

## Relationship between Constituents of Daily Meals and Nutrient Intake in Okinawa from the viewpoint of cooking

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Key words :

Dietary habits in Okinawa Prefecture have many unique characteristics because of its' geographical location and historical background. Since this prefecture has lower occurrence rates of cancer and diseases of the circulatory organs, and is also known for its' longevity, studies have been conducted on the relationship between nutrients, food and the health of Okinawa's people and also from the viewpoint of the prefecture's traditional food culture<sup>1)-8)</sup>. Some Okinawan dishes are characterized by their unique handling of food, cooking methods (cooking practices, methods of using seasonings) and so forth<sup>9)-10)</sup> and so simply studying the intake of food and nutrients, etc. is not enough to understand the characteristics of the dietary habits of Okinawan people fully<sup>11)-13)</sup>.

This study aims to analyze the daily meals eaten in the prefecture from the viewpoint of cooking, examine their characteristics and also examine the relationship between these meals and health and other related relative factors.

### Method

The present study covered a total of 365 men and women living in Okinawa for 30 years or more to whom a questionnaire on daily habits for health improvement was sent. Of these subjects, 337 responded. The questionnaire asked them about the meals they ate on one day in October, 1994, not including Sundays and holidays

(breakfast, lunch and dinner) and the approximate intake as well as their daily habits for health improvement.

What was examined in the questionnaire was 1) the intake of food, energy and nutrients, 2) the cooking methods of the staple (rice, bread, etc.), main dishes and side dishes, the materials used and the menu of breakfast, lunch and dinner (these are for analyses from the viewpoint of cooking), 3) reproduction of the dishes eaten most frequently and analysis of their ingredients by the "KAGEZEN" method, and 4) the respondents' daily habits for health improvement.

To calculate the outcome of the study of the respondents' food intake, we checked the contents of the questionnaire and established classification codes for each type of dish. The estimated amount of food from the questionnaire was included into the weight, in grams, considered appropriate referring to the data we had. The nutrients contained in food were calculated using the Table of Food Composition in Japan , 4<sup>th</sup> edition.

The dishes included in the menus were classified into 18 groups according to the classification shown in Table 1. Food eaten raw, and soup were classified as main dishes if their main ingredient contained 6g or more of protein and as side dishes if the main ingredient's protein content was less than 6g.

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To examine changes, the energy and nutrients were calculated by the method mentioned above. In addition, we reproduced these dishes at the study site in Okinawa and made a chemical analysis of them. The items analyzed are as shown in Table 2.

**Table 1 Classification of cooking methods used in the daily meals**

1.rice,	2.bread,	3.noodle,
4.raw food,	5.mixed,	6.boiled,
7.steamed,	8.grilled,	9.stir-fried,
10.deep-fried,	11.soup,	12.pickles,
13.prepared food,	14.drinks,	15.milk,
16.beverages,	17.fruit,	18.snacks

As for the answers to the questions about daily habits for health improvement, their frequency was mainly examined.

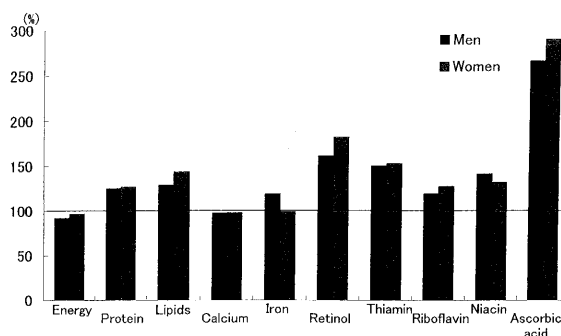
**Table 2 Analytical methods for energy and nutrients**

items	analytical methods
energy	calculation
moisturs	vacuum 70°C oven drying
protein	Kjeldahl method
lipid	Soxhlet methods
carbohydrate	calculation
dietary fiber	Henneberg-Stoman's improvement
ash	550°C direct ashing
calcium	potassium permanganate titration
phosphorus	molybdenum blue colorimetry
iron	ortho-phepanthrolone colorimetry
sodium	atomic absorption spectrometry
potassium	atomic absorption spectrometry
retinol	high performance liquid chromatography
β-carotene	high performance liquid chromatography
vitamin B <sub>1</sub>	thiochrome fluorescence
vitamin B <sub>2</sub>	thiochrome fluorescence
niacin	bioassay
vitamin C	high performance liquid chromatography

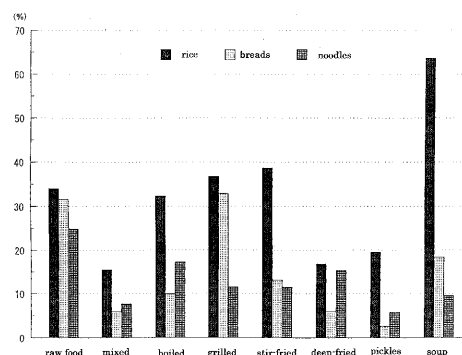
## Results and Discussion

### 1) Intake of energy and nutrients

The sufficiency ratio of energy and nutrients of the respondents, which shows the ratio of the requisite nutrients to their actual energy and nutrient intake, is as shown in Fig. 1. Nutrients with a sufficiency ratio of less than 100% were energy and calcium for men and women and iron for women. Men had a higher ratio than women only for iron and had a similar or lower ratio than women for all other nutrients. Vitamin intake showed a high ratio. The PFC ratio is 15.9%, 33.1% and 46.1%, the ratio of animal protein, 58.5% and that of animal fats, 46.6%. In particular, the ratio of lipid to energy is fairly high.



**Fig. 1** Daily intake of energy and nutrients based on the RDA in Japan



**Fig. 2** Frequency of cooking methods used for each staple

### 2) Analysis of menus

1.Staple, main and side dishes and cooking methods

Fig. 2 shows the ratio of meals eaten by the type of staple and cooking method. As for staples,

the ratio of rice to bread was 7:3 for breakfast, while rice was the staple food for dinner in almost all cases. Rice was eaten with no mixture or mixed with some millet, or other grain or with some soybean or red bean. When rice was eaten as the staple, soup was also eaten with very high frequency and stir-fried food, grilled food, raw food and boiled food were served in many cases. Deep-fried food and pickles are also eaten with rice. When bread was the staple, stir-fried food and raw food were eaten together with higher frequency than other types of dishes. In this case, raw food was mainly salad and fried dishes were mostly those fried in a frying pan. Fig. 3 shows the percentage of main dishes eaten for breakfast, lunch and dinner. The present study was the first one in which soup was defined as a main dish and this fact clearly indicates the characteristics of the dietary habits of Okinawan people. Stir-fried food, grilled food and boiled foods were eaten at a high frequency but the ratio of eating these dishes differed between breakfast, lunch and dinner.

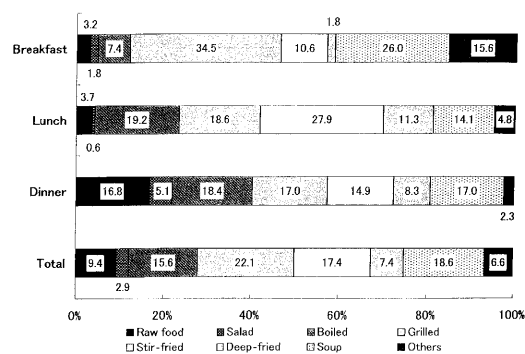


Fig. 3 Cooking methods used in breakfast, lunch and dinner

The frequency of the food groups used in cooking dishes is shown in Table 3.

The fats and oils used for raw food are probably the same as those for dressing for salad and those used for stir-fried food are probably the same as those for frying in a frying pan. Grilled food, stir-fried food and soup contained more varied food groups than other dishes. Soybeans are commonly used for Okinawa tofu (bean curd) and their consumption is further increased as a result of eating soup, mostly miso (bean paste) soup. Processed food used for cooked dishes is mostly Okinawan kamaboko (steamed fish paste cake) and that for grilled dishes is sausage and other processed meat products. The high ratio of prepared deep-fried food suggests the fact that the respondents eat deep-fried food sold on the market (prepared food) frequently.

Table 4 Number of dishes eaten for each staple

	rice	bread	noodles	average
day	3.8	2.6	2.7	3.2
breakfast	3.7	2.3	1.0	2.9
lunch	3.8	3.4	2.8	2.9
dinner	4.0	4.4	2.8	3.7

Table 4 shows the number of dishes served for breakfast, lunch and dinner. Three to four dishes are eaten including soup and the number of dishes is the largest for dinner. When bread is eaten as the staple, the number of dishes is smaller but the frequency of serving drinks and fruit is higher,

Table 3 Frequency of food groups used for main cooking methods

cooking methods	food groups (%)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
raw food	10.8	△	6.9	12.7	△	22.2	14.7	△	△	14.8	△	△	11.4
mixed	△	33.7	△	△	△	△	7.0	△	9.5	5.9	△	△	△
boiled	△	10.8	39.3	8.7	8.7	14.6	12.7	26.4	12.5	8.5	23.3	△	13.0
grilled	△	△	5.5	22.7	△	6.1	6.6	△	△	10.8	19.7	34.3	18.2
stir-fried	5.4	6.0	△	26.4	12.0	20.3	21.8	14.8	△	12.0	21.0	10.2	△
deep-fried	△	△	11.6	13.1	△	△	△	△	△	5.1	7.4	14.8	57.2
soup	32.3	△	17.1	△	63.0	14.9	18.8	36.6	55.3	29.8	11.9	12.6	△

△ shows less than 5%

food groups 1.noodles, 2.nuts and seeds, 3.potatoes, 4.fats and oils, 5.pulses, 6.dark green and yellow vegetables, 7.other vegetables 8.mushrooms,9.algae, 10.fishes and shellfishes, 11.meats, 12.eggs, 13.prepared foods

Table 5 Number of beverages, milk and fruit eaten for each staple

	rice	bread	noodles	average
day	1.4	2.1	1.4	1.5
breakfast	1.6	2.2	1.3	1.8
lunch	1.5	2.1	1.4	1.5
dinner	1.3	1.0	1.6	1.3

as shown in Table 5, as compared with the case where rice is the staple. By cooking method, in the case where rice is eaten for breakfast, the frequently used menu consists of soup and fried food or natto (fermented soybeans) or other processed food, while the combination of salad, stir-fried food or sausage or other processed food, milk and fruit is the popular menu when bread is the staple for breakfast. In the case of dinner, the staple is mostly rice and sashimi (thinly sliced raw fish) and grilled food are most frequently served as side dishes, followed by stir-fried food and deep-fried food. Soup is eaten less frequently than for breakfast. A noteworthy fact is that men

drink alcoholic beverages at dinner at a high rate.

One of the characteristics of the Okinawan diet is that stir-fried food, grilled food and soup all contain four to five different food ingredients and so, while the number of dishes is not so large itself the kinds of food eaten are. Goyachanpuru, irichi and soup contain a lot of Okinawan tofu, wakame (seaweed), konbu (kelp) and other seaweed. Okinawa soup consists of many types, too, including fish soup and vegetable soup. These facts show that Okinawan people have adopted many traditional dishes as their daily meals. The frequency of eating pickles is very low despite the fact that rice is the main staple. This is probably one of the reasons that the salt intake of Okinawans is lower than that of those in other parts of Japan.

3) Changes in nutritious ingredients during cooking (analysis by 'KAGEZEN' method)

The menu shown in Table 6 was cooked at the study site in Okinawa using ordinary cooking

Table 6 Typical daily meals menu used for chemical analysis

Breakfast		Lunch		Dinner				
food	weight(g)	food	weight(g)	food	weight(g)			
Toast	bread	66.0	Boiled rice	rice	90.0	boiled rice	rice	90.0
	margarine	2.0	Soup	somen (noodle)	20.0	fish-ball soup	fish paste	25.0
	strawberry jam	2.0		scallion	5.0		egg white	4.0
	peanut-butter	4.0		bonito-broth	200.0		starch	1.5
Vegetable salad	cabbage	30.0		salt	1.0		shiitake	1.5
	tomato	25.0		soy sauce	2.5		spinach	15.0
	green pepper	5.0	Deep-fried Gurukun	gurukun	160.0		salt	1.0
	canned tuna	38.0		oil	10.0		soy sauce	2.5
	mayonnaise	5.0		soy sauce	2.0		sake	2.0
Beverages	milk	45.0	Kobuirichi (kombu stir-fried)	sliced kombu	6.0	Tofu champuru (tofu & vegetables stir-fried)	cabbage	75.0
	soy milk	50.0		carrot	20.0		carrot	30.0
	apple juice	50.0		konjak	30.0		soy bean sprouts	40.0
	instant coffee	0.5		kamaboko (boiled fish paste)	20.0		onion	30.0
	sugar	0.8		green pepper	10.0		Okinawa-tofu	60.0
	powdered milk	0.5		oil	9.0		pork	25.0
				soy sauce	3.0		oil	17.0
				sugar	2.0		salt	0.5
				sweet sake	2.0	Fruit	soy sauce	2.5
				sake	2.0	Beverages	orange	35.0
			Baked sweetpotato	sweet potato	44.0		beer	175.0
			Fruit	banana	30.0		green tea	60.0
			Beverages	instant coffee	0.5			
				sugar	0.8			
				green tea	60.0			

Table 7 Daily intake of dietary energy and nutrients

Energy and Nutrients		A	B	C
		Calculated by Japanese Standard Table of Food Composition 4th Edition	Quantitative Data from the Chemical Analysis	(B/A×100) %
Energy	kcal	2204	2195	99.6
Protein	g	99.2	99.1	99.8
Lipids	g	78.4	73.8	94.1
Carbohydrate	g	253.7	277.7	110
Fiber	g	3.8	3.9	102
Ash	g	19.2	15.5	81.1
Calcium	mg	429	835	195
Phosphorus	mg	1320	1457	110
Iron	mg	10.0	29.1	292
Sodium	mg	3656	2913	79.7
Salt	g	9.3	7.4	79.6
Potassium	mg	3180	2525	79.4
Retinol	μg	93	155	168
Carotene	μg	4095	5827	142
Thiamin	mg	1.89	0.58	30.8
Riboflavin	mg	1.17	0.39	33.3
Niacin	mg	27.4	23.3	85.1
Ascorbic acid	mg	121	0	0.0

PFC ratio: 18.0 32.0 50.0(A)  
18.1 30.0 51.9(B)

methods and was chemically analyzed. The result of the analysis is shown in Table 7. Column C of Table 7 shows the ratios of analyzed values after cooking, of energy and nutrients to the values calculated using the standard Table of Food Composition in Japan, 4<sup>th</sup> edition. The calculated and analyzed values were similar for energy, protein and dietary fiber. Carbohydrates, calcium, phosphorus, iron, retinol and β-carotene showed a higher rate in the analyzed value than in the calculated value. The analyzed value of all other ingredients was smaller than the calculated value, suggesting that these ingredients were reduced by cooking practices. The values were especially high for water soluble vitamins. The value of sodium, that is, salt equivalent, is low because in the case of stir-fried food, salt flows out into water, resulting in a decrease in salt intake. The decrease in lipid is probably caused by the unique cooking methods in Okinawa; for example, pork the most commonly eaten meat, is cooked in water in advance to remove fat. The fact that salt and fat intake is low is a very desirable one from the standpoint of health improvement.

The reason that the chemical analysis value of

calcium, phosphorus and iron was higher than their calculated value is probably the fact that we analyzed the ingredients of deep-fried “gurukun” (160g) without removing the head, bones and skins though we removed the internal organs. The result that the analyzed value of vitamin B<sub>1</sub>, B<sub>2</sub> and C was much smaller than their calculated values is perhaps caused by a loss due to cooking with heat, a loss at the stage of preparing samples for chemical analysis, and other factors.

The outcome of the comparison between the value of the intake of energy and nutrients, calculated using the standard Table of Food Composition in Japan, 4<sup>th</sup> edition and the chemical analysis value differs greatly according to the kind, cultivation and harvesting time, storage period, etc. of the food materials used for the analysis, the analysis of single food materials, the analysis of dishes which are the combinations of food materials, the analysis of a meal or the day's three meals that are composed of several kinds of dishes, and other factors. In the comparison made in the present study, too, the analyzed value of retinol and carotene was higher than their calculated value. This confirmed the necessity of giving adequate consideration to the method of classifying the food materials analyzed according to the standard Table of Food Composition in Japan, the type of food and other variable elements.

#### 4) Questionnaire on daily habits for health improvement

Almost all of the respondents were married and more than 60% of them lived together with their children. Over 90% of them, both men and women, were born in Okinawa and 83.6% of men and 89.1% of the women lived in the prefecture for 30 years or more in total. By occupation, 24.2% of the men were engaged in office work, followed by those doing other types of work (23.2%), while 31.5% of the women were housewives, followed by those engaged in clerical work (19.3%). The ratio of those suffering from

marginal hypertension or hypertension tended to rise with aging, the men's ratio being higher than the women's. Though no noteworthy characteristics were observed, it was confirmed that the ratio of those suffering from hypertension or obesity was lower than the average ratio of the national nutrition survey; in particular, the obesity of the women was much less than the national average.<sup>14)</sup> One important reason for this is probably the lifestyle of Okinawan people who exercise their body and walk much more than those following an urban, less active lifestyle. Further examination, such as activities and a time study of daily living is needed to explain this difference.

Okinawa is Japan's top prefecture in terms of longevity and an important reason for this is said to be the unique dietary habits and food intake of Okinawan people. But it has been said that the prefecture's traditional dietary life has almost disappeared in urban areas. The present study was conducted mostly in Naha, the capital, and the respondents covered a broad range of age groups of 30 years or over. Through this study it was possible to show the main characteristics of Okinawan's daily meals. The prefecture's traditional dishes were created through its long history as the methods most suited to its special food materials. They will continue to play an important role in making Okinawan people's dietary habits better for their health and longevity.

### Summary

To study the characteristics of Okinawan dietary habits and diet, their daily meals were analyzed from the standpoint of cooking and the relationship between these dishes and health improvement were examined.

1. A questionnaire study on the meals on one weekday and on daily meals/activity/habits for health improvement was conducted for 365 men and women, 30 years or over who lived in Okinawa.

2. The energy and calcium were less than 100% required for both men and women. Men had a similar or lower ratio than women for all nutrients except iron. The ratio of lipid to energy was fairly high.
3. The analysis of menus showed that the ratio of rice as the staple was high but the ratio of bread eaten for breakfast was only about 30%. Though the number of dishes per meal ranged from three to four, each dish contained many food groups. Okinawan tofu, seaweed, vegetables, etc. were commonly used for soup, stir-fried food, boiled food, grilled food, raw food, etc.
4. In a chemical analysis using the KAGEZEN method, the decrease in lipid and sodium was observed probably as a result of losses during the cooking process. This is a desirable fact from the viewpoint of health improvement. However, the analyzed value was higher than the calculated value for some nutrients and further examination is needed.
5. The questionnaire on daily habits for health improvement showed that the ratio of hypertension and obesity was lower than the national average both for men and women surveyed and confirmed the fact that Okinawan people were physically healthier than those in other prefectures.

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