Journal of Obesity and Chronic Diseases

https://doi.org/10.17756/jocd.2018-013

Research Article

Open Access

Effects of Brown Rice on Obesity: GENKI Study I (Cross Sectional Epidemiological Study)

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Received: January 31, 2018
Accepted: April 18, 2018
Published: April 20, 2018

Citation: Watanabe S, Mizuno S, Hirakawa A. 2018. Effects of Brown Rice on Obesity: GENKI Study I (Cross Sectional Epidemiological Study). *J Obes Chronic Dis* 2(1): 12-19.

Published by United Scientific Group

Abstract

Purpose: Current epidemiological data are inconclusive about the effects of traditional brown rice on obesity. The purpose of this study was to explore the relationship between the people's preferences for brown rice in their diet and obesity, by conducting a questionnaire survey focused on brown rice and natural foodstuffs.

Method: A cross sectional study was performed through an individual questionnaire administered to 1100 participants. Their staple food preferences included: polished white rice in 330, partially milled rice in 117, germinated rice in 12, brown rice in 406, *Jurokkoku* rice in 10, and 205 mixed brown rice and others. Baseline and outcome variables were principally chosen to address the following categories: BMI, dietary habits, lifestyle, and living conditions.

Result: Among all participants (Males = 339, Females = 741), average BMI was 22.3 ± 3.2 in males and 20.7 ± 2.8 kg/m^2 in females. Current consumers of brown rice had a significantly lower BMI than all other categories aggregated (BMI brown rice = 20.6 ± 2.0, BMI white rice = 22.3 ± 3.3; $p < 0.000$). They reduced body weight 9 kg in males and 6 kg in females from the maximal body weight in middle age. Brown rice eaters preferred to eat Japanese foods and traditional vegetables, avoiding meat, dairy products and western foods. They disliked oily and spicy taste, and their optimal food attributes were fresh, organic, no additives, without genetically-modified foodstuff and locally-produced. Brown rice eaters had bowel movements once or twice a day, and their stools had the shape of a banana. Dietary habits contributed to their healthy feeling in conjunction with other life attitudes.

Conclusion: The brown rice diet seemed to improve or prevent obesity compared with a polished white rice eating. The good bowel movement and the stool figure suggested a good intestinal environment which led to avoid obesity and kept health. Dietary habits with brown rice, rich vegetables, avoiding meat, should support the healthy life.

Keywords

BMI, Obesity, Brown rice diet, Lifestyle, Epidemiology, Cross sectional study

Introduction

A relationship between food and health have been reported by a lot of epidemiological studies. The seven countries study by Keys et al. and the planned residents-based cohort study by Takashi Hirayama are considered to open a nutritional epidemiology [1-4]. The Mediterranean Diet, DASH diet, Zone, Ornish and others were thus proposed [5-9]. There are only a few epidemiological

data about the health effects of the brown rice diet [10], which has been popular in Japan. *Genmai* (brown rice) diet was originally proposed by Sagen Ishizuka [11] and Kenzo Futaki [12] combined with wellness fasting and the carbohydrate restriction diet, so it is important to get a basic data of *genmai* eating people [13, 14].

In the previous JPHC cohort of 140,000 people in the National Cancer Center did not distinguish a kind of rice, and in the Saku Human Dock cohort targeting 50,000 health check-up examinees, there were only several 10 people who had consumed brown rice, so the statistical analysis could not be possible [15-20]. There are many healthy people who run a brown rice vegetarian diet in the group such as Japan Society of Integrative Medicine, Japan CI Association, the Japan Macrobiotic Association, and the AOB KEIO Group [21-23]. The above groups had organized the Integrated Shokuiku (eating education) Promotion Council five years ago [24]. Each group has more than a thousand members and act to distribute natural foods.

For this study, the authors asked to investigate the health effects of brown rice with a collaboration with the Research Laboratory of the Life Science Promoting Association Japan, and to clarify the health effects of brown rice eating. Each participating group understood the importance of this study and supported to recruit their members to this study by the board decision. The authors sent a questionnaire to the applicants and got the informed consent to make a cross-sectional study, ahead of their inclusion in a forthcoming cohort study for the future follow-up study and/or a nested study in the cohort population.

The purpose of this study was to clarify the relationship between the health effects of brown rice diet and the obesity in which a questionnaire survey was conducted mainly for a group of brown rice and natural foods intake. The relationship between diet and health is a field that requires more research for an ultra-aging society like Japan.

The Japanese cuisine has become popular worldwide as one of world legacies, but the evaluation of brown rice is left behind. It is necessary to investigate the current status by good epidemiological design to study the population of brown rice eaters. *GENKI* study is an abbreviation of "*Genmai* Epidmiology Nutrition and *Kenko* (health) Innovation", and planned to find integrated solution by accumulating multidimensional evidences for healthy longevity.

Subjects and Methods

We made public relations about the study through the monthly magazine of each society, and called participation. The participants returned the application form enclosed in the magazine to the Office by fax or e-mail, and the registration office confirmed the intention of participants, and sent a questionnaire. The survey was carried out from April 1, 2016 to March 31, 2017, and 1,100 people participated to the study.

The questionnaire form is 8 pages in A4 size and needed about 30 minutes to 1 hour to fulfil the questionnaire. It asked dietary habits, life habits, past history, family history, health awareness, etc. The foods of 116 items were adopted by a semi-quantitative food frequency question. The dietary habits of the brown rice diet were usually matched to the recommendation of dietitian's proverb "*ma/go/wa/ya/sa/shi/i*" which means "grand children are kind" in Japanese. "*Ma*" is a prefix of beans, "*go*" is sesame seeds and nuts, "*wa*" is seaweed, "*ya*" is vegetables, "*sa*" is fishes, "*shi*" is *shiitake* and mushrooms, and "*i*" is yam. All these foodstuffs were included, and a detailed question about brown rice and natural food intake was prepared. Eating habits, exercise habits, living conditions, educational background, profession and annual income, and for women, menstruation, childbirth, feeding history, etc. were asked. Most questions were similar to those of JPHC cohort study to compare the results of residential population [17]. Our PDF version can be downloaded from the address below: (http://www.lifescience.or.jp/genki1/questionair/).

The questionnaire that had been sent back was stored in a locked locker with a key ID. The abnormal value or lack of answer was confirmed to the subject, and data were stored in the Excel database.

Items of the questionnaire were as follows:

- Age, height, current weight, BMI, weight at 20 years old, maximal weight and age in the past
- Staple rice, food preferences and eating habits
- Dietary awareness, food intake status (SFFQ), meal sketches
- Lifestyle and habits
- Current health condition, bowel movement, and stool feature
- Health history, parents, siblings, chief complaints
- Changes of health condition from the last year, and healthy habits
- Liquor, tobacco, eating out, supplements, fasting experience
- Physical activities, living way, occupations, education, income
- Stress, and Life Creed (Religion)
- Women's Health, menarche, menstruation, hormone use, delivery history, childcare history
- Contact and free comments space
- Address, e-mail, name, telephone, etc. for communication, if desired

Ethical Issue

For this study, the steering Committee by Japan Society of Integrative Medicine, Japan CI Association, the Japan Macrobiotic Association, and the AOB KEIO Group examined the proposed research plan and approved the ethics review by the Ethics Review Board of the Life Science

Promoting Association (No. 003 in September 2015) [21-23]. Collected data were all anonymized in the Excel spreadsheet for analysis, and consent forms and confidential information were separately stored in the locked locker. Original questionnaire shall be returned to each participant with a report of the study for self-education.

Statistical Analysis

The information obtained from the questionnaire was used for the Excel database, and transferred to SPSS database. Non-parametric analysis was used for categorical data, and parametric analysis for continuous variables. The complete data of 1080 people were provided for analysis. The SPSS statistical package ver.24 and the soft R GLM for logistic regression analysis were used [25, 26].

The odds ratio (OR) was determined as a descriptive variable. The odds ratio is represented by odds ratio (95% CI), and the significance level of the decision was shown by $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Crude (OR) and adjusted OR by sex and age with 95% CI were also shown [27]. We also adopted a logistic regression analysis for factor variable. The analysis which paid attention to the brown rice food was done by calculation of ratio between brown rice vs. non-brown rice. Further analysis was done between brown rice vs. white rice, if necessary. The purpose of the analysis was to make the relation between the characteristic of the brown rice eating person and body weight.

Type of rice was categorized to polished white rice, partially polished rice, germinated rice, brown rice, and *jurokkoku* (mixture of 16 crops) rice. A *Genmai* (brown rice) index was calculated by multiplying the daily intake frequency, size of bowel, portion size, mixture of other rice and/or crops. The distribution of *genmai* index corresponded well to polished white rice being 0 and brown rice being 1.0, and other rice mixture dropped between 0 and 1.0. So, three categories were used as rice eating pattern; Group 1 for white rice, Group 3 for brown rice, and Group 2 for mixed use of rice.

Results

Subjects

The number of participants recruited by organization was 536 from the Japan Society of Integrative Medicine, 192 from the Japan Macrobiotic Association, 79 from the Japan CI Association, 78 from the ABO KEIO Group, 78 from Miki Shoji Co. Ltd, 27 from the Academy of Integrated Medicine, 73 from Noguchi's Zen Fasting Society, and 9 undescribed. Totaled was 1100 which was composed of 347 men, 752 women and 1 undescribed.

Average age, and standard deviation were 53.2 ± 17.9 years-old in males and 53.7 ± 15.4 in females. Average height was 168.5 ± 8.3 in males and 156.7 ± 8.0 in females. Body weight was 63.1 ± 11.7 kg in males and 50.9 ± 7.8 kg in females. BMI of both sex was 22.1 ± 3.2 and 20.7 ± 2.8, respectively. The age of participants was almost uniform in males and more in middle age in females figure 1. The place of residence was distributed from Hokkaido to Kyushu in Japan, so regional bias could be neglected (data not shown).

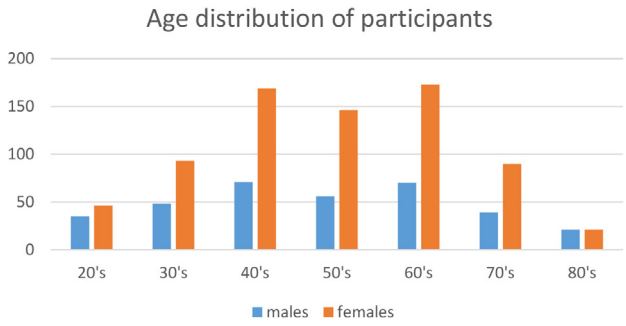

Figure 1: Age category distribution of participants. Male participants are uniformly dispersed, but female participants are more abundant in age 40-60 years.

Rice category

Single rice consumption was observed in 875 (81%) subjects, mixed use of two different kind of rice in 174 (16.7%), 3 kinds of rice in 25 (2.3%) and mixture of 4 kinds of rice in 6 (0.56%) (Table 1). The single rice consumption was a polished white rice in 330, partially polished rice in 117, germinated rice in 12, brown rice in 406, and *jurokkoku* rice in 10 people (plural answers). Brown rice was used in 92 (52.9%) in two mixtures, and 24 (96%) in three mixtures. The women showed a constant intake rate of brown rice at almost all ages, and in men brown rice consumed more according to their age. Unlike white rice, grains, such as wheat, millet, and beans were often mixed to the unpolished rice.

Table 1: Kinds of rice comsumption by sex.

Rice	Males	Females	Total
Polished white rice	131	199	330
Partially polished rice	47	70	117
Germinated rice	6	6	12
Brown rice	107	299	406
jurokkoku rice	3	7	10
White rice & mixture	24	58	82
Brown rice & mixture	15	77	92
Three kinds mixture	5	20	25
Four kinds mixture	1	5	6
Total	339	741	1080

Genmai index 0 corresponded to polished white rice and 1.0 to brown rice, and the mixed use varied between 0 and 1.0. So, the rice intake category was set for further analysis, such as Group 1 (white rice; 131 males and 199 females), Group 2 (mixed rice; 101 males and 243 females) and Group 3 (brown rice; 107 males and 299 females). Total number for further analysis was 1080.

Body weight and BMI by rice category

Average BMI in males was 22.0 ± 3.2 and 20.7 ± 2.8 in

females. BMI more than 25 was 54 (15.7%) in males and 47 (6.4%) in females, more than 30 was 5 (1.5%) and 6 (0.8%) in males and females, respectively, while BMI less than 18 was 31 (9%) in males and 99 (13.4%) in females figure 2. Current and past anthropometric data of the participants by rice category is shown in table 2. Brown rice eaters shows lower BMI in men and women at all ages figure 3. In women, brown rice is stable at around 20 regardless of the median age category.

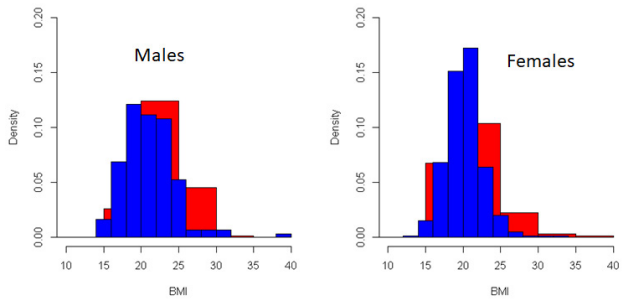

Figure 2: Distribution of BMI by rice intake.

Blue columns are brown rice and red columns are white rice eaters.

White rice eaters distributed to high BMI in both males and females.

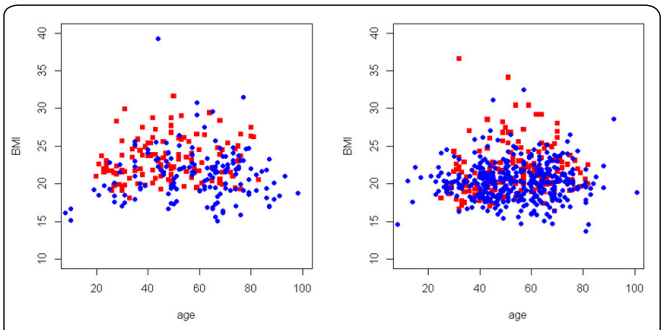

Figure 3: Distribution of BMI by age.

Both males (left) and females showed stable BMI around 20. Some brown rice eaters are thin below BMI 18 kg/m^2. Blue dots are brown rice eaters and red dots are polished white rice eaters.

food. Mix rice eaters often showed the intermittent values (Table 3). Rice and miso soup were usually consumed daily at the same time. Miso soup consumption in both sex in Group 3 was similarly high being nearly 50%, while it was less than one third in Group 1.

The preference of taste was also different by rice groups. Brown rice eater's preferred non-oily taste and avoided fat taste. Hot dishes were avoided by males and hot/spicy taste was not preferred by females.

Table 2: Anthropometric data of participants by rice group.

		Group 1			Group 2			Group 3			
		n	Mean	SD	n	Mean	SD	n	Mean	SD	p
Males	Body weght at age 20	154	**62.2**	9.9	50	**59.9**	7.9	94	**61.1**	8.6	0.258
	Maximal body weight	167	**71.0**	11.9	61	**67.2**	14.9	102	**69.9**	11.5	0.120
	Current body weight	167	**66.0**	11.4	61	**62.4**	12.4	106	**58.9**	10.8	**0.000**
	Difference from max	167	**5.0**	[2,8]	60	**4.0**	[1.25, 8.75]	101	**9.0**	[5, 14]	**0.000**
	Age at max body weight	163	**35.9**	13.0	57	**40.3**	25.7	98	**34.6**	14.1	0.102
Females	Body weght at age 20	234	**50.4**	6.0	137	**50.3**	5.6	251	**50.9**	6.2	0.571
	Maximal body weight	265	**58.5**	11.9	157	**56.9**	11.1	279	**58.6**	15.0	0.374
	Current body weight	268	**52.1**	8.1	162	**50.0**	6.6	288	**50.3**	8.0	**0.005**
	Difference from max	261	**5.0**	[2, 8]	156	**5.0**	[3, 9]	276	**6.0**	[4,10]	**0.036**
	Age at max body weight	244	**34.3**	16.2	148	**30.4**	13.8	258	**32.6**	15.3	**0.050**

Group 1; white rice, Group 2; mixed used of polished and unpolished rice; Group 3; brown rice.
Difference from max body weight is shown by median and [25,75] percentile.

Median decrease of body weight in Group 3 was 9.0 kg in men and 6.0 kg in women. The maximum weight and the current weight comparison showed more than 10 kg reduction in four men and 3 women. When we sought the odds ratio of the relationship between the changes of BMI by rice type, odds ratio by brown rice vs. polished rice was significantly low in brown rice (OR 1.45 $p < 0.001$).

Dietary habit of brown rice eaters

Consumption of foods for side dishes showed characteristic trend by the rice category. The food intake indexes were standardized by multiplying the daily frequency of food intake x standard dose per meal. Polished white rice and brown rice eaters showed a significantly different tendency to choose

Group 3 brown rice eaters consumed significantly more dose than Group 1 in carrot, green yellow vegetables, radish, ginger, burdock, lotus root, sweet potatoes, yam, salty plum pickles (*umeboshi*), sesame, peanut, chestnut, mushroom, dried mushroom (*shiitake*), dried radish, dried sea weed (*nori*), kelp (*konbu*), red bean (*azuki*), and soy milk. Lettuce, avocado, banana, melon and other Western vegetables are few. They did not consume meat, but soy protein was substituted to meat and fish.

Group 1 white rice eaters preferentially consumed sweet bread, broccoli, bell pepper, eggplant, banana, grapefruit, red meat fish like tuna, cow and pig meat, egg, dairy products, sugar, curry and mayonnaise. Coffee and soft drinks, chocolate, cakes, ice cream and jelly were also consumed more in Group 1. Brown rice eaters drank *sannen bancha* (matured black tea),

Table 3: Food consumption by rice group.

Food	Group 1	Group 2	Group 3	p1	p2		Food	Group 1	Group 2	Group 3	p1	p2
white rice	**0.805**	0.07	0	0	0		red bean	0.039	0.072	**0.141**	0.003	0
brown rice	0.007	0.004	**0.897**	1	0		**tofu**	0.439	0.538	0.522	0.398	0.201
bread	0.119	0.13	0.094	1	0.755		***natto***	0.285	0.372	0.378	0.221	0.11
noodles	0.167	0.159	0.128	1	0.243		**soy milk**	0.035	0.069	**0.137**	0.054	0
onion	0.572	0.668	0.647	0.069	0.017		**red meat fish**	**0.121**	0.11	0.053	1	0
carrot	0.484	0.639	**0.682**	0	0		white meat fish	0.071	0.076	0.048	1	0.314
pumpkin	0.12	0.163	0.166	0.086	0.076		fish egg	0.036	0.029	0.016	0.111	0
green yellow veg	0.453	0.646	**0.742**	0	0		shrinmp	0.048	0.044	0.034	0.647	0.176
lettuce	0.253	0.239	0.167	1	0.097		**chicken**	**0.192**	0.136	0.054	0.001	0
tomatoe	0.327	0.308	0.168	1	0.097		**beaf**	**0.078**	0.044	0.021	0	0
bell pepper	0.198	0.195	**0.141**	1	0.004		**pork**	**0.224**	0.156	0.049	0	0
jinger	0.235	0.344	**0.346**	0	0.011		**ham**	**0.1**	0.041	0.025	0	0
burdock	0.134	0.186	**0.23**	0.001	0		**soy protein**	0.007	0.02	0.023	0.17	**0.012**
lotus root	0.081	0.154	**0.175**	0	0		**egg**	**0.434**	0.227	0.082	0	0
potatoe	0.246	0.224	0.172	1	0.108		**milk**	**0.027**	0.021	0.008	0.003	0
sweet potatoe	0.096	0.127	**0.135**	1	0.004		**yogurt**	**0.097**	0.057	0.017	0.469	0
yam	0.088	0.127	**0.139**	0.802	0.003		**cheese**	**0.067**	0.055	0.026	1	0
sesami	0.221	0.465	**0.56**	0	0		**sugar**	**0.239**	0.123	0.034	0.058	0
peanut	0.051	0.111	**0.124**	0.002	0.001		honey	0.025	0.024	0.022	1	0.14
walnut	0.03	0.065	**0.067**	0	0		**curry**	**0.06**	0.049	0.027	0.094	0
dried mushroom	0.072	0.165	**0.207**	0.008	0		**green tea**	**0.263**	0.243	0.069	0.4	0
dried radish	0.052	0.12	**0.13**	0.001	0		***sannen bancha***	0.013	0.055	**0.171**	0.01	0
nori	0.188	0.351	**0.319**	0.001	0		herb tea	0.014	0.02	0.015	0.022	1
kelp	0.052	0.098	**0.133**	0.225	0		**coffee**	**0.886**	0.802	0.569	0.41	0
banana	0.057	0.052	0.031	1	0		cocoa	0.011	0.01	0.008	0.414	1
apple	0.109	0.133	0.141	1	1		veg. juice	0.038	0.064	0.031	0.148	0.56
orange	0.125	0.145	0.146	0.689	1		**soft drink**	**0.018**	0.009	0.004	0.023	0
persimon	0.047	0.054	0.054	1	1		**chocolate**	**0.1**	0.086	0.062	0.51	0
watermelon	**0.048**	0.055	0.044	1	0.009		**ice cream**	**0.045**	0.028	0.017	0.003	0

Food consumption is shown by index [Food frequency (once a day = 1.0) x (portion size; 0.5, 1.0, 1.5)]
p1; difference between Group 1 and 2, p2; difference between Group 1 and 3, by ANOVA test.

and persimmon leaf teas. There was no significant difference in wine, beer, *shochu* and other alcoholic beverage intake.

Supplement intake

Supplement intake, such as multi-vitamin, multi-mineral, vitamin B complex, vitamin C, vitamin E, iron, calcium, DHA/EPA, nutrient drink, fermented rice bran, dietary fiber, oligo saccharide, chondroitin sulfate, amino acid/peptides, lactobacillus, gingko leaves, and others was significantly low in Group 3, except for "enzyme" drink, which was a fermented mixed vegetable juice (Table 4).

Meal preferences and eating habits

As for the style of the meal, Japanese cuisine was significantly preferred in both sex in Group 3 brown rice, and Western or Chinese cuisines was only a few percent and mixed choice was about 20-28%. White rice eaters took mixed cuisine more frequently in nearly half in both sex, as Group 1 people noticed more on the food balance, low calorie and price. On the contrary, the brown rice eaters noticed freshness, no-additives, pesticide-free, organic, germ-free, production area of the foods when they buy.

Bowel condition

Once a day bowel movement was common; nearly 60% in men and 48-55% in women. Less than 3/week was present more than 10% women of Group 1 and 2, while it was only 4.3% in Group 3 women. Rice category clearly showed the benefit of

Table 4: Supplement intake by rice group.

	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	OR brown vs. others
Multiple vitamins	38	23	16	49.4%	29.9%	20.8%	0.66*
Multiple minarals	31	19	18	45.6%	27.9%	26.5%	0.7
Vitamin B complex	39	20	25	46.4%	23.8%	29.8%	0.63*
Vitamin C	72	30	38	51.4%	21.4%	27.1%	0.53***
Vitamin E	45	12	9	68.2%	18.2%	13.6%	0.23***
Iron	33	21	16	47.1%	30.0%	22.9%	0.6*
Calcium	47	21	20	53.4%	23.9%	22.7%	0.39***
DHA/EPA	23	16	14	43.4%	30.2%	26.4%	0.65
Nutritional drink	13	9	5	48.1%	33.3%	18.5%	0.56
Enzyme drink	13	15	23	25.5%	29.4%	45.1%	2.05*
Fermented bran	64	28	32	51.6%	22.6%	25.8%	0.65*
Dietar fiber	51	14	15	63.8%	17.5%	18.8%	0.28***
Chondroitin sulfate	6	5	3	42.9%	35.7%	21.4%	0.43*
Oligosaccharide	20	7	10	54.1%	18.9%	27.0%	0.51
Peptid/ aminoacid	17	8	11	47.2%	22.2%	30.6%	0.77
Lactobacillus	35	23	28	40.7%	26.7%	32.6%	0.61
Ginkgo leaf	1	4	4	11.1%	44.4%	44.4%	0.89
others	68	46	89	33.5%	22.7%	43.8%	1.39

Table 5: Bowel movement and stool figure by rice group.

		Males						Females					
		Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3
		n	n	n	%	%	%	n	n	n	%	%	%
Bowel management	1/week	0	0	0	0.0%	0.0%	0.0%	0	2	0	0.0%	1.3%	0.0%
	2/week	2	1	0	1.2%	1.6%	0.0%	12	3	4	4.5%	2.0%	1.4%
	3/week	6	3	3	3.6%	4.8%	2.9%	25	10	8	9.3%	6.6%	2.9%
	>4/week	21	7	5	12.5%	11.3%	4.8%	54	20	48	20.1%	13.2%	17.3%
	1/day	94	36	62	56.0%	58.1%	59.0%	128	83	147	47.8%	54.6%	52.9%
	2/day	31	11	28	18.5%	17.7%	26.7%	36	31	52	13.4%	20.4%	18.7%
	3/day	13	4	6	7.7%	6.5%	5.7%	12	3	15	4.5%	2.0%	5.4%
	>4/day	1	0	1	0.6%	0.0%	1.0%	1	0	4	0.4%	0.0%	1.4%
	Pearson	0.657						p = 0.001					
Stool figure		4		0	2.4%	1.8%	0.0%	1	0	5	0.4%	0.0%	1.8%
	Solid	60	20	27	36.1%	35.1%	25.5%	57	26	52	21.8%	17.0%	18.6%
	banana	77	30	65	46.4%	52.6%	61.3%	144	102	190	55.0%	66.7%	67.9%
	solid	21	5	13	12.7%	8.8%	12.3%	54	24	29	20.6%	15.7%	10.4%
	watery/ solid	4	1	1	2.4%	1.8%	0.9%	6	1	4	2.3%	0.7%	1.4%
	Pearson	0.343						p = 0.007					

brown rice eaters (Table 5). Twice a day defecation and banana like shape was significantly high in Group 3, and odds ratio between brown rice vs. white rice was 1.72 ($p < 0.0001$).

Banana shape stool was most frequently present in Group 3 in both men and women. Stool of soft, solid or alternative watery and solid was low in Group 3 compared to Group 1.

Life condition

Occupation of Group 3 people was noticed that there

were more self-employ and depended on pension than Group 1. Group 1 included many middle school and high school graduates and regular employee than Group 3. Income of more than 4 million yen was common in Group 1. Group 3 showed low and high income diversity, but they spend more for foods than Group 1 and 2, although there was no difference among 3 Groups who spent more than 50000 yen for foods (Table 6).

There are many people living alone in Group 1. The income of the brown rice group was divided into 2 million yen or less. This seems to be due to the elderly people was living by the pension.

Table 6: Occupation, education, income and expense for foods by rice group.

	rice group			rice group%		
Profession	1	2	3	1	2	3
employee	193	78	107	48.9	42.6	30.6
parttime	42	17	44	10.6	9.3	12.6
temporary	4	5	9	1.0	2.7	2.6
self employ	53	29	80	13.4	15.8	22.9
housekeeper	60	28	53	15.2	15.3	15.1
student	8	5	8	2.0	2.7	2.3
none	7	6	8	1.8	3.3	2.3
pension	28	15	41	7.1	8.2	11.7
Education	*0.001*			*Pearson 35.719a*		
middle school	25	3	11	**5.9**	**1.5**	**2.9**
high school	130	46	92	**30.4**	**22.9**	**24.5**
training school	95	63	108	**22.2**	**31.3**	**28.7**
university	158	78	147	**37.0**	**38.8**	**39.1**
graduate school	19	10	17	**4.4**	**5.0**	**4.5**
	0.023			*Pearson 23.564a*		
<2 million	54	22	61	13.2	11.2	16.5
2-4 million	146	56	129	35.6	28.6	35.0
4-8 million	148	69	111	36.1	35.2	30.1
>4 million	62	49	68	15.1	25.0	18.4
	0.043			*Pearson 16.033a*		
<10000yen	5	2	1	1.4	1.2	0.3
10000-19999	45	21	29	12.5	12.1	8.7
20000-29999	64	32	58	17.7	18.5	17.4
30000-39999	69	22	80	19.1	12.7	24.0
40000-49999	42	12	40	11.6	6.9	12.0
>50000	136	84	126	37.7	48.6	37.7

Discussion

There are a lot of individual case reports describing the benefits of brown rice eating [28]. We also have heard that about 1/3 *genmai* eater quitted eating *genmai*. It is important to show the evidence based benefit, and we found *genmai* eating is beneficial to keep the proper body weight. It was difficult to find the habitual *genmai* eater in the previous epidemiological studies, because white rice is soft and tastier, and fit to any kind of side dishes [15-17]. This study was cross-sectional design for a specific group and contained confounding factors, but since the results were obtained from more than 1,000 persons, the relationship between brown rice eating and obesity was able to be evaluated.

Kenzo Futaki [12], who founded the Japan Society of Integrative Medicine, advocated "20 virtues of brown rice" and tried to spread the brown rice diet. Dietary fiber, rich in brown rice, was known to have a good influence on the bowel movement, and arrange intestinal environment by maintaining bacterial flora [29-32]. From the recent intestinal bacterial research people who ingested dietary fiber has been reported that there are many bacteria producing citric acid, propionic acid, and bifidobacterium produces short-chain fatty acids such as butyric acid. The bowel movement of the brown rice diet can induce good intestinal environment suggested by a banana-like form and twice a day defecation.

It has been clarified in recent studies, that brown rice contains substances that have various effects on physiological functions in addition to the function as ordinary nutrients. Functional components like γ-oryzanol of brown rice could control diabetes, and GABA may keep mental health [28]. The rice bran was originally known to have a rich amount of vitamins and minerals, in addition, various substances such as long-chain fatty acids, ferulic acid and inositol are also included. In that sense, the influence of brown rice on health is extremely large and could be called "medical rice" [33].

Rice is the staple food of 70% of the world's people. The annual production is about 600 million tons, and it is likely that rice will become a major grain when the amount of wheat production would reduce by global warming in the future. More than 90% of rice is made in Asian countries. There are a lot of developing countries which are the sources of protein and fat intake. Rice as a staple food can provide various nutrients beyond a necessary energy source in these countries. Polished white rice should lose these benefits.

As a weakness of this research, the possibility that a selection bias would be remained, because participants were particular subjects with a background of the macrobiotic group. So, holistic dietary habits might influence for keeping proper BMI. There might be a possibility that such people were recruited. However, even if there were a selection bias, it would be possible to recognize the effects of brown rice on BMI and obesity.

Weight reduction is essential for preventing type 2 diabetes. Recent study (DiRECT) of primary care-led weight management for remission of type 2 diabetes successfully showed that 24% participants lost 15 kg or more body weight, and diabetes remission was achieved in 46% participants by total diet replacement, stepped food reintroduction, and structured support for long-term weight loss maintenance [34]. Thus, population approach to reduce obesity is very effective, and brown rice as a staple food could provide useful tool [35].

Acknowledgements

The authors appreciate the board members of macrobiotic groups to help this research. We devote this paper to Mr. Yasuhiko Katsumata who passed a few months ago. Dr. Philippe Calain is appreciated for his constructive discussion and English editing.

Conflict of Interest

Funding of this research was supported by the Life Science Promoting Association.

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