Short Communication

Validity of a food frequency questionnaire in a population with high alcohol consumption in Japan

Noriko Tsunematsu Nakahata RD[1], Akihiko Nakamura Takada PhD, MD[2], Nahomi Imaeda PhD, RD[3], Chiho Goto PhD, RD[4], Kazuyo Hirasada Kuwabara PhD, MN[5], Hideshi Niimura PhD, MD[6], Yusuke Arai PhD, RD[7], Katsushi Yoshita PhD, RD[8], Toshiro Takezaki DMSc, MD[1]

[1]*Department of International Island and Community Medicine, Kagoshima University Graduate School of Medical and Dental Sciences, Kagoshima, Japan*
[2]*Misato Central General Hospital, Saitama, Japan*
[3]*Department of Nutrition and Food Science, Nagoya Women's University, Aichi, Japan*
[4]*Department of Health and Nutrition, Faculty of Health and Human Life, Nagoya Bunri University, Aichi, Japan*
[5]*Department of Preventive Medicine and Public Health, School of Medicine, Keio University, Tokyo, Japan*
[6]*Yonemori Hospital, Kagoshima, Japan*
[7]*Department of Nutrition, Faculty of Healthcare Sciences, Chiba Prefectural University of Health Sciences, Chiba, Japan*
[8]*Department of Food and Human Health Sciences, Osaka City University, Graduate School of Human Life Science, Osaka, Japan*

Background and Objectives: Alcohol consumption has a relatively large impact on energy intake in drinkers, and several studies reported different dietary habits from non-drinkers. However, few studies have investigated the influence of alcohol consumption on the validity of the Food Frequency Questionnaire (FFQ). To investigate its influence, we conducted a validity test in a population with high alcohol consumption. **Methods and Study Design:** The study subjects were 66 residents living on an island in the south-western part of Japan. We conducted the FFQ and 12-day-weighed dietary records (12d-WDRs) in each 3 day of each 4 season. We calculated Pearson correlation coefficients (CCs) and agreement rates according to quartile classification after adjusting for energy. **Results:** The intake energy (kcal) estimated from 12d-WDRs and FFQ was 1,641 and 1,534 in women, and 2,093 and 1,979 in men, respectively. The cumulative percentage contribution of the alcohol energy was 6.7% in men. De-attenuated, log-transformed Pearson's median CCs between the nutrients quantified with the 12d-WDRs and FFQ were 0.51 in women and 0.38 in men. The CCs for carbohydrate and saturated fatty acids intake of men were lower than those in the previous Tokai study using the same FFQ. The findings in agreement rates were consistent with the Tokai study. **Conclusion:** This study suggested that the FFQ can be used for epidemiological studies using categorical comparisons in this population, although the underestimation of carbohydrates and other nutrients in the FFQ should be taken into consideration.

Key Words: validity, Food Frequency Questionnaire, alcohol consumption, weighed dietary record, energy intake

INTRODUCTION

Alcohol consumption in drinkers is relatively high compared to the total amount of energy consumption.[1,2] The amount of alcohol consumption differs by sex, nationality, ethnicity groups,[3] and regions within a country, and sex differences in Asian countries are greater than those in Western countries.[4] Compared to the UK and the USA, the amount of alcohol consumption in Japan is relatively high.[5] There are even regional differences within Japan in alcohol consumption per adult; the alcohol consumption in Tokyo is 1.7 times higher than that in Nara prefecture.[6]

Validity of the estimation of alcohol consumption amounts using quantity-frequency is reported to be high.[7] On the other hand, since eating habits of heavy drinkers are different from those of non-drinkers,[8,9] there has not been a sufficient analysis of the validity differences of dietary surveys between populations with high and low alcohol consumption.

Corresponding Author: Prof Toshiro Takezaki, Department of International Islands and Community Medicine, Kagoshima University Graduate School of Medical and Dental Sciences, 8-35-1 Sakuragaoka, Kagoshima 890-8544, Japan.
Tel: +81 99 275 6853; Fax: +81 99 275 6854
Email: takezaki@m.kufm.kagoshima-u.ac.jp
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As a member of the Japan Multi-Institutional Collaborative Cohort Study (J-MICC study),[10] we conducted a cohort study in the Amami Islands area, Kagoshima prefecture. The J-MICC study used a common questionnaire, including the Food Frequency Questionnaire (FFQ). In order to obtain eating habit information in the J-MICC study, the FFQ was developed based on a dietary survey data of the Tokai area in Japan.[11] Kagoshima prefecture is an area in Japan with a high amount of alcoholconsumption.[6] We conducted a dietary survey in the Amami Islands area to evaluate the FFQ validity in a Japanese population with high alcohol consumption and compared the results with a previous study's results using the same FFQ.[12]

MATERIALS AND METHODS

Study subjects

The study subjects were residents of the Amami Islands area, which is located in the south-western part of Japan, and were recruited using three methods. First, 426 men and women 40 to 69 years old participated in the baseline J-MICC study survey conducted in Amami city in 2007.[13] Of those, 44 participants agreed to participate in the dietary survey following a request for cooperation sent via post in 2009 (agreement rate=10.3%). Second, 12 current municipal officers around 50 years of age and 1 retirees around 60 years of age and seven dietician investigators of the present study were included. Spouses (n=35) of the participants mentioned above were also recruited. In total, there were 99 participants in this study. Participants were excluded as follows: 25 participants who did not keep the total 12-day (12d)-weighed dietary records (WDRs) or complete the FFQ, four participants older than 70 years, two participants with FFQ energy exceeding ±2.5 SD, and two participants with incomplete WDR. Finally, 66 appropriate participants were included in the analysis (including 23 couples). The present study obtained approval from the Ethics Committee of Epidemiological Studies of Kagoshima University Graduate School of Medical and Dental Sciences.

Data collection, nutrients selected, and their calculation

After the investigators obtained oral and written informed consent from each participant, an FFQ survey similar to the J-MICC study was conducted. After that, WDRs were conducted seasonally over two weekdays and one weekend day (Friday, Saturday, Sunday), comprising a total of three days in each season. In total, 12d-WDRs were collected over one year. In order to standardize the survey results, prior training was given to the local dietician investigators. In order to obtain accurate information, three interviews in the three-day dietary survey were carried out by a pair of dieticians in the initial season, twice in the second season, and once or twice in the following seasons. In addition, a verification process was conducted together by a supervisor dietician and the investigators in each survey.

The FFQ collected information on average food consumption of 47 foods from the previous year.[11] This FFQ consisted of quantity and frequency in two parts. Subjects identified categorized frequencies and intake amounts of three staple foods and six types of alcohol drinks that contributed greatly to energy. In the second part, subjects reported frequency only of 43 food items.

WDR was employed as the gold standard for validity analysis, and data were individually collected except several cases using a household-based method (28.7%). The food weight was quantified before processing if the meal was prepared at home, while that from cooked dishes was estimated by a dietician, referring the recipe in cooking textbooks. The foods were coded according to the fifth edition of the Standard Table of Food Composition[14,15] and a fatty acids composition table.[16] The codes of foods without food numbers were referred to the list of similar foods from the National Health and Nutrition Survey-Japan;[17] enriched foods were referred to the typical foods. Oral supplements, spices, and alcohol for cooking were excluded, because oral supplements were included in the J-MICC questionnaire as independent items and the intake amount from spices and alcohol for cooking was too small to estimate in the FFQ. These data were sent to the co-researchers who developed the J-MICC FFQ to recheck food codes and weights.[18]

We determined the intake of 22 macro- and micronutrients, energy% of three macronutrients, and alcohol energy and energy%. Calculation of the average amount of nutrient consumption per day from 12d-WDRs and the FFQ was conducted according to the methods used in the previous study.[11,12]

In order to clarify food characteristics that contribute to energy in the Amami area, cumulative contribution ratios of the 10 highest-ranking foods were obtained from 12d-WDRs. Energy was calculated separately by sex.

Statistical analysis

We calculated de-attenuated, log-transformed, and energy-adjusted Pearson correlation coefficients (CCs) between consumptions of selected nutrients based on the FFQ and 12d-WDRs. Energy adjustment was executed using regression models.[19] De-attenuated Pearson CCs were computed by partitioning within- and between-individual variations by one way analysis of variance according to the formula described elsewhere.[20] Statistical significance was verified with the 95% CI. The percentage exact agreement (EA), agreement within adjacent categories (AA), and disagreement (DA) for subjects in each group were calculated and compared, because this appears to be referring to a future epidemiological study applying the categorical analysis. Statistical analysis was performed with Stata, version 12.0 for Windows (Stata Corp LP, College Station, Texas).

RESULTS

The mean ages and SDs were 58.3±6.2 years in women (n=37) and 59.1±7.3 years in men (n=29) (data not shown in Table). BMI were 23.5 and 23.8, respectively. The distribution of drinkers (≥1 time/week in FFQ) was 24.3% in women and 69.0% in men. The intake energy estimated from 12d-WDRs and FFQ was 1,641 and 1,534 kcal in women, and 2,093 and 1,979 kcal in men, respectively. The percentage differences of energy and three major nutrients between 12d-WDRs and FFQ were relatively small (-16 to 1), but the difference of alcohol energy was relatively large (-45% in women and -40% in men).

De-attenuated, log-transformed Pearson's CCs between the energy quantified with the 12d-WDRs and FFQ were 0.35 in both women and men (Table 1). CCs in the 22 nutrients and three macronutrient energy% after adjustment for energy were distributed from 0.25 (vitamin C) to 0.81 (SFA) in women and from 0.18 (β-carotene Eq) to 0.64 (vitamin D) in men. The median CC (0.51) in the present Amami study was higher than that in the previous Tokai study in women (0.39), but men showed the opposite trend (0.38 vs 0.47).[12] The CC differences between Amami and Tokai were statistically significant in n-3 PUFA, n-3 polyunsaturated fatty acids, highly unsaturated fatty acids, and cholesterol in women and carbohydrate and SFA in men.

Median percentages of EA, AA, and DA according to the quartile classification after energy adjustment were almost similar between women and men, and their DA values were less than 10%, except calcium in women and protein and SFA in men (Table 2). The median values of EA, AA, and DA were similar between Amami and Tokai in women and men.

The cumulative percentage contributions of the top 10 foods for the energy intake from the 12d-WDRs were 39.4% in women and 46.5% in men (Supplemental Table 1). Distilled alcoholic beverage, Shochu (25 vol% alcohol), was ranked second, and pale beer was ranked seventh for the energy consumption in men. The cumulative percentage contribution of total alcohol energy from the top 20 foods was 6.7% in men and 0.9% in women (not all data shown in Tables). The cumulative percentage contributions of total sugar for energy were 1.9% in women and 0.8% in men.

DISCUSSION

The median CCs of nutrients were 0.51 in women and 0.38 in men, which were slightly higher in women and lower in men than the median (0.41, 0.31 to 0.45) in a

Table 1. Pearson correlation coefficients of intakes of energy, alcohol, and nutrients between WDRs and FFQ by sex in Amami and Tokai[12]

	Nutrients and alcohol De-attenuated, log-transformed and energy-adjusted correlation coefficient (95% CI)			
	Women		Men	
	Amami (n=37)† 12d-WDRs	Tokai[12] (n=129)‡ 3d-WDRs	Amami (n=29)§ 12d-WDRs	Tokai[12] (n=73)¶ 3d-WDRs
Energy††	0.35 (0.03–0.61)	0.44 (0.30–0.65)	0.35 (-0.02–0.64)	0.49 (0.29–0.65)
Alcohol energy	0.77 (0.59–0.88)		0.71 (0.46–0.85)	
Protein	0.56 (0.29–0.75)	0.36 (0.25–0.62)	0.33 (-0.04-0.62)	0.50 (0.25–0.71)
Fat	0.54 (0.26–0.74)	0.48 (0.40–0.72)	0.48 (0.14–0.72)	0.62 (0.39–0.80)
Carbohydrate	0.63 (0.38–0.79)	0.64 (0.61–0.85)	0.25 (-0.13–0.56)	0.86 (0.71–0.96)
Alcohol energy%	0.88 (0.78–0.94)		0.77 (0.56–0.89)	
Protein energy%	0.58 (0.32–0.76)	0.37 (0.26–0.63)	0.34 (-0.03–0.63)	0.51 (0.26–0.72)
Fat energy%	0.66 (0.43–0.81)	0.48 (0.40–0.72)	0.56 (0.24–0.77)	0.61 (0.39–0.79)
Carbohydrate energy%	0.64 (0.40–0.80)	0.66 (0.64–0.87)	0.43 (0.08–0.69)	0.86 (0.71–0.97)
Calcium	0.53 (0.25–0.73)	0.59 (0.53–0.78)	0.63 (0.34–0.81)	0.49 (0.25–0.69)
Iron	0.34 (0.02–0.60)	0.44 (0.34–0.66)	0.36 (-0.01–0.64)	0.58 (0.35–0.76)
β-carotene Eq	0.38 (0.06–0.63)	0.38 (0.28–0.65)	0.18 (-0.20–0.51)	0.39 (0.09–0.65)
Retinol Eq	0.53 (0.25–0.73)	0.22 (0.06–0.48)	0.38 (0.02–0.66)	0.27 (-0.03–0.55)
Vitamin D	0.73 (0.53–0.85)	0.40 (0.33–0.73)	0.64 (0.36–0.82)	0.65 (0.36–0.89)
Vitamin B-1	0.30 (-0.03–0.57)	0.10 (-0.10–0.35)	0.48 (0.14–0.72)	0.26 (-0.03–0.52)
Vitamin B-2	0.40 (0.09–0.64)	0.43 (0.32–0.65)	0.57 (0.26–0.77)	0.57 (0.36–0.77)
Folate	0.41 (0.10–0.65)	0.38 (0.25–0.59)	0.29 (-0.09–0.59)	0.36 (0.12–0.58)
Vitamin C	0.25 (-0.08–0.53)	0.52 (0.43–0.71)	0.51 (0.18–0.74)	0.45 (0.21–0.66)
SFA	0.81 (0.66–0.90)	0.42 (0.32–0.66)	0.23 (-0.15–0.55)	0.64 (0.48–0.90)
MUFA	0.36 (0.04–0.61)	0.34 (0.22–0.60)	0.56 (0.24–0.77)	0.43 (0.15–0.55)
PUFA	0.48 (0.18–0.70)	0.25 (0.10–0.51)	0.28 (-0.10–0.59)	0.44 (0.14–0.61)
n-6 PUFA	0.45 (0.15–0.68)	0.31 (0.14–0.46)	0.31 (-0.06–0.61)	0.12 (-0.11–0.34)
n-3 PUFA	0.54 (0.26–0.74)	0.23 (0.06–0.39)	0.30 (-0.07–0.60)	0.55 (0.37–0.69)
n-3 Highly-unsaturated fatty acids	0.72 (0.52–0.85)	0.35 (0.19–0.49)	0.61 (0.31–0.80)	0.36 (0.14–0.55)
Cholesterol	0.71 (0.50–0.84)	0.19 (0.02–0.47)	0.37 (0.00–0.65)	0.13 (-0.16–0.38)
Soluble dietary fiber	0.45 (0.15–0.68)	0.37 (0.25–0.62)	0.50 (0.16–0.73)	0.25 (-0.03–0.50)
Insoluble dietary fiber	0.47 (0.17–0.69)	0.46 (0.36–0.70)	0.47 (0.13–0.71)	0.33 (0.06–0.58)
Total dietary fiber	0.42 (0.11–0.65)	0.47 (0.38–0.71)	0.35 (-0.02–0.64)	0.36 (0.09–0.60)
Median∫	0.51	0.39	0.38	0.47

WDRs: weighed diet records; FFQ: food frequency questionnaire.
†For n=37, $r>0.32$ ($p<0.05$), $r>0.42$ ($p<0.01$).
‡For n=129, $r>0.20$ ($p<0.05$), $r>0.26$ ($p<0.01$).
§For n=29, $r>0.37$ ($p<0.05$), $r>0.47$ ($p<0.01$).
¶For n=73, $r>0.24$ ($p<0.05$), $r>0.31$($p<0.01$).
††CCs of energy were de-attenuated after log- transformed without adjustment for energy.
∫Alcohol energy and alcohol energy% were excluded.
*The number refers to reference in the reference section.

Table 2. Comparison of intakes of energy, alcohol, and nutrients between WDRs and FFQ according to quartile classification by sex in Amami and Tokai[12]

Nutrients and alcohol	Energy-adjusted (%)											
	Women						Men					
	Amami			Tokai[12]			Amami			Tokai[12]		
	EA	AA	DA	EA	AA	DA	EA	AA	DA	EA	AA	DA
Energy†	27	70	5	31	75	5	17	72	7	33	74	3
Alcohol energy	49	81	3				55	93	0			
Protein	38	78	8	34	75	4	34	76	10	29	75	5
Fat	46	73	3	36	76	6	34	69	7	42	84	3
Carbohydrate	41	68	5	41	78	5	31	62	3	42	92	0
Alcohol energy%	54	76	3				55	97	3			
Protein energy%	24	76	8	35	77	3	41	76	10	32	77	4
Fat energy%	46	76	0	37	74	7	34	55	7	41	79	3
Carbohydrate energy%	41	76	0	40	81	5	28	66	0	49	93	0
Calcium	35	68	11	36	83	5	31	76	0	32	78	3
Iron	43	76	3	35	77	5	24	79	7	42	82	4
β-carotene Eq	27	76	5	33	73	6	48	79	0	37	66	10
Retinol Eq	22	68	8	33	73	9	38	76	7	27	66	8
Vitamin D	41	78	0	29	74	9	31	79	0	38	75	7
Vitamin B-1	41	73	8	29	65	9	34	76	3	36	66	5
Vitamin B-2	32	65	0	35	75	5	34	79	3	42	82	1
Folate	41	84	0	40	74	7	31	83	3	38	79	5
Vitamin C	32	81	5	36	78	4	41	76	3	33	74	3
SFA	38	84	0	39	79	9	34	62	21	41	85	5
MUFA	46	73	5	36	72	8	38	79	3	29	71	4
PUFA	35	81	8	27	68	11	38	76	10	32	74	7
n-6 PUFA	38	81	8	26	62	13	38	66	7	26	62	17
n-3 PUFA	35	76	8	28	71	12	21	66	7	28	71	15
n-3 Highly-unsaturated fatty acids	43	73	5	33	70	7	31	79	3	33	70	9
Cholesterol	54	95	3	33	73	12	34	72	3	25	70	12
Soluble dietary fiber	41	73	5	29	76	4	45	79	3	32	68	12
Insoluble dietary fiber	38	73	5	40	77	5	41	72	7	33	70	7
Total dietary fiber	35	78	5	40	76	5	41	83	3	26	70	5
Median‡	38	76	5	35	75	6	34	76	3	33	74	5

WDRs: weighed diet records; FFQ: food frequency questionnaire; EA: exact agreement; AA: agreement within adjacent categories; DA: disagreement.
†Crude.
‡Alcohol energy and alcohol energy% were excluded.
*The number refers to reference in the reference section.

review of seven previous Japanese studies using short FFQs with fewer than 70 food items.[21] The CCs of the previous Tokai study, using the same FFQ as the present study, were 0.39 in women and 0.47 in men.[12] These differences are potentially caused by individual variations due to a small number of subjects, specific local foods that might have been left out of the FFQ, and partially by high alcohol consumption. In the present study, WDRs were implemented for 12 days in order to decrease intra-individual variations. Therefore, the estimated average amount of total energy consumption by the WDR area was similar to that in the adjacent area, Okinawa,[22] suggesting that the quality of gold standard data was secured. As for local specific dietary habits in this study, there was a high consumption of brown sugar as a small refreshment in addition to its usage as seasoning. Rice was often consumed as rice cakes, in addition to its major use as a staple (data not shown). Because these foods were not included in the FFQ, the CCs might have been slightly lowered.

Contribution ratios of alcohol to total consumption energy in men were 3.4% in Tokyo,[23] and high (6.7%) in this study area. For women, it was almost equal, being much lower than that in men. Another study that was conducted among a Japanese male population with higher alcohol consumption similar to our population reported a relatively lower median CC (0.36) of total energy.[24] High alcohol consumption may partially influence the underestimation of nutrient intake using FFQ.

Dietary habits of heavy drinkers were different from those of non-drinkers; in addition to low dietary carbohydrate[25] and fiber[8,26] consumption, they were reported to have a high lipid energy% and protein energy%.[27] On the contrary, because of its limited type and its customary uniform quantity, accurate amounts of alcohol consumption were thought to be easier to estimate than food. Therefore, the influence of alcohol consumption for FFQ validity is complicated and potentially different between populations with different alcohol consumption. The present result of a lower CC for carbohydrate among men was concordant with that in the previous report.[28] However, a relatively high agreement obtained using the quartile classifications between 12d-WDRs and FFQ suggested that the present FFQ could be used for epidemiological study using categorical comparison in the Amami region, although the underestimation of carbohydrates and other nutrients in the FFQ should be taken into consideration.

One of the limitations of this study was the small number of subjects, which resulted in larger individual variations. However, to reduce individual and seasonal variations, we surveyed 12 total days across four seasons. The total number of survey days in this study was 792 days, which was not remarkably different from previous studies.[21] Second, the participation ratio in this study was not high;[28] accordingly, there was a possibility of choice bias of those who liked eating. Third, because the FFQ used was developed in a different area with specific local dietary habits, there is a chance of more foods being left out from the estimation. This study revealed local characteristics of a higher amount of alcohol and sugar consumption.

This study used 12d-WDRs as the gold standard for evaluating FFQ validity among the population with relatively high alcohol consumption. A relatively high agreement between the quartile classifications between 12d-WDRs and FFQ suggested that the present FFQ could be used for epidemiological study using categorical comparison in this population, although the underestimation of carbohydrates and other nutrients in the FFQ should be taken into consideration.

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AUTHOR DISCLOSURES

The authors have no conflict of interest to disclose.

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Supplemental Table 1. Cumulative percentage contribution of the top 10 foods for energy intake by sex in Amami

Rank	Food	Cumulative % contribution
Women		
1	Rice, paddy rice grain, well-milled rice	21.5
2	Breads, white table bread	25.7
3	Swine, pork, large-type breeds, belly, lean and fat, raw	28.5
4	Fats and oils, vegetable oil, blend	30.9
5	Hen's eggs, whole, raw	33.0
6	Liquid milks, ordinary liquid milk	35.0
7	Bananas, raw fruit	36.3
8	Sugars, soft sugars, white	37.4
9	Tofu (soybean curd), momen-tofu	38.4
10	Rice, glutinous rice products, rice cake	39.4
Men		
1	Rice, paddy rice grain, well-milled rice	25.0
2	Distilled alcoholic beverages, Shochu, 25% alcohol	29.3
3	Breads, white table bread	33.3
4	Fats and oils, vegetable oil, blend	36.1
5	Hen's eggs, whole, raw	38.7
6	Swine, pork, large-type breeds, belly, lean and fat, raw	40.9
7	Fermented alcoholic beverages, beer, pale	42.4
8	Liquid milks, ordinary liquid milk	43.9
9	Rice, paddy rice grain, brown rice	45.3
10	Tofu (soybean curd), momen-tofu	46.5

Short Communication

Validity of a food frequency questionnaire in a population with high alcohol consumption in Japan

Noriko Tsunematsu Nakahata RD[1], Akihiko Nakamura Takada PhD, MD[2], Nahomi Imaeda PhD, RD[3], Chiho Goto PhD, RD[4], Kazuyo Hirasada Kuwabara PhD, MN[5], Hideshi Niimura PhD, MD[6], Yusuke Arai PhD, RD[7], Katsushi Yoshita PhD, RD[8], Toshiro Takezaki DMSc, MD[1]

[1]Department of International Island and Community Medicine, Kagoshima University Graduate School of Medical and Dental Sciences, Kagoshima, Japan
[2]Misato Central General Hospital, Saitama, Japan
[3]Department of Nutrition and Food Science, Nagoya Women's University, Aichi, Japan
[4]Department of Health and Nutrition, Faculty of Health and Human Life, Nagoya Bunri University, Aichi, Japan
[5]Department of Preventive Medicine and Public Health, School of Medicine, Keio University, Tokyo, Japan
[6]Yonemori Hospital, Kagoshima, Japan
[7]Department of Nutrition, Faculty of Healthcare Sciences, Chiba Prefectural University of Health Sciences, Chiba, Japan
[8]Department of Food and Human Health Sciences, Osaka City University, Graduate School of Human Life Science, Osaka, Japan

日本高酒精消费人群食物频率问卷的有效性

背景与目的：酒精消费对饮酒者的能量吸收有相对较大的影响，一些研究报告了非饮酒人群不同的饮食习惯。然而，很少有研究调查酒精消费对食物频率问卷（FFQ）有效性的影响。为了研究它的影响，我们对高酒精消费人群进行了有效性测试。**方法与研究设计**：研究对象为居住在日本西南部的一个岛屿上的 66 名居民。我们进行了 FFQ 和 12 天称重饮食记录（12d-WDRS），4 个季节，每个季节 3 天。我们根据四分位数分类校正能量后计算了 Pearson 相关系数（CCS）和一致率。**结果**：根据 12d-WDRS 和 FFQ 估计摄入的能量（千卡）女性为 1641 和 1534，男性为 2093 和 1979 人。男性酒精能量的累积贡献率为 6.7%。12d-WDRS 和 FFQ 之间营养素量化后对数变换 Pearson 中位 CCS 在女性为 0.51，男性为 0.38。男性碳水化合物和饱和脂肪酸摄入量之间的 CCS 低于之前在东海使用相同 FFQ 进行的研究，但一致率的结果与东海的研究一致。**结论**：尽管我们应该考虑到 FFQ 会低估碳水化合物和其他营养素，但 FFQ 可用于日本高酒精消费这一群体分类比较的流行病学研究。

关键词：有效性、食物频率问卷、酒精消费、称重饮食记录、能量摄入