,2]: development of stroke [3,4]: development of and death from cardiovascular disease [2,5]: development of diabetes [5,6]: and development of breast and gastric cancers [7,8].

The compositional formula of carbohydrate is C_n $(H_2O)_n$. Carbohydrates can be monosaccharides or polymers: monosaccharides are the minimum constituent unit. They are classified according to their chemical: physical: and physiological characteristics. When classified according to the degree of polymerization: which is a chemical characteristic: carbohydrates are divided into saccharides (1 degree or 2 degrees of polymerization): oligosaccharides (3–9 degrees of polymerization): and polysaccharides (10 or more degrees of polymerization). Saccharides are further divided into monosaccharides and disaccharides. Monosaccharides include glucose: fructose: and galactose: and disaccharides include sucrose: lactose: and maltose. Oligosaccharides are divided into maltooligosaccharides (alpha-glucan): and oligosaccharides containing monosaccharides other than glucose. Polysaccharides are divided into starch and non-starch polysaccharides. The former consists of amylose and amylopectin: while the latter includes cellulose: hemicellulose: and pectin. In terms of physiological classification, carbohydrates are classified into carbohydrates that can be digested by human digestive enzymes: and carbohydrates that cannot be digested. However, dietary fibre is classified based on emphasis of physiological characteristics: and the definition of dietary fibre is slightly different between organisations [9]. For example, the Dietary Reference Intakes for Japanese 2020 defines indigestible carbohydrates as dietary fibre: and oligosaccharides with polymerisation of 3-9: such as maltodextrin: are not categorized as dietary fibre [10].

Until 2017: the value of dietary fibre in the Standard Tables of Food Composition in Japan (STFC-J) was measured using the modified Prosky method [11], but from STFCT-J 2015 (supplementary edition 2018): the dietary fibre in some foods has been measured using the AOAC 2011.25 method [12]. The AOAC 2011.25 method is characterised by the ability to measure small-molecule soluble dietary fibre that cannot be measured using the modified Prosky method: and the inclusion of resistant starch: which is partially measured as insoluble dietary fibre using the modified Prosky method. The small-molecule water-soluble dietary fibre: including soybean oligosaccharide: fructooligosaccharide: and galactooligosaccharide: newly measured using the AOAC 2011.25 method is an indigestible oligosaccharide. Japanese people consumed dietary fibre form cereal, especially rice. Among a dietary intake content of 1.5 g/100 g of polished rice measured using the AOAC 2011.25 method: 0.9 g is occupied by small-molecule water-soluble dietary fibre: but its function has not yet been clarified [12].

The STFC-J was used to estimate nutrient intake in the National Health and Nutrition Survey in Japan (NHNS-J). The dietary fibre

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intake of Japanese people aged ≥20 years has fluctuated from 14 to 15 g/day over the past 20 years [13]. When dietary fibre intake was estimated using the STFC-J 2015 (supplementary edition 2018) in 2019 for the first time: the daily dietary fibre intake increased by 3.8 g from the previous year to 18.8 g [14]. This increase may be largely due to changes in the STFC-J: which is used to estimate dietary fibre intake: however, thus far: no study has reported the reason for the increase. Therefore, we conducted this study to clarify the reason for the increase. We focused on dietary fibre derived from rice and explored changes in dietary fibre intake from NHNS-J 2018 to NHNS-J 2019 by comparing both years. The purpose of this study was to compare dietary fibre intakes of NHNS-J 2019 using STFC-J 2015 (supplementary edition 2018) and STFC-J 2015 (supplementary edition 2017). We hypothesized the change in dietary fibre intake was mainly due to the revision of analytical methods used to estimate dietary fibre intake in SFFC-J.

Materials and methods

Change in dietary fibre intake from 2018 to 2019

We used the results of food group intake for people aged ≥20 years in the NHNS-J 2018 and the NHNS-J 2019 [13,14]. First: for each food group: we calculated the percentage of the contribution to the increase in dietary fibre intake from 2019 to 2018 as follows: $(X_{i;\,2019} - X_{i;\,2018}) / (Y_{2019} - Y_{2018}) \times 100$: where $X_{i;\,2019}$ is the intake of dietary fibre derived from food group *i* in 2019: $X_{i;\,2018}$ is the intake of dietary fibre derived from food group *i* in 2018: Y_{2019} is the total dietary fibre intake in 2019: and Y_{2018} is the total dietary fibre intake in 2018.

Estimate of rice intake

The nutrient intake recorded in the NHNS-J was calculated using the STFC-J [13,14]. Therefore, if the number of foods in a food group is less than the calculated nutrient intake from the food group: then the individual intake of foods that form the food group can be mathematically estimated by solving the simultaneous equations. However, rice shown in the NHNS-J is present in 25 types of food: and the intake of 20 nutrients is derived from rice [13,14]. Therefore, we could not estimate the individual food groups that included rice. However, among the foods that included rice: brown rice and polished rice are the most consumed [15]: therefore: we decided to use brown rice (food number 01085) and polished rice (food number 01088) as foods that included rice.

Calculation of dietary fibre from rice

In the STFC-J 2015 (supplementary edition 2018): the dietary fibre content in brown rice has not yet been analysed for dietary fibre using the AOAC 2011.25 method: and the value analysed using the modified Prosky method is shown. The dietary fibre content in polished rice was analysed using the AOAC 2011.25 method. Therefore, we calculated the two values of dietary fibre content in polished rice. That is: we calculated the dietary fibre content in polished rice using the AOAC 2011.25 method shown in SFTC-J 2015 (supplementary edition 2018) [11] and using the Prosky method shown in SFTC-J 2015 (supplementary edition 2017) [12].

Results

Table 1 shows the dietary fibre intake by food group for people aged ≥20 years and in the NHNS-J in 2018 and NHNS-J in 2019. From 2018 to 2019: dietary fibre intake increased by 3.8 g: and rice contributed to 86.8% of the increase. The increase in the contribution rate of other foods was less than 10%. Rice contributed the most to dietary fibre intake.

When we approximated the foods that included rice from NHNS-J 2018 using two foods (brown rice and polished rice): we observed minimal differences between the actual nutrient intake derived from the rice-derived nutrient intake shown in NHNS-J 2018 and the calculated nutrient intake (Table 2). Similarly, we could approximate foods that included rice shown in NHNS-J 2019 using the two foods.

According to the results of the NHNS-J 2019: we could estimate that the intake of polished rice by participants aged ≥20 years was 290 g/day. The dietary fibre content in polished rice as measured using the modified Prosky method was 0.3 g/100 g. Therefore, if the dietary fibre intake in the NHNS-J 2019 is estimated using the dietary fibre intake measured in the same way as that measured in the NHNS-J 2018: then the intake of dietary fibre derived from polished rice was 0.9 g/day. Additionally, the intake of dietary fibre derived from brown rice was 0.0 g/day. Therefore, it can be estimated that the dietary fibre intake derived from rice was 0.9 g/day. This value is almost the same as the dietary fibre intake from rice: as shown in the National Health and Nutrition Survey in Japan in 2018.

Discussion

In the present study, we estimated the dietary fibre content in polished rice using the value obtained using the Prosky method, which used NHNS-J 2018. There was minimal difference in the dietary fibre intake between NHNS-J 2019 and NHNS-J 2018. Therefore, the increase in dietary fibre intake shown from NHNS-J 2019 to NHNS-J 2018 may not be an actual increase in dietary fibre intake: rather: it was an apparent increase due to the revision of analytical methods used to estimate dietary fibre intake in STFC-J.

The number of foods measured using the AOAC 2011.25 method has increased since the STFC-J 2015 (supplementary edition 2018) was released: but the latest STFC-J lists 60 foods as of 2020 [16]. However, brown rice is not listed among the 60 foods. As a method for estimating the dietary fibre content in brown rice measured using the AOAC 2011.25 method: a method for substituting the component values of black rice and red rice: whose values are already measured using the AOAC 2011.25 method: has been proposed [17]. However, in the future, the dietary fibre content in brown rice can be shown as a value measured using the AOAC 2011.25 method because Japanese people rank second in terms of brown rice consumption.

The Dietary Reference Intake for Japanese 2020 indicates that it is ideal for adults to consume at least 24 g of dietary fibre every day: based on a review of the Dietary Reference Intakes in the United States and Canada [18]. However, in consideration of feasibility, the tentative dietary goal for preventing lifestyle-related diseases (DG) for Japanese people is set as an intermediate value of the ideal value and the median dietary fibre intake: based on the results of the NHNS-J in the Dietary Reference Intakes for Japanese 2020 [10]. These values are based on the dietary fibre data measured using the modified Prosky method. Therefore, to compare these data with the DG: the dietary fibre intake data of the NHNS-J should show the dietary fibre intake measured not only using the AOAC 2011.25 method but also using the modified Prosky method.

Limitations

This study had some limitations. First, the intake of foods that included rice was estimated. Moreover, because we were able to obtain

Table 1. Food group intake of participants aged ≥20 years: NHNS-J.

	NHNS-J 2018			NHNS-J 2019			Δ^1, g/day	Δ^2, %
	Weight, g/day	Energy, kcal/day	Dietary fibre, g/day	Weight, g/day	Energy, kcal/day	Dietary fibre, g/day		
Total	2070	1930	15.0	2039	1915	18.8	3.8	-
Cereals	419	758	3.1	411	739	6.5	3.4	89.5
Rice and its products	309	519	1.0	298	499	4.3	3.3	86.8
Rice	304	510	1.0	293	490	4.3	3.3	86.8
Rice products	5	9	0.0	4	9	0.0	0.0	0.0
Wheat and its products	100	221	1.8	103	224	1.9	0.1	2.6
Flour	4	13	0.1	4	13	0.1	0.0	0.0
Bread	34	92	0.8	35	96	0.8	0.0	0.0
Sweat bread	5	15	0.1	5	16	0.1	0.0	0.0
Udon and Chinese noodles	37	48	0.4	38	50	0.4	0.0	0.0
Instant Chinese noodles	5	21	0.1	5	21	0.1	0.0	0.0
Pasta	11	18	0.2	10	17	0.3	0.1	2.6
Other wheat products	6	15	0.1	6	12	0.1	0.0	0.0
Other cereals and its products	10	19	0.3	10	16	0.3	0.0	0.0
Buckwheat and its products	6	8	0.1	6	8	0.1	0.0	0.0
Corn and its products	1	5	0.0	1	3	0.0	0.0	0.0
Other cereal and its products	3	6	0.2	3	5	0.1	-0.1	-2.6
Potatoes and starches	51	38	1.0	50	37	1.4	0.4	10.5
Potatoes and their products	48	33	1.0	47	32	1.3	0.3	7.9
Sweet potato	7	10	0.2	6	9	0.2	0.0	0.0
Potato	24	18	0.4	22	16	0.7	0.3	7.9
Other potatoes	18	5	0.4	19	7	0.4	0.0	0.0
Starches	3	5	0.0	3	5	0.0	0.0	0.0
Sugars and sweeteners	7	25	0.0	7	24	0.0	0.0	0.0
Pulses	66	76	1.2	65	75	1.4	0.2	5.3
Soybeans and its products	65	73	1.1	63	72	1.2	0.1	2.6
Soybean (whole grains)	2	4	0.1	2	4	0.2	0.1	2.6
Tofu	37	25	0.1	35	26	0.3	0.2	5.3
Fried tofu	7	18	0.1	7	18	0.1	0.0	0.0
Natto	10	20	0.7	10	19	0.6	-0.1	-2.6
Other soybean products	9	6	0.1	10	6	0.1	0.0	0.0
Other beans and their products	2	3	0.1	2	3	0.1	0.0	0.0
Seeds and nuts	3	14	0.2	3	15	0.3	0.1	2.6
Vegetables	281	71	5.4	281	71	5.4	0.0	0.0
Green and yellow vegetables	87	25	2.2	85	26	2.1	-0.1	-2.6
Tomato	17	4	0.2	17	4	0.2	0.0	0.0
Carrot	18	6	0.4	19	6	0.5	0.1	2.6
Spinach	12	2	0.3	9	2	0.2	-0.1	-2.6
Green pepper	4	1	0.1	5	1	0.1	0.0	0.0
Other green and yellow vegetables	36	13	1.1	34	13	1.1	0.0	0.0
Other vegetables	170	37	2.9	173	38	3.0	0.1	2.6
Cabbage	29	6	0.5	33	7	0.6	0.1	2.6
Cucumber	9	1	0.1	9	1	0.1	0.0	0.0
Radish	29	5	0.5	27	5	0.5	0.0	0.0
Onion	33	10	0.5	32	9	0.5	0.0	0.0
Chinese cabbage	24	2	0.2	24	2	0.2	0.0	0.0
Other vegetables	46	13	1.0	48	14	1.1	0.1	2.6
Vegetable juice	14	4	0.1	13	3	0.1	0.0	0.0
Pickles	10	4	0.3	9	4	0.2	-0.1	-2.6
Pickled leaves	4	1	0.1	3	1	0.1	0.0	0.0
Pickled radish and other pickles	7	3	0.2	6	3	0.2	0.0	0.0
Fruits	101	64	1.4	100	65	1.4	0.0	0.0
Fresh fruits	92	58	1.3	92	59	1.3	0.0	0.0
Strawberry	0	0	0.0	0	0	0.0	0.0	0.0
Citrus	22	10	0.2	20	9	0.2	0.0	0.0
Banana	16	14	0.2	17	15	0.2	0.0	0.0
Apple	19	11	0.3	19	11	0.3	0.0	0.0
Other fresh fruits	35	23	0.7	36	24	0.7	0.0	0.0

Jam	1	3	0.0	1	3	0.0	0.0	0.0
Fruit juice	7	3	0.0	7	3	0.0	0.0	0.0
Mushrooms	17	3	0.7	18	3	0.7	0.0	0.0
Algae	9	3	0.6	11	3	0.5	-0.1	-2.6
Confectionaries	25	85	0.4	24	84	0.4	0.0	0.0
Japanese confectionaries	11	34	0.2	11	32	0.2	0.0	0.0
Cakes and pastry	6	21	0.1	6	21	0.0	-0.1	-2.6
Biscuit	2	8	0.0	2	9	0.0	0.0	0.0
Candy	0	1	0.0	0	1	0.0	0.0	0.0
Other confectionaries	6	21	0.1	6	21	0.1	0.0	0.0
Beverages	690	91	0.1	674	92	0.1	0.0	0.0
Alcohol beverages	122	67	0.0	127	69	0.0	0.0	0.0
Japanese sake	8	9	0.0	8	9	0.0	0.0	0.0
Bear	71	30	0.0	76	33	0.0	0.0	0.0
Western liquor	43	28	0.0	42	27	0.0	0.0	0.0
Non-alcohol beverages	568	23	0.1	547	23	0.1	0.0	0.0
Tea	276	4	0.0	262	4	0.0	0.0	0.0
Coffee and cocoa	164	10	0.0	164	10	0.0	0.0	0.0
Other non-alcohol beverages	128	9	0.1	121	10	0.0	-0.1	-2.6
Seasoning and spices	63	114	0.8	65	113	0.8	0.0	0.0
Seasoning	63	112	0.8	65	112	0.8	0.0	0.0
Sauce	2	2	0.0	2	2	0.0	0.0	0.0
Soy sauce	13	9	0.0	12	9	0.0	0.0	0.0
Salt	1	0	0.0	1	0	0.0	0.0	0.0
Mayonnaise	4	24	0.0	4	23	0.0	0.0	0.0
Soy paste	11	20	0.5	10	20	0.5	0.0	0.0
Other seasoning	33	57	0.2	36	58	0.3	0.1	2.6
Spices	1	1	0.0	1	1	0.0	0.0	0.0

NHNS-J: National Health and Nutrition Survey, Japan

Δ^1: Difference between the intake recorded in NHNS-J 2019 (X_{2019}) and the intake recorded in NHNS-J 2018 (X_{2018}), X_{2019}-X_{2018}.

Δ^2: Percent difference between the intake recorded in NHNS-J 2019 (X_{2019}) and the intake recorded in NHNS-J 2018 (X_{2018}), $(X_{i,2019}\text{-}X_{i,2018})/(Y_{2019}-Y_{2018})\times 100$, where $X_{i,2019}$ is the intake of dietary fibre derived from the food group *i* in 2019, $X_{i,2018}$ is the intake of dietary fibre derived from the food group *i* in 2018, Y_{2019} is the total dietary fibre intake in 2019, and Y_{2018} is the total dietary fibre intake in 2018.

Table 2. Comparison between estimated rice intake and actual rice intake.

	Weight, g	Energy, kcal	Protein, g	Fat, g	VB1, mg	VB2, mg	Niacin, mg	VB6, mg	Folate, mg	Pantothenate, mg	VC, mg	Na, mg	K, mg	Ca, mg	Mg, mg	P, mg	Fe, mg	Zn, mg	Cu, mg
	NHNS-J 2018																		
Estimated brown rice	4.1	7	0.1	0.0	0.01	0.00	0.1	0.01	0.0	0.03	0	0.0	4.0	0.0	2.0	5.0	0.0	0.0	0.00
Estimated polished rice	300	504	7.5	0.9	0.06	0.03	2.4	0.06	9.0	0.75	0	3.0	87.0	9.0	21.0	102.0	0.3	1.8	0.30
Estimated rice	304.1	511	7.6	0.9	0.07	0.03	2.5	0.07	9.0	0.78	0	3.0	91.0	9.0	23.0	107.0	0.3	1.8	0.30
Actual rice	304.1	510	7.6	0.9	0.07	0.03	2.6	0.07	9.5	0.78	0	3.0	91.0	9.3	23.4	107.6	0.3	1.8	0.30
Difference	0.0	1	0.0	0.0	0.00	-0.02	-0.1	0.00	-0.5	0.00	0	0.0	0.0	-0.3	-0.4	-0.6	0.0	0.0	0.00
	NHNS-J 2019																		
Estimated brown rice	3.3	5	0.1	0.0	0.01	0.00	0.1	0.01	0.0	0.02	0	0.0	3	0	2	4.0	0.0	0.0	0.00
Estimated polished rice	290.0	487	7.3	0.9	0.06	0.03	2.3	0.06	9.0	0.73	0	3.0	84	9	20	99.0	0.3	1.7	0.29
Estimated rice	293.3	493	7.3	0.9	0.06	0.03	2.4	0.06	9.0	0.75	0	3.0	87.0	9.0	22.0	103.0	0.3	1.8	0.29
Actual rice	293.1	490	7.3	0.9	0.07	0.03	2.5	0.07	9.1	0.75	0	2.9	87.3	8.9	22.4	103.1	0.3	1.8	0.29
Difference	0.2	3	0.0	0.0	-0.01	0.00	-0.1	-0.01	-0.1	0.0	0	0.1	-0.3	0.1	-0.4	-0.1	0.0	0.0	0.00

VB, Vitamin B; VC, Vitamin C; NHNS-J: National Health and Nutrition Survey, Japan

the original data of NHNS-J: we were able to estimate changes only in rice: not in all foods. Second, we were not able to examine the results of the NHNS-J after 2019. However, the NHNS-J was not conducted after 2019 because of the coronavirus diwsease pandemic. The increase in dietary fibre intake shown from NHNS-J 2019 to NHNS-J 2018 may not be an actual increase in dietary fibre intake: rather: it may be an apparent increase resulting from the revision of analytical methods used to estimate dietary fibre intake in STFC-J.

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