Table 2. Summary of validation studies on correlation coefficients between intaks assessed with a questionnaire and with dietary record or recall methods as gold standard

Author	Date	Takatsuka	Sasaki	Katagiri	Shimizu		Egami		Yamaoka	Tokudome	Takahashi	Lee	Ogawa		Tsugane		Ishihara		Tsubono		All studies		
Published year	1996	1997	1998	1998	1999		1999		2000	2001	2001	2003	2003		2003		2003		2003				
Questionnaire ID	1	2	3	4	5		6		7	8	9	10	11		12		12		13				
Sex	M+W	M+W	W	M+W	M	W	M	W	M	W	M+W	M	M	W	M	W	M	W	M	W			
Method of analysis																							
Log-transformation[a]	…	…	X	X	X		X		X	X	…	X	…		…		…		…				
Adjustment[b]	X	X	X	…	X		X		X	X	…	X	X		X		X		X		n	Median	Range
Deattenuation[c]	…	…	X	…	…		…		…	X	…	…	X		…		…		…				
Type of correlation	P,S	P	P	P	P		P		P	P,S	P	P	S		S		S		S				
Energy (kcal)	0.65	…	0.48	0.55	0.38	0.25	0.25	0.39	0.64	0.48	0.47	0.23	0.55	0.36	0.55	0.44	0.34	0.22	0.52	0.38	17	0.44	0.22−0.65
Carbohydrate (g)	0.58	0.34	0.48	0.57	0.51	0.29	0.52	0.24	0.56	0.57	0.49	0.45	0.57	0.43	0.56	0.37	0.59	0.39	0.51	0.33	18	0.51	0.29−0.59
Protein (g)	…	0.57	0.48	0.42	0.45	0.37	0.19	0.30	0.16	0.53	0.42	0.44	0.25	0.49	0.43	0.40	0.30	0.31	0.28	0.34	17	0.40	0.16−0.57
Fat (g)	…	−0.03	0.55	0.35	0.43	0.51	0.62	0.30	0.65	0.49	0.39	0.19	0.37	0.50	0.52	0.46	0.57	0.40	0.30	0.41	17	0.46	−0.03−0.65
SFA (g)	…	0.51	0.75	…	…	…	0.76	0.37	…	0.62	0.27	…	…	…	0.61	0.60	0.62	0.51	0.42	0.50	10	0.61	0.42−0.76
MUFA (g)	…	0.12	0.50	…	…	…	0.61	0.28	…	0.44	0.24	…	…	…	0.50	0.44	0.55	0.37	0.23	0.39	10	0.44	0.12−0.61
PUFA (g)	…	−0.15	0.37	…	…	…	0.39	0.42	…	0.28	0.24	…	…	…	0.27	0.24	0.44	0.33	0.06	0.22	10	0.28	−0.15−0.44
Cholsterol (mg)	…	0.52	0.49	…	0.36	0.31	0.53	0.21	−0.19	0.59	0.52	…	…	…	0.33	0.35	0.47	0.47	0.36	0.30	13	0.36	−0.19−0.59
Vitamin A (IU)	0.21	0.22	0.38	0.45	0.42	0.27	0.46	0.52	0.36	0.35	0.06	0.19	…	…	…	…	…	…	…	…	10	0.36	0.19−0.46
Retinol (μg)	0.53	0.21	…	…	…	…	0.63	0.48	…	…	0.18	…	0.38	0.30	0.22	0.43	0.35	0.47	0.36	0.34	11	0.36	0.21−0.63
Carotene (μg)	0.25	0.45	…	…	0.36	0.48	0.36	0.51	…	0.33	…	…	0.56	0.45	0.36	0.33	0.47	0.49	…	…	12	0.41	0.25−0.56
Thiamin (mg)	…	…	0.46	0.37	…	…	…	…	0.42	…	0.40	…	0.33	0.31	0.40	0.41	0.28	0.32	0.36	0.22	11	0.36	0.22−0.46
Riboflavin (mg)	…	…	0.58	0.36	…	…	…	…	0.37	…	0.42	…	0.43	0.54	0.34	0.45	0.55	0.55	0.43	0.39	11	0.43	0.34−0.58
Niacin (mg)	…	…	0.19	…	…	…	…	…	−0.07	…	0.24	…	0.33	0.47	0.35	0.15	0.33	0.22	0.14	0.11	10	0.21	−0.07−0.47
Vitamin C (mg)	0.38	0.44	0.45	0.36	0.21	0.21	0.45	0.40	0.52	0.42	0.48	0.35	0.58	0.43	0.42	0.22	0.46	0.44	0.38	0.29	18	0.42	0.21−0.58
Calcium (mg)	0.74	0.69	0.49	0.41	0.51	0.59	0.61	0.73	0.55	0.64	0.41	0.52	0.57	0.67	0.43	0.47	0.65	0.64	0.56	0.37	18	0.57	0.37−0.74
Phosphorus (mg)	…	…	0.59	…	…	…	…	…	0.26	0.58	0.45	…	0.52	0.69	0.37	0.42	0.49	0.54	0.56	0.44	11	0.52	0.26−0.69
Iron (mg)	…	…	0.40	0.15	…	…	0.22	0.57	0.14	0.55	−0.01	0.31	0.35	0.47	0.49	0.33	0.54	0.51	0.31	0.30	14	0.34	0.14−0.55
Sodium (mg)	0.26	0.33	0.32	0.16	0.18	0.10	…	…	0.34	…	0.43	…	0.37	0.33	0.41	0.48	0.42	0.45	0.33	0.49	15	0.33	0.10−0.49
Potassium (mg)	0.50	…	0.68	…	…	…	0.55	0.52	−0.10	0.61	0.23	0.63	0.45	0.45	0.39	0.31	0.49	0.49	0.38	0.37	14	0.47	−0.10−0.68
All nutrients[d]																							
n	8	13	17	10	9		14		14	14	18	8	14		18		18		17			282	
Median	0.44	0.34	0.48	0.37	0.42	0.31	0.53	0.41	0.35	0.54	0.40	0.40	0.41	0.46	0.41	0.41	0.48	0.46	0.36	0.34		0.42	
Macronutrients																							
n	1	6	6	3	3		6		3	6	6	3	3		6		6		6			94	
Mean	0.58	0.23	0.49	0.42	0.45	0.37	0.57	0.30	0.56	0.51	0.33	0.44	0.37	0.49	0.51	0.42	0.56	0.38	0.29	0.37		0.43	
Micronutrients																							
n	7	7	11	7	7		7		11	8	12	5	11		12		12		11			188	
Mean	0.38	0.44	0.46	0.36	0.36	0.29	0.50	0.52	0.34	0.57	0.41	0.35	0.43	0.45	0.38	0.38	0.47	0.48	0.36	0.34		0.41	

[a] Values were log-transformed before analysis
[b] Values were adjusted for energy by residual method except for energy intake
[c] Values were deattenuated considering within-subject variation
[d] Except energy intake
Abbreviations : P : Pearson's product moment correlation coefficient, S : Spearman's rank correlation coefficient, … : Not reported, SFA : Saturated fatty acids,
SFA : saturated fatty acids, MUFA : onounsaturated fatty acids, PUFA : polyunsaturated fatty acids

Table 3. Summary of validation studies on percent differences between intaks assessed with a questionnaire and with dietary record or recall methods as gold standard

Author	Date	Takatsuka	Sasaki	Katagiri	Shimizu	Egami	Yamaoka	Tokudome	Takahashi	Lee	Ogawa		Tsugane		Ishihara		Tsubono		All studies		
Published year	1996	1997	1998	1998	1999	1999	2000	2001	2001	2002	2003		2003		2003		2003				
Questionnaire ID	1	2	3	4	5	6	7	8	9	10	11		12		12		13		n	Median	Range
Energy (kcal)	− 8	⋯	1	−10	4	7	− 8	− 3	6	−39	−16	−27	0	11	− 4	5	−15	−25	17	− 6	−39− 11
Carbohydrate (g)	− 3	19	3	−13	0	8	−13	− 5	3	−32	− 6	−22	− 4	7	− 8	0	− 2	−18	18	− 4	−32− 19
Protein (g)	⋯	28	1	−26	3	1	− 8	1	3	−45	−32	−31	− 4	11	−13	0	−30	−31	17	− 6	−45− 28
Fat (g)	⋯	23	− 1	3	7	0	− 8	2	9	−39	−37	−36	12	22	10	22	−41	−40	17	1	−41− 23
SFA (g)	⋯	15	2	⋯	⋯	6	⋯	6	11	⋯	⋯	⋯	11	18	22	31	−20	−17	11	9	−20− 31
MUFA (g)	⋯	15	7	⋯	⋯	− 1	⋯	2	9	⋯	⋯	⋯	19	32	28	42	−46	−45	11	11	−46− 42
PUFA (g)	⋯	24	7	⋯	⋯	− 1	⋯	− 2	13	⋯	⋯	⋯	− 9	6	−11	2	−58	−58	11	− 2	−58− 24
Cholsterol (mg)	⋯	19	19	⋯	14	− 1	− 5	− 5	5	⋯	⋯	⋯	−20	−11	−18	6	−33	−29	13	− 5	−33− 19
Vitamin A (IU)	−15	67	1	−16	14	3	66	17	4	−53	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	10	3	−53− 67
Retinol (μg)	−12	8	⋯	⋯	⋯	22	⋯	⋯	12	⋯	17	8	49	63	53	71	76	86	12	49	−12− 86
Carotene (μg)	−18	80	⋯	⋯	40	−11	⋯	5	⋯	⋯	−57	−39	16	29	7	26	⋯	⋯	11	7	−57− 80
Thiamin (mg)	⋯	⋯	17	−19	⋯	⋯	− 7	⋯	10	⋯	−30	−26	− 4	10	−10	5	−30	−32	12	−10	−32− 17
Riboflavin (mg)	⋯	⋯	15	− 6	⋯	⋯	17	⋯	− 1	⋯	−25	−22	15	25	2	14	−12	− 6	12	2	−25− 25
Niacin (mg)	⋯	⋯	6	⋯	⋯	⋯	25	⋯	5	⋯	−39	−34	− 4	8	−16	0	−37	−40	11	−10	−40− 25
Vitamin C (mg)	7	148	13	9	−19	41	−17	17	11	−44	−22	−17	29	40	13	30	−33	−28	18	9	−44−148
Calcium (mg)	10	34	25	−26	9	16	− 7	13	5	−42	−29	−23	10	17	− 3	3	−11	− 5	18	3	−42− 34
Phosphorus (mg)	⋯	⋯	9	⋯	⋯	⋯	−16	5	5	⋯	−31	−28	1	13	− 7	6	−17	−18	12	− 7	−31− 13
Iron (mg)	⋯	⋯	16	−36	⋯	1	− 6	0	−11	−50	−35	−33	− 5	7	−18	− 6	−35	−36	15	−12	−50− 16
Sodium (mg)	2	24	2	−21	−20	⋯	− 7	⋯	− 3	⋯	−59	−56	9	17	1	8	−53	−56	15	− 3	−59− 24
Potassium (mg)	4	⋯	2	⋯	⋯	11	−17	2	3	−40	−36	−30	3	13	− 8	4	−30	−28	15	− 3	−40− 13
All nutrients[a]																					
n	8	13	17	10	9	14	14	14	18	8	14	14	18	18	18	18	17	17		259	
Median	− 1	24	7	−18	7	2	− 7	2	5	−43	−32	−29	6	15	− 5	6	−30	−29		1	
Range	−18−10	8−148	−1−25	−36−9	−20−40	−11−41	−17−66	−5−17	−11−13	−53−−32	−59−−17	−56− 8	−20−49	−11−63	−18−53	−6−71	−58−76	−58− 86		−59−148	
Macronutrients																					
n	1	6	6	3	3	6	3	6	6	3	3	3	6	6	6	6	6	6		85	
Median	− 3	23	3	−13	3	1	− 8	2	9	−39	−32	−31	4	15	1	12	−36	−36		1	
Range	− 3	15− 28	−1− 7	−26−3	0− 7	−1− 8	−13−−8	−5− 6	3−13	−45−−32	−37−− 6	−36−−22	− 9−19	6− 32	−13−28	0−42	−58−−2	−58−−17		−58− 42	
Micronutrients																					
n	7	7	11	7	6	8	11	8	12	5	11	11	12	12	12	12	11	11		174	
Median	2	24	13	−19	12	7	− 7	5	5	−44	−31	−28	6	15	− 5	6	−30	−28		1	
Range	−18−10	8−148	1−25	−36−9	−20−40	−11−41	−17−66	−5−17	−11−12	−53−−40	−59− 17	−56− 8	−20−49	−11−63	−18−53	−6−71	−53−76	−56− 86		−59−148	

See Table 2 for reference number and method of analysis
[a]Values were log-transformed before analysis
Abbreviations : SFA : saturated fatty acids, MUFA : monounsaturated fatty acids, PUFA : polyunsaturated fatty acids, ⋯ : not reported

Table 4. Summary of validation studies with biomarkers as gold standard : correlation coefficients between calculated intake and corresponding biomarker

Authors, years	Sasaki, 2000; Sasaki 1998		Kobayashi, 2003; Kobayashi, 2003; Kobayashi, 2003; Iso, 2003; Karita, 2003; Yamamoto, 2001; Sasaki, 2003; Sasaki, 2003	
Questionnaire ID	3		12	
Sex	Men	Women	Men	Women
Method of analysis				
Log-transformation[a]	X		…	
Adjustment[b]	X		X	
Type of correlation	Pearson		Spearman	
Serum/plasma concentration				
Fatty acid[c]	(n = 42)	(n = 44)	(n = 88)	
Palmitic acid	−0.16	−0.01	−0.44	…
Oleic acid	−0.13	−0.03	−0.05	…
Linoleic acid	0.15	0.39	0.18	…
Alpha-linoleic acid	−0.22	0.36	−0.09	…
Eicosapentaenoic acid	0.64	0.65	0.44	…
Docosahexaenoic acid	0.44	0.59	0.32	…
Marine origin n-3 PUFA	0.51	0.69	…	…
SFA	−0.20	0.00	−0.09	…
MUFA	−0.04	−0.05	0.04	…
PUFA	0.30	0.37	0.19	…
Vitamin			(n = 102)	(n = 113)
Alpha-carotene	0.56	0.42	0.21	0.08
Beta-carotene	0.34	0.49	0.34	0.30
Total carotene	0.40	0.47	0.18	0.03
Lycopene	…	…	0.26	0.10
Alpha-tocopherol	−0.23	0.09	…	…
Vitamin C	…	…	−0.20	−0.14
Folate	…	…	0.26 (n = 87)	…
Vitamin B_6	…	…	0.23 (n = 87)	…
Vitamin B_{12}	…	…	0.06 (n = 87)	…
Mineral			(n = 85)	(n = 95)
Selenium (in serum)	…	…	0.16	−0.02
Selenium (in erythrocyte)	…	…	0.15	0.13
Other nutrient			(n = 202)	
Daidzein	…	…	0.26	
Genistein	…	…	0.22	
24-hour urinary excretion[d]				
Mineral	(n = 154)	(n = 69)	(n = 32)	(n = 57)
Sodium	0.14	0.23	0.35	0.25
Potassium	0.34	0.40	0.48	0.18
Daidzein	…	…	0.40 (n = 202)	
Genistein	…	…	0.30 (n = 202)	

[a]Values were log-transformed before analysis
[b]Values were adjusted for energy by residual or density method
[c]In phospholipid fraction in serum
[d]Adjustment for creatinine
Abbreviations : SFA : saturated fatty acids, MUFA : monounsaturated fatty acids, PUFA : polyunsaturated fatty acids

Table 5. Summary of validation study for examining validity to assess change in intakes : correlation coefficients between calculated intake and corresponding biomarker

Author, year	Sasaki, 1999
Questionnaire ID	3
Biomarker = change in serum cholesterol (n = 63)	
SFA (%E)	0.25
PUFA (%E)	0.06
Cholesterol (%E)	0.22
Keys score (score)	0.33

Abbreviations : SFA : saturated fatty acids, MUFA : monounsaturated fatty acids, PUFA : polyunsaturated fatty acids, %E : percentage of energy intake

0.68 and −0.19 − 0.59 respectively.

Table 3 shows the percent differences between intakes assessed with a questionnaire and with dietary record or recall method as gold standard. The results varied by studies, i.e., 4 questionnaires substantially underestimated their intakes by more than nearly 20% or more as median, and one overestimated the intakes by more than 20% as median. Relatively cross estimate for macronutrients was shown in 4 questionnaires, i.e., the range was less than ± 10%. Relatively narrow range of percent difference, i.e., less than 30%, for micronutrients was observed in 4 questionnaires. Only two questionnaires developed by Sasaki et al. and Tokudome et al. were included in both. Among nutrients examined, vitamin C, carotene, and vitamin A showed considerably different results between studies, i.e., the difference between the minimum and the maximum values was more than 100%.

Table 4 shows the summary results of validation studies in which biomarkers were used as gold standard. Eicosapentaenoic and docosahexaenoic acids, alpha- and beta-carotene showed in general a reasonably high level of correlation in both questionnaires. Folate and vitamin B_6 in serum also showed meaningful correlation in one questionnaire. In the analysis with 24-hour urinary excretions, potassium showed a reasonably high level of correlation in both questionnaires. The correlations observed in daidzein and genistein in one questionnaire was of interest. The correlation for sodium was relatively high in men in one questionnaire, but not so in the other. The correlation in women was moderate in both questionnaires.

Table 5 shows summary results for examining validity to assess change in intake. Only one questionnaire was examined using change in serum cholesterol as biomarker. The calculated Keys score showed a reasonable level of correlation, 0.33, with the change in serum cholesterol.

Discussion

Although the level of research activities on human nutrition in Japan is much behind those in Western countries, development and use of dietary assessment questionnaires have rapidly increased during these 8 years.

The correlation coefficients reported in the validation studies included in the present study were generally lower than those reported by studies in Western countries (Willett, Lenart 1998). Although we can not know real reasons, it may partly attribute to the dietary pattern of Japanese subjects and their recognition of foods and menus. For example, a Japanese meal usually consists of main staple, main dish, side dishes, and miso (fermented soybean paste) soup. Main and side dishes contain several, at least three or four, food items. In each dish, meat and vegetables are usually mixed. Their portion size varies according to dishes. Therefore, Japanese do not have a clear concept for "standard portion size". This may make answers to questions about portion size difficult. This problem may severely affect to underreporting among subjects who do not know cooking and ingredients in dishes, and overreporting among subjects who know them very much, because the former may omit several food items included in mixed dishes and the latter may count foods with small portions in mixed dishes. But no report has yet existed for this topic in Japanese populations.

Number of foods/menus assessed in a questionnaire should carefully be considered when developing a dietary assessment questionnaire. A questionnaire with a large number of foods/menus can expect higher validity than that with a fewer number of foods/menus. On the other hand, the opposite is expected for feasibility. When the correlation coefficients listed in Table 2 were divided into two groups, i.e., 7 questionnaires with 97 foods/menus or more and with 65 or less, the mean correlation coefficient was 0.44 (n = 11) and 0.36 (n = 9) (the difference was statistically significant, $p < 0.01$), respectively. But interpretation of this result is not so easy because the comparisons between questionnaires and results of validation studies are difficult because both structures of questionnaires and characteristics of subjects were different from each other.

For correlation coefficients observed in the studies with dietary record or recall methods as gold standard, relatively high level of correlation was observed in SFA (median r =

0.61), calcium (median r = 0.57), and phosphorus (median r = 0.52). In contrast, it was relatively low in niacin (median r = 0.22), PUFA (median r = 0.28). It varied between questionnaires in potassium (range of r = −0.10 − 0.68) and cholesterol (range of r = −0.19 − 0.59). The low validity in PUFA may attribute partly to cooking oil. In contrast, milk, which is relatively easy to assess, is one of the major contributors of SFA as wells as calcium in the Japanese population (Tokudome et al. 1999). High validity of milk intake may partly contribute to the high validity in SFA as well as calcium. Validity in sodium was not so high (median = 0.33). The difficulty of assessment of sodium intake by questionnaire has long been discussed (Shepherd et al. 1985). Several dietary assessment questionnaires developed in Western countries did therefore not include sodium in the targeted nutrients. Among these 13 questionnaires, 3 questionnaires did not report validity for sodium. Expected correlation is slightly lower and higher than a true correlation when a questionnaire is assessed before and after the measurement by dietary record or recall, respectively (Willett, Lenart 1998). Majority of validation studies included in the present analysis used assessment of questionnaire after the completion of measurement of gold standard. This may be considered to evaluate validity of a questionnaire although many other confounders do exist.

Biomarkers were used only in two questionnaires. In both questionnaires, reasonable validity was observed for marine-origin n-3 PUFA, and carotenes. In studies with 24-hour urinary excretion as biomarker, potassium showed a relatively reasonable validity except for women in one questionnaire. But more careful validation seems necessary for sodium. In one questionnaire, several nutrients were examined. Among them, folate ad vitamin B6 showed a relatively high level of correlation. The validation for daidzein and genistein was of great interest because their intake was extremely high in Japanese compared to Western populations (Greendale et al. 2002), and several health effects are postulated in these nutrients (Setchell 1998).

Only one questionnaire developed by Sasaki et al. was validated of its ability to assess change in nutrient intakes. Change in serum cholesterol was used as a biomarker for this purpose. This type of validity, which is called "responsiveness", is essential when a questionnaire is used for evaluating change in dietary habits. This is particularly important in questionnaires used in dietary intervention studies.

In most of epidemiologic studies to examine relative risk of exposures to outcome measures, ranking ability is more important than ability to estimate true, i.e., absolute, intake levels. In these studies, questionnaires with high level of correlation coefficients of targeted nutrients shown in Table 2 are more useful regardless of the results on percent difference shown in Table 3. In contrast, in health educations absolute values of intakes, rather than the ranking, are used, ability to estimate absolute intake at an individual level is needed. In this case, high level of ability both in correlations shown in Table 2 and percent differences shown in Table 3 is required. Further research is needed to develop this type of questionnaire for Japanese subjects.

One of the shortcomings in nutritional research in Japan is a lack of reliable food composition tables in several nutrients. Several missing values exist especially in micro- and trace nutrients. It has made the nutrient calculation by the developed questionnaires difficult or impossible. Some groups have developed food composition tables of nutrients for their research interest such as fatty acids (Sasaki et al. 1999) and carotenes (Takahashi et al. 2001). They included the tables into the nutrient calculation algorism of questionnaires developed by their own. This is considerably important because targeted nutrients in recent nutritional epidemiologic studies and dietary education shifted from conventional macronutrients to micro- and trace-nutrients.

Most of the validation studies used middle-aged subjects. Epidemiologic studies and dietary education is also interesting and necessary for children and elderly subjects. To our knowledge, neither development nor validation study has been published either for children nor elderly subjects. Development and validation of specific population may be one of the future research topics in this field.

Although beyond the scope of this review, feedback system with high quality seems to be important in order to obtain high feasibility. This is, without doubt, important when a questionnaire is used for health education.

Summary and Conclusion

Few self-administered dietary assessment questionnaires have been developed and validated in Japan during these 8 years. These questionnaires are now widely used in several nutritional epidemiological and dietary intervention studies in Japan. We can expect several scientific communications in this field from Japan in near future. At the same time, more validation studies using biomarkers are needed because studies with dietary record or dietary recall method are imperfect. We also need to develop and validate new questionnaires for special purposes and populations such as studies for children and elderly subjects.

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Influence of Co-Habitation on a Family Line Resemblance in Nutrient and Food-Group Intake among Three Generations of Japanese Women*

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ABSTRACT

Although a generation-related difference in nutrient and food-group intake has been broadly recognized in the Japanese population, few studies have examined the difference and correlation of intakes with consideration of a family line and co-habitation status. We conducted a dietary survey using female college students in dietetic course in Aichi, Japan, and their mothers and grandmothers. A validated self-administered diet history questionnaire was used for assessment of intakes. Data from 110 families were included in the analysis. The means of 13 nutrients and 10 food groups (of the 15 and 14, respectively) showed significant differences among the three generations. A significant difference was observed in the carbohydrate, protein, saturated fatty acid, cholesterol, and fish intakes between the students living with their mothers and those apart. In the correlation analyses between generations, moderate correlation was observed for most nutrients and food groups between the students and their mothers living together (correlation range = 0.30 − 0.61 for nutrients, and = 0.21 − 0.56 for food groups). A wide variation with no consistency was observed for the correlation between the students and their grandmothers (−0.18 − 0.59 and −0.33 − 0.65, respectively). No meaningful correlation was observed between any two generations living apart. Among the food groups examined, pulses, fish, and vegetables showed relatively large differences for the correlation between two groups with different living conditions. When living together, the correlation coefficients for nutrients and food groups between the students and their mothers decreased according to the increase in frequency of eating out by the students. These results suggest that living together and eating together were an important factor for the resemblance in dietary habits between generations in the population with a marked generation-related difference in intakes. (*J Community Nutrition* 5(2) : 93~104, 2003)

KEY WORDS : generation · co-habitation · dietary survey · women · Japanese.

Introduction

The disease structure of adult Japanese has changed markedly for the past 40 years. As it is represented by the great reduction of cerebrovascular mortality, the change is greatly notable in comparison with those in European countries and U.S.A. (Kesteloot et al. 1994). Concerning the intake of nutrients which are considered to be associated with these diseases, a great change was observed during the same period (Yoshiike et al. 1996). It has been also pointed out that the change influenced the disease structure (Ueshima et al. 1987). When such a rapid change in eating habit occurs, it is assumed that the change differs among generations (age groups). Several studies have reported that the nutrient intakes differed according to generations (Ministry of Health and Welfare. 1998 ; Kimura et al. 1992). On the other hand, in Europe and U.S.A., no notable difference of the nutrient and food group intakes among different generations has been observed so much as that in Japan (Block et al. 1988 ; Kornitzer, Bara 1989 ; Bir et al. 1996).

To examine the differences of the nutrient and food intakes among different generations, there is a method which pays attention to family unit. For example, if the intake of nutrient

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and food groups in a mother is ranked at a high position among a mother group, the intake of her daughter may or may not be ranked at a high position among a daughter group. This becomes possible by examining the correlation between the intakes of the mothers and the daughters. A characteristic of this method is to investigate for similarity of the intake of nutrient and foods among family members. A great factor to influence the result is how much they take common foods. According to European studies using this method, when they live together in a house and take common foods, the intakes of nutrient between parents and children were correlated at the correlation coefficient of about 0.24 − 0.55. On the other hand, in case of parents and children who don't live together, the coefficient is reported to range from 0.13 to 0.27 (Stafleu et al. 1994). In Japan where a marked difference of nutrient intakes is observed among generations, the correlation may be different from those observed in Europe. Because dietary survey at individual level for a large number of subjects is difficult, to our knowledge, no study on this matter exists in Japan.

Therefore, we examined generation-related differences of nutrient and food group intakes and their correlations between generations using 110 family sets of female college students, their mothers and grandmothers.

Subjects and Methods

1. Subjects

In July, 1996, 173 female students (freshmen and sophomore) taking dietetic course of junior college in Aichi, Japan, and their mothers and grandmothers were invited to the survey. As for grandmothers, those of the maternal line were given priority, and when a grandmother of the maternal line was difficult to be investigated, a grandmother of the paternal line was made a subject. When the relevant persons were difficult to be investigated, others (aunt or father) were included.

2. Survey methods

In the middle of July, 1996, self-administered diet history questionnaire (DHQ) (Sasaki et al. 1998a ; Sasaki et al. 1998b) was distributed to the students and it was requested to answer it during summer holidays and submit it to one of the authors (TT). For students who lived apart and planed to return home during the holidays, they were instructed to answer the questions before or soon after returning home in order to know habitual dietary habits. In the beginning of September, 519 questionnaires answered were submitted. When errors or illogical answers were found, it was requested to re-answer it. In the end of September, valid answers were obtained from 518 subjects who submitted the questionnaires.

In addition, current residential style, such as living with the mother, living apart from the mother was asked. As for students living apart from the mother, residential style was divided into dormitory and living apart (apartment or rooming). Date of birth, body height, and body weight were also asked.

The valid answers were collected from 173 students, 171 mothers, 145 grandmothers, and 29 other persons. The valid answers from all female three generations were obtained from 144 families.

3. Self-administered diet history questionnaire(DHQ)

For the survey of nutrient and food intakes, we used a validated self-administered diet history questionnaire (Sasaki et al. 1998a ; Sasaki et al. 1998b). The questionnaire was structured to ask eating habit for past one month, and was divided into seven sections as follows : 1) Questions about behaviors including preference of seasonings. 2) Questions about intake frequency of 125 foods and their relative portion sizes. 3) Questions about intake, frequency and relative portion size, of 12 kinds of main staples including rice, breads, noodles, and other wheat products, and miso-soup (fermented soy bean paste soup). 4) Questions about main cooking methods for fish and selfish, meats, eggs, and vegetables. 5) Questions about intake frequency of six kinds of liquors and their portion sizes. 6) Questions about intake frequency and amount, and brand-name if possible, of 10 kinds of dietary supplements. 7) For foods which are not listed above, frequency and description about foods taken habitually.

The above 2), 3), 5), and 6) correspond to the semiquantitative questions about food intake frequency (Willett 1998), with which daily food intake is calculated. A program was developed to estimate intake of salt, cooking oil, and sugar by technique of diet history method with the information obtained from 1), 2), and 4) (Burke 1947). The intake of soup for noodles is estimated from the questions contained in 1) and 2). The intake of curry and stew roux from the questions in 1). The 5 − 10% of subjects answered some foods in 7) in previous studies (unpublished data). As most of them answered about the same food in 2) too, they were corrected when the answers were checked. Besides it, the

Table 1. Classification of food and food groups assessed with self-administered diet history questionnaire and used in the present study

Food group	Number of food items[1)]	Food name[2)]
(Foods assessed with the semiquantitative frequency question section)		
Cereals	1(1)	Cornflake[1)]
Potatoes	5(1)	Potato chips, French fry, potatoes by other cooking method, sweet potatoes, yam, taros, konnyaku[1)]
Sugars and sweeteners	2(0)	Sugar for coffee and tea, jam/marmalade
Confectioneries	10(3)	Rice snacks/crackers, snacks made from wheat flowers, Japanese sweets with azuki-beans, Japanese sweets without azuki-beans, cakes, cookies/biscuits, chocolates, jellies[1)], candies[1)], caramels[1)]
Nuts and seeds	2(1)	Peanuts, other nuts[1)]
Fats and oils		
Animal fats	1(0)	Butter
Vegetable oils	3(0)	Margarine, mayonnaise, salad-dressings
Pulses	5(1)	Tofu, tofu-products, natto, other beans, miso as seasoning[1)]
Fish and shellfish	15(4)	Dried fish, small fish with bones, canned tuna, fish with white meat, fish with blue back, fish with red meat, surimi (ground fish meat)-products, squids/octopus, shrimps/crabs, oysters[1)], other selfish[1)], fish eggs[1)], salted fish guts[1)]
Meats	8(1)	Ground beef/pork meats, chicken, pork, beef, liver, hum/sausage, bacon, salami-sausage[1)]
Eggs	1(0)	Eggs (hen's, quail's)[1)]
Milks	6(1)	Milk (full-fat, low-fat, skimmed-), yogurt (sweetened, no sweetened), cheese, ice-cream (lacto-ice, high fat), coffee cream, cottage cheese[1)]
Fruits	14(8)	Oranges (including grapefruits), bananas, strawberries, fruit juice (100%), other fruit juices, kiwifruits[1)], persimmons[1)], melons[1)], waterme-lons[1)], raisons[1)], plums[1)], canned fruits[1)], tomato juices[1)]
Vegetables		
Green and yellow vegetables	6(2)	Carrots, pumpkins, tomato, green leafy vegetables, pimentos[1)], broccolis[1)]
Light-color vegetables	18(9)	Umeboshi (salted plum pickles), salted pickles except umeboshi, cabbages, lettuces, Chinese cabbages, cucumbers, bean sprouts, Chinese radishes, onions, scallion bulbs[1)], cauliflowers[1)], cowpeas[1)], eggplants[1)], burdocks[1)], turnips[1)], bamboo shoots[1)], lotus roots[1)], vegetable juices[1)]
Mushrooms	1(0)	Mushroom
Seaweeds	2(1)	Wakame seaweed, laver[1)]
Seasonings	3(1)	Ketchup, table salt, non-oil type salad dressing[1)]
Alcoholic beverages	7(1)	Japanese alcohol (sake), beer, wispy, shochu, shochu highball, wine, Chinese herbal liquors[1)]
Non-alcoholic beverages	11(6)	Green tea, oolong tea, tea, coffee, soft drinks such as cola, soft drinks without sugar such as sports beverages, fruit juices other than 100% fruits, lactic acid bacteria beverages[1)], cocoa[1)], nutrition tonics[1)], fiber-enriched beverages[1)], other diet beverages[1)]
Soups	2(2)	Corn soup[1)], Chinese soup[1)]
Diet foods	2(2)	Nutrition tonic bars[1)], artificial sweeteners[1)]
Total	125(0)	
Water[3)]	1(1)	Water[1)]
Dietary supplements[3)4)]	10(10)	Calcium[1)], vitamin C[1)], vitamin B[1)], vitamin E[1)], multivitamin[1)], beta-carotene[1)], soy protein[1)], dietary fiber[1)], soy lecithin[1)], EPA/DHA[1)]
(Foods estimated from the questions about main staples)		
Cereals	3	Rice (polished, 70%-polished, 50%-polished, unpolished, with barley), breads, other wheat products other than noodles (breads in-cluding, French breads, cake breads, buttered roll, croissant, donut, pizza, Japanese-style pancakes, grilled dumplings with bits of octopus), noodles (buckwheat, Japanese wheat noodle, instant noodle, Chinese noodle, spaghetti, pastas)
Pulses	1	Miso in miso-soup
(Foods estimated by combination of the questions about semiquantitative food frequency and eating behaviors)		
Sugars	1	Sugars used during cooking
Oils (vegetable oil)	1	Oils used during cooking
Seasonings	2	Salt and salt-rich seasonings used during cooking, table salt and salt-rich seasonings used at table
Soup, roux[3)]	2	Needle soup, curry, roux in stew
Total	146	

[1)] Food of which intake is estimated from frequency only. ( ) indicates the number of the foods
[2)] More detail names of foods are listed in the questionnaire
[3)] Foods excluded from the food-group based analysis in this study.
[4)] Foods excluded from both nutrient calculation and food-group based analysis in this study

portion sizes reported in 7) were relatively small in most cases. Consequently, overall influence of foods reported in 7) was considered negligible. Finally they were not used for calculation of the intake of nutrients.

Table 1 shows food names whose intake is calculated in DHQ. The intakes of total energy and 21 kinds of nutrients are calculated from the attached program and food component tables. For nutrients with missing values in the food composition tables available in Japan, such as fatty acid, cholesterol, and dietary fibers, the compositions were estimated (Sasaki et al. 1999). The questionnaire consists of 16 pages includeing the cover sheet. About 45 minutes will be necessary to answer it. The questionnaire is available by request to the corresponding author.

In the validation study with comparison with diet record for three days, mean correlation coefficient for 17 nutrients was 0.41, 0.46, and 0.48 for crude values, energy-density values, and de-attenuated values with consideration for day-to-day variation of intake, respectively (Sasaki et al. 1998a). In the study to examine the correlation between the excretion level of potassium in 24-hour urine and the intake estimated from DHQ, the correlation was 0.40 (Sasaki et al. 1998b). Unfortunately, the result was inconclusive for sodium because of a single day urine collection. In addition, reproducibility study with five month interval ($n = 122$) showed mean correlations of 0.56 and 0.59 for crude and energy-density values, respectively (unpublished data).

4. Analytical methods

1) Subject classification

Because the eating habits of the students living in college dormitories might severely be influenced by factors other than themselves and their families. Among 144 families, 110 families remained after excluding the families with the students living in college dormitory. They were included in the analysis.

Analysis was done considering residential style as follows. In the analysis between students and mothers, two groups were made by whether they were living together or apart each other. The same grouping method was used in the analysis between students and grandmothers.

The reported intake with energy intake with extremely high or low is generally considered that the reliability is low. But no consensus has been given for exclusion criteria for these cases (Black et al. 1991). In the present study, the minimum intake was 662kcal/day (less than 1,000kcal/day, 12 cases), and the maximum was 3,503kcal/day (3,000kcal/day or more, 4 cases). Because relatively few subjects reported extreme intakes, all cases were included in the analyses.

2) Variables used in the analyses

Age was calculated from birth date and the date of survey. The obesity index was calculated as body mass index (BMI ; kg/m^2) : the reported body weight (kg) divided by reported body height squared (m^2). The age was missing in 2 grandmothers, and the body height and body weight were missing in 12 mothers and 12 grandmothers. They were excluded from the analyses.

We analyzed the intake of six kinds of macronutrients, nine kinds of micronutrients (including dietary fiber), and 14 kinds of food groups in addition to the intake of total energy. In the present analysis, nuts and seeds whose mean intake was relatively small were included into pulses. Mushrooms and seaweeds were included into light-color vegetables. Sugar and sweeteners were included into seasonings.

It has been reported that energy-adjusted value is more valid than crude one in self-administered dietary assessment methods (Willett 1998). Similar results have been obtained with DHQ (Sasaki et al. 1998a). Various methods are proposed for adjustment of total energy (Willett 1998). In this analysis, we used nutrient density method which is simple to calculate, and is reported to have no great difference with other methods (Kipnis et al. 1993).

3) Statistical analyses

We compared the mean intakes among groups and then analyzed the correlation between generations. To investigate the correlation between generations, two kinds of combinations between the students and mothers, and between the students and grandmothers were analyzed. For comparison of the mean intakes, paired t-test and two-way ANOVA were used in case of two and three groups, respectively. We considered between-family effect in the ANOVA. For the comparison of mean intakes between groups with different residential styles within same generation, non-paired t-test was used.

Since many nutrients and food groups showed skewed distribution, Spearman's rank correlation coefficient was used for correlation analysis. Next, we calculated z-score using the following formula for the comparison of the correlation coefficients obtained from two groups (Diem et al. 1982).

$$z = |z_1 - z_2| / \sqrt{(1/(n_1 - 3) + 1/(n_2 - 3))}$$

where $z_i = n(1 + r_i)/2(1 + r_i)$

(r_i = correlation coefficient of group i, n_i = the number of observations of group i)

Tested two correlation coefficients are concluded statistically different in case of $z > 1.96$ and $z > 2.57$ with significance level of 5% and 1%, respectively.

It has been reported that even when they lived together, the correlation of the intake of nutrients between parents and children differed by eating together or not (Feunekes et al. 1997). In order to examine this tendency, correlation between the students and their mothers was compared among groups

Table 2. Anthropometric variable, energy and nutrient, and food group intakes (mean and standard deviation) by generation (110 family sets with female three generations) : a survey with self-administered diet history questionnaire

	Students	Mothers	Grandmothers	F-value[3]
Anthropometric variable[1]				
Body height (cm)[2]	157.8 ± 5.9	154.4 ± 4.9	147.3 ± 5.5	162.0*
Body weight (kg)[2]	52.9 ± 7.0	53.4 ± 7.2	48.1 ± 7.2	24.2*
Body mass index (kg/m²)	21.2 ± 2.6	22.4 ± 2.8	22.1 ± 2.9	6.9*
Dietary intake				
Total energy (kcal/day)	1536 ± 447	1701 ± 440	1562 ± 493	5.0*
Nutrient				
Carbohydrate (%E)	56.1 ± 6.8	55.2 ± 5.8	59.8 ± 8.6	17.6*
Protein (%E)	13.9 ± 2.2	15.5 ± 2.2	15.1 ± 2.7	16.1*
Total fat (%E)	28.4 ± 5.9	27.5 ± 4.8	24.1 ± 6.6	21.9*
SFA (%E)	8.9 ± 2.1	8.0 ± 2.0	7.0 ± 2.3	27.8*
MUFA (%E)	10.0 ± 2.3	9.4 ± 2.0	7.8 ± 2.4	35.0*
PUFA (%E)	6.6 ± 2.0	7.1 ± 1.6	6.4 ± 2.2	4.8*
Calcium (mg/1000kcal)	278 ± 90	336 ± 104	368 ± 135	23.4*
Iron (mg/1000kcal)	4.1 ± 0.8	4.8 ± 0.9	5.0 ± 1.0	41.3*
Sodium (mg/1000kcal)	1992 ± 545	2486 ± 672	2758 ± 862	44.1*
Potassium (mg/1000kcal)	1032 ± 228	1288 ± 262	1370 ± 323	57.3*
Vitamin C (mg/1000kcal)	42.8 ± 22.9	57.7 ± 35.5	74.9 ± 71.8	13.3*
Retinol (μg/1000kcal)	303 ± 444	267 ± 290	255 ± 246	0.8
Carotene (μg/1000kcal)	958 ± 572	1124 ± 629	1218 ± 672	5.2*
Cholesterol (mg/1000kcal)	168 ± 81	171 ± 61	160 ± 79	0.9
Dietary fiber (g/1000kcal)	5.7 ± 1.3	6.8 ± 1.7	7.8 ± 2.0	46.0*
Food group (g/1000kcal)				
Cereals	274.9 ± 66.3	264.6 ± 63.9	292.9 ± 84.3	6.3*
Potatoes	15.4 ± 9.6	17.7 ± 12.6	26.2 ± 19.2	21.5*
Confectioneries	13.8 ± 9.2	16.0 ± 11.9	17.1 ± 15.9	2.5
Fats and oils	11.8 ± 7.1	10.6 ± 5.2	7.8 ± 5.5	12.2*
Pulses (including nuts and seeds)	20.0 ± 14.9	35.8 ± 19.2	42.1 ± 24.6	44.5*
Fish and shellfish	28.0 ± 17.4	45.3 ± 23.1	48.0 ± 29.2	25.7*
Meats	38.6 ± 20.7	34.0 ± 21.1	23.8 ± 19.5	19.7*
Eggs	20.2 ± 16.1	18.8 ± 11.9	17.1 ± 14.5	1.7
Milks	94.5 ± 67.8	90.0 ± 72.7	87.8 ± 83.3	0.3
Green and yellow vegetables	33.1 ± 22.9	44.2 ± 25.8	51.1 ± 30.7	14.5*
Light-color vegetables	65.5 ± 34.7	102.3 ± 44.1	120.3 ± 56.1	39.1*
Fruits	34.7 ± 30.7	38.9 ± 39.7	57.1 ± 63.2	8.6*
Beverages	420.4 ± 290.2	508.7 ± 284.3	475.4 ± 319.7	1.6
Seasonings[4]	10.9 ± 6.1	12.9 ± 5.3	12.2 ± 4.9	6.1*

[1] n = 98 in mothers and n = 98 in grandmothers, [2] Self-reported values, [3] F-value considering between-family effect by two-way ANOVA (*$p < 0.05$), [4] Including sugars and sweeteners

Abbreviations : %E = percentage of total energy, SFA = saturated fatty acid, MUFA = monounsaturated fatty acid, PUFA = polyunsaturated fatty acid with different frequencies of eating out in the students. For this purpose, the subjects were divided into tertiles using weekly frequency of eating out at breakfast, lunch, and supper. Because the mean frequency of eating out in the mothers, 1.9times/week, was much less than that of students, 5.9times/week, only the frequency of eating out in students was considered for grouping.

The significant level was set at 5%. All statistical analyses were done with SAS (SAS Institute Inc. Cary NC).

Results

1. Group mean values

The mean age was 19, 46, and 73 in the students, mothers, and grandmothers, respectively. The mean body height was the largest in the students. The body weight was similar between the students and mothers, and heavier in the grandmothers. The BMI was similar between the mothers and

Table 3. The intake of energy, nutrients, and food groups in the students and mothers by residential style of student : a survey with self-administered diet history questionnaire

Residential style of students generation	Living with mother (n = 79)			Living apart (n = 31)				
	Students	Mothers	t-value[1)]	Students		Mothers		t-value[2)]
					t-value[1)]		t-value[2)]	
Total energy (kcal/day)	1581 ± 459	1729 ± 470	2.64*	1422 ± 397	1.70	1630 ± 348	1.05	2.16*
Nutrient								
Carbohydrate (%E)	55.0 ± 6.5	55.1 ± 6.5	0.12	58.7 ± 7.1	−2.66 #	55.5 ± 3.9	−0.38	2.31*
Protein (%E)	14.4 ± 2.1	15.3 ± 2.3	3.29*	12.8 ± 2.0	3.60 #	15.9 ± 2.1	−1.16	6.71*
Total fat (%E)	29.2 ± 5.4	27.8 ± 5.2	2.19*	26.5 ± 6.8	2.15 #	26.9 ± 3.6	0.97	0.29
SFA (%E)	9.3 ± 2.0	8.1 ± 2.1	4.54*	8.1 ± 2.0	2.86 #	7.7 ± 1.6	0.90	0.66
MUFA (%E)	10.2 ± 2.1	9.5 ± 2.1	2.65*	9.3 ± 2.7	1.85	8.9 ± 1.4	1.80	0.73
PUFA (%E)	6.7 ± 1.8	7.1 ± 1.7	1.90	6.5 ± 2.3	0.42	7.1 ± 1.2	−0.13	1.33
Calcium (mg/1000kcal)	285 ± 88	322 ± 96	3.09*	261 ± 94	1.25	372 ± 117	−2.33 #	4.18*
Iron (mg/1000kcal)	4.2 ± 0.8	4.7 ± 0.9	5.06*	3.8 ± 0.8	2.35 #	4.9 ± 1.0	−1.05	4.74*
Sodium (mg/1000kcal)	2027 ± 537	2434 ± 678	5.71*	1901 ± 563	1.09	2619 ± 650	−1.30	4.37*
Potassium (mg/1000kcal)	1042 ± 210	1265 ± 266	7.45*	1008 ± 271	0.70	1346 ± 245	−1.47	4.99*
Vitamin C (mg/1000kcal)	41.6 ± 20.1	58.8 ± 39.6	3.79*	45.8 ± 28.8	−0.75	54.7 ± 21.9	0.70	1.39
Retinol (μg/1000kcal)	343 ± 487	290 ± 325	0.96	201 ± 291	1.87	207 ± 160	1.78	0.09
Carotene (μg/1000kcal)	916 ± 519	1148 ± 604	2.89*	1065 ± 686	−1.23	1064 ± 696	0.62	0.00
Cholesterol (mg/1000kcal)	181 ± 82	171 ± 66	1.01	136 ± 69	2.66 #	170 ± 46	0.09	2.51*
Dietary fiber (g/1000kcal)	5.5 ± 1.3	6.7 ± 1.7	6.10*	6.0 ± 1.4	−1.48	7.0 ± 1.8	−0.63	2.18*
Food group (g/1000kcal)								
Cereals	265.0 ± 60.5	261.8 ± 69.6	0.46	300.4 ± 74.2	−2.59 #	271.7 ± 46.6	−0.87	1.96
Potatoes	14.7 ± 9.7	16.6 ± 12.6	1.13	17.0 ± 9.3	−1.09	20.5 ± 12.5	−1.47	1.27
Confectioneries	14.3 ± 9.2	16.0 ± 12.2	1.14	12.5 ± 9.4	0.96	15.9 ± 11.4	0.04	1.41
Fats and oils	11.4 ± 6.3	10.7 ± 5.7	0.90	12.8 ± 8.9	−0.79	10.4 ± 4.1	0.22	1.46
Pulses (including nuts and seeds)	21.5 ± 15.9	34.1 ± 18.5	6.93*	16.4 ± 11.6	1.61	40.3 ± 20.5	−1.53	5.61*
Fish and shellfish	31.0 ± 17.8	41.8 ± 21.0	4.11*	20.3 ± 13.8	3.00 #	54.3 ± 26.0	−2.62 #	5.97*
Meats	41.7 ± 21.1	37.2 ± 22.8	1.45	30.6 ± 17.4	2.60 #	26.0 ± 13.4	3.17 #	1.63
Eggs	21.5 ± 16.7	19.0 ± 12.4	1.33	16.9 ± 14.2	1.36	18.2 ± 10.5	0.34	0.42
Milks	93.8 ± 68.5	87.5 ± 72.1	0.77	96.3 ± 67.1	−0.17	96.2 ± 75.0	−0.56	0.00
Green and yellow vegetables	33.2 ± 22.7	44.1 ± 25.1	3.58*	33.0 ± 23.7	0.03	44.7 ± 28.0	−0.11	1.78
Light color vegetables	62.1 ± 30.8	99.3 ± 38.9	7.53*	74.2 ± 42.4	−1.45	109.9 ± 55.2	−0.98	2.49*
Fruits	36.0 ± 32.7	37.5 ± 40.8	0.29	31.5 ± 24.9	0.69	42.6 ± 37.3	−0.61	1.55
Beverages	432.2 ± 301.7	550.0 ± 280.8	2.96*	390.3 ± 261.0	0.68	403.5 ± 269.7	2.49 #	0.20
Seasonings[3)]	11.1 ± 6.6	12.6 ± 4.7	2.13*	10.6 ± 4.5	0.40	13.5 ± 6.8	−0.65	1.97

[1)] Paired t-test for between-generation differences (*p < 0.05), [2)] Non-paired t-test for between-residential style differences (#p < 0.05), [3)] Including sugars and sweeteners. See Table 2 for abbreviations grandmothers, and slightly lower in the students (Table 2). Table 2 shows the mean total energy, macro-and micronutrient, and food group intakes by generation. The intake of total energy was the largest in the mothers, followed by the grandmothers and students. As for the intake of nutrients, except for retinol and cholesterol, significant difference was observed among the generations. The intake of saturated fatty acid (SFA), monounsaturated fatty acid, and total fat was higher in younger generations. The intake of vitamin C, sodium, dietary fiber, potassium, calcium, carotene, and iron was lower in younger generations. As for the intake of food groups, meats and oils were higher in younger generations, and those of pulses, light-color vegetables, fish and selfish, potatoes, fruits, and green and yellow vegetables tended to be low.

Table 3 shows the intake of the students and mothers in different residential types of the students. Among the students, only the group living together tended to show a high intake of fat, and the lower tendency of the micronutrient intakes was more marked in the group living apart. As for the intake of food groups, both groups living together and apart in the students showed the lower tendency of the intake of pulses and fish and selfish, although the group living apart tended more notable. The low tendency of the intake of vegetables was not influenced by the difference of living apart or together. When the group living together and the group living apart in the students were compared, the group living together showed higher intake of carbohydrate and cereals and lower of protein and fat (especially, SFA). In food groups, the group living together tended to have a lower intake of fish and selfish and meats.

2. Correlation among generations

Positive correlation coefficients in the body height, body weight, and BMI were observed among the three generations. No significant differences of the correlation coefficient were observed between the groups living apart and together, although the correlation in the group living together was slightly higher than the group living apart (Table 4). These correlations were also seen between the mothers and grandmothers. The correlation coefficient of the body weight in the group living apart, 0.06 between the students and the mothers and 0.17 between the students and the grandmothers, tended to be lower than other coefficients.

Table 4 also shows the correlation coefficients of the intake of total energy, nutrients, and food groups among generations in different residential styles. In case of living together, moderate positive correlation between the students and mothers were observed in total energy, nutrients, and food groups, with the correlation coefficient of 0.30 − 0.61 for nutrients and 0.21 − 0.56 for food groups. The correlation between the students and the grandmothers was −0.18 − 0.59 and −0.33 − 0.66, respectively, showing a wide range correlation of nutrients and food groups. On the other hand, in the case of living apart, the correlation coefficient between the students and mothers was −0.31 − 0.31 and −0.29 − 0.52, respectively, and those between the students and grandmothers was −0.07 − 0.24 and −0.03 − 0.24, respectively. When the differences of correlation coefficient between the groups living together and apart in each nutrient were compared between the students and mothers, the group living apart showed lower levels in all the nutrients examined. Significant difference for correlations between the groups living together and apart was observed for cereals, pulses, fish and selfish, milk, light-color vegetables, and seasonings. On the other hand, the higher correlation was observed in the group living apart for meats, fruits, and oils. As for the coefficient between the students and grandmothers, because of small number of observations in the group living together (n = 17), nutrients and food groups showing significantly different correlation were only green and yellow vegetables. When the mean levels of the correlation coefficient were compared, between the students and mothers, both nutrients and food groups were significantly higher in the group living together than in the group living apart.

Table 5 shows correlation between the students living together and their mothers in different frequencies of eating out in the students. The frequencies were divided into three groups, 0 − 3times/week (n = 25), 4 − 6times/week (n = 29), and 7 − 15times/week (n = 22). The range of the correlation coefficient for nutrients was 0.17 − 0.70, 0.07 − 0.39, and −0.08 − 0.67 in this order. The range for food groups was 0.07 − 0.85, −0.10 − 0.62, and −0.24 − 0.55, respectively. Although it was not significant, the mean correlation coefficient tended to be lower both in nutrients and food groups with higher frequency of eating out.

Discussion

1. The mean intakes by generation

Marked differences among generations were observed in

Table 4. Spearman's rank correlation coefficients of the intake of total energy, nutrients, and food groups between generations by residential style : Survey with self-administered diet history questionnaire

Comparison pair residential style		Students and mothers		Students and grandmothers	
		Living together (n = 79)	Living apart (n = 31)	Living together (n = 17)	Living apart (n = 93)
Anthropometric variable					
Body height (cm)		0.41	0.38	0.43	0.32
Body weight (kg)		0.41	0.06	0.37	0.17
Body mass index (kg/m^2)		0.23	0.35	0.39	0.25
Dietary intake					
Total energy (kcal/day)		0.40	0.19	−0.08	0.04
Nutrient[1]					
Dietary fiber (g/1000kcal)		0.43	−0.31*	0.22	−0.01
Sodium (mg/1000kcal)		0.57	−0.10*	0.56	0.22
Iron (mg/1000kcal)		0.61	0.00*	0.59	0.14
Potassium (mg/1000kcal)		0.43	−0.07*	−0.18	0.04
Total fat (%E)		0.42	−0.02*	0.47	0.17
Retinol (μg/1000kcal)		0.53	0.09*	0.33	0.11
PUFA (%E)		0.44	0.03*	0.15	0.20
Calcium (mg/1000kcal)		0.37	−0.02	−0.05	0.18
SFA (%E)		0.33	−0.05	0.35	0.09
Vitamin C (mg/1000kcal)		0.32	−0.04	0.40	−0.07
Carbohydrate (%E)		0.39	0.08	0.49	0.24
Carotene (μg/1000kcal)		0.30	0.03	0.21	0.05
Protein (%E)		0.45	0.21	0.27	0.15
MUFA (%E)		0.40	0.20	0.45	0.15
Cholesterol (mg/1000kcal)		0.32	0.19	0.56	0.23
Food group (g/1000kcal)[1]					
Light-color vegetables		0.25	−0.29*	0.04	−0.02
Pulses (including nuts and seeds)		0.51	−0.01*	0.36	0.18
Fish and shellfish		0.36	−0.11*	−0.14	−0.03
Cereals		0.56	0.10*	0.45	0.15
Milks		0.39	−0.06*	−0.33	0.07
Seasonings[2]		0.36	−0.07*	−0.03	0.10
Green and yellow vegetables		0.36	0.08	0.65	0.07*
Beverages		0.29	0.07	0.22	0.20
Confectioneries		0.41	0.22	0.45	0.13
Eggs		0.33	0.15	0.43	0.24
Potatoes		0.23	0.06	0.39	0.09
Fats and oils		0.27	0.31	−0.06	0.05
Fruits		0.21	0.44	0.29	0.02
Meats		0.21	0.52	0.47	0.20
Nutrients	Mean (SD)	0.42 (0.09)	0.02 (0.13)###	0.32 (0.22)	0.13 (0.09)##
	Minimum-maximum	0.30 − 0.61	−0.31 − 0.21	−0.18 − 0.59	−0.07 − 0.24
Food groups	Mean (SD)	0.34 (0.11)	0.10 (0.22)##	0.23 (0.28)	0.10 (0.08)
	Minimum-maximum	0.21 − 0.56	−0.29 − 0.52	−0.33 − 0.65	−0.03 − 0.24

[1] The results were listed by descending order of correlation of student-mother pairs, [2] Including sugars and sweeteners
Significant (*$p < 0.05$) difference between correlation coefficients between different residential pairs (see text for the method)
Significant (##$p < 0.01$, ###$p < 0.001$) difference between mean correlation coefficients between different residential pairs (paired t-test), See Table 2 for abbreviations

the intake of nutrients and food groups similarly to the results from other studies in Japanese (Ministry of Health and Welfare 1998 ; Kimura et al. 1992). To our knowledge, no study observed clear generation-related nutrient and food group intakes in Europe and U.S.A. (Block et al. 1988, Kornitzer, Bara 1988 ; Bir et al. 1996). In addition, some nutrient and food group intakes significantly differed by residential style in the students.

The intake of total energy was the largest in the mothers, followed by the grandmothers and students. Although this is somewhat difficult to understand from the viewpoint of energy requirement, similar tendency has often been observed in

Table 5. Spearman's rank correlation coefficients of the intake of total energy, nutrients, and food groups between students and mothers who were living together by frequency of eating out of student: Survey with self-administered diet history questionnaire

Frequency of eating out of students (times/week)[1]		0 – 3 (n = 28)	4 – 6 (n = 29)	7 – 15 (n = 22)
Total energy (kcal/day)		0.57	0.19	0.35
Nutrient[2]				
Carbohydrate (%E)		0.60	0.27	0.17
Potassium (mg/1000kcal)		0.44	0.69	0.05
SFA (%E)		0.61	0.12	0.22
Cholesterol (mg/1000kcal)		0.45	0.42	0.13
MUFA (%E)		0.66	0.10	0.36
Total fat (%E)		0.70	0.13	0.43
Carotene (μg/1000kcal)		0.17	0.62	−0.08
Dietary fiber (g/1000kcal)		0.57	0.35	0.34
Vitamin C (mg/1000kcal)		0.25	0.67	0.20
Iron (mg/1000kcal)		0.63	0.60	0.59
Protein (%E)		0.43	0.47	0.44
PUFA (%E)		0.57	0.07	0.64
Retinol (μg/1000kcal)		0.44	0.63	0.54
Calcium (mg/1000kcal)		0.22	0.69	0.44
Sodium (mg/1000kcal)		0.41	0.60	0.67
Food group (g/1000kcal)[2]				
Meats		0.38	0.31	−0.24
Light-color vegetables		0.44	0.48	−0.16
Fruits		0.33	0.23	−0.03
Cereals		0.85	0.34	0.49
Eggs		0.52	0.28	0.19
Seasonings[3]		0.45	0.55	0.17
Green and yellow vegetables		0.29	0.62	0.01
Fats and oils		0.57	−0.01	0.34
Potatoes		0.37	−0.10	0.37
Fish and shellfish		0.33	0.36	0.35
Pulses (including nuts and seeds)		0.52	0.44	0.55
Confectioneries		0.40	0.34	0.54
Milks		0.21	0.60	0.39
Beverages		0.07	0.46	0.37
Nutrients[4]	Mean (SD)	0.47 (0.17)	0.43 (0.24)	0.34 (0.22)
	Minimum-maximum	0.17 – 0.70	0.07 – 0.69	−0.08 – 0.67
Food groups[5]	Mean (SD)	0.41 (0.18)	0.35 (0.21)	0.24 (0.26)
	Minimum-maximum	0.07 – 0.85	−0.10 – 0.62	−0.24 – 0.55

[1] Sum of frequency of eating out at breakfast, lunch, and dinner, [2] The results were listed by descending order of the difference between correlations of the 0 – 3time/week group and the 7 – 15times/week group, [3] Including sugars and sweeteners, [4] Effect of eating out frequency after taking between-nutrient effect into consideration by two-way ANOVA : F-value = 1.32 (p = 0.28), [5] Effect of eating out frequency after taking between-food group effect into consideration by two-way ANOVA : F-value = 2.09 (p = 0.14), See Table 2 for abbreviations

other populations in Japan (Ministry of Health and Welfare 1992). Although several possibilities are postulated, the reason is unclear : whether underreporting by students, overreporting by mothers and grandmothers, or different physical activity levels among generations. Use of energy-adjusted intakes which can avoid this problem to some extent is considered more appropriate in comparison.

2. Correlation of the intake among generations

To our knowledge, no previous report has existed in Japan about correlation for nutrient and food group intakes between generations. In a Dutch study using mothers and their children (daughters) of the similar ages as the present study, the correlation coefficient of the intake of total fat between the mothers and children living together was about 0.40 (only foods taken at home) and 0.32 (only foods taken outside home) (Feunekes et al. 1997). The correlation observed in this study, 0.42, was slightly higher than the above results. The correlation for nutrients between mothers and children living separately in other studies has been reported to be 0.13 – 0.27 (Stafleu et al. 1994). Our results, −0.31 – 021 was lower than the values. Although the results are inclusive because of both insufficient factors considered other than living together or apart and difference of survey methods, the present subjects showed a higher correlation when living together and lower when living apart.

The result of significantly low correlation in the group living apart indicates that eating habit may easily change by starting living apart. Intervention or education to young people may be needed for pulses, fish and selfish, light-color vegetables, and green and yellow vegetables because the correlation was low in these intake levels. On the other hand, establishment of favorable dietary customs may be important for fat and oils because no remarkable difference was observed for the correlation between the groups living together and apart.

Although not significant, the higher was the frequency of eating out in students, in general, the lower the correlation. The results were in agreement with a Dutch study (Feunekes et al. 1997). However, the correlation varied by nutrient and food group, a larger number of subjects has might needed for this analysis.

3. Validity of survey method

In this study, we used self-administered dietary assessment questionnaire to assess nutrient and food intakes for past one month. Taking presence of day-to-day variation of intake into consideration (Basiotis et al. 1987 ; Nelson et al. 1989), this assessment method which could cover one-month dietary habits seemed to be appropriate, compared to other conventional methods such as dietary record or recall. A previous study with a similar purpose also used a similar type of questionnaire (Stafleu et al. 1994).

Validity must be investigated in advance when a questionnaire was used for dietary assessment. We therefore used a validated questionnaire (Sasaki et al. 1998a ; Sasaki et al. 1998b). However, because validity of the questionnaire was not fully examined for the age-range examined in this study such as the students and the grandmothers, the results should cautiously be interpreted.

4. Limitation of this study

This study suggested that residential style may influence to the eating habit. In this study, meals of other family members living together were not examined. It may have influenced to the results. It is also reported that even when the generation structure of a family is identical, the eating habit of the family differs according to the member who prepares their meals (Kasamatsu et al. 1995). However, because mother was the most predominant cook in their families, this influence may not have been a serious bias, if existed.

The students were in dietetic course of college. Their dietary behaviors and knowledge was likely to be different from representative Japanese adolescents. Generalization of the results may, therefore, be difficult.

We did not consider family line of grandmother, i.e., maternal or paternal, although grandmother of maternal line was given priority to examine. A different correlation may exist between students and grandmothers of two different family lines. But it could not be examined because of too small number of subjects.

Since this was a cross-sectional study, we could not examine causes and effects : whether living apart changed dietary intake of the students or the students living apart were eating differently before they lived apart. In order to clarify this question, a prospective study is needed. But it is beyond the scope of the present study.

Conclusions

We examined generation-related differences of intakes and the correlation of intakes between generations using the college students taking dietetic course in Aichi, Japan, and their mothers and grandmothers.

Among 15 nutrients and 14 food groups examined, significant differences among generations were found in the mean intake of 13 nutrients. In the students, significant differences between the groups living together with family and living apart were found in the intake of carbohydrate, protein, SFA, cholesterol, and fish and selfish. In the correlation analysis among generations, moderate correlation between the students and mothers who lived together was observed in most of the nutrients and food groups (correlation coefficient = −0.30 − 0.61 in nutrients and 0.21 − 0.56 in food groups). The correlation between the students and grandmothers differed according to nutrients and food groups, and no constant tendency was found. Correlation was largely different for some nutrients and food groups between two groups, i.e., the group with students living with the mother and the group with students living apart. When living together, the correlation coefficients between the students and their mothers decreased according to the increase in frequency of eating out by the students. These results suggest that living together and eating together were an important factor for the resemblance in dietary habits between generations in the population with a marked generation-related difference in intakes.

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Tailored Dietary Counseling Using Self-Administered Diet History Questionnaire is Effective for Health Promotion : Japanese Experience

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ABSTRACT

Dietary counseling is undoubtedly important for prevention and treatment of chronic diseases. Several dietary counseling methods have been developed and used in Japan to promote healthier diets. However, in Japan, few studies have established effective counseling methods. We developed a computer-assisted tailored dietary counseling system with self-administered diet history questionnaire (DHQ) to assess nutrient intakes and the feedbacks for counseling. We examined the effectiveness of the system in three studies, two among mildly-hypercholesterolemic and one among healthy subjects. We observed significant changes in intakes of targeted nutrients in all three studies. We also observed favorable changes in the corresponding serum and urinary biomarkers in two studies, i.e., non-significant change in serum cholesterol, serum carotene and vitamin C, and a significant change in 24-hour urinary excretion of sodium. In addition, one of the studies observed a significant modified dietary habit for one-year after the intervention was completed. No unfavorable change was observed for non-targeted nutrients in all three studies. The dietary counseling system with DHQ was concluded to be effective among motivated high-risk and healthy subjects. The system's application to other diseases and populations such as children, adolescents, and elderly, should be examined further. (*J Community Nutrition* 5(2) : 112~119, 2003)

KEY WORDS : dietary intervention · education · effectiveness · Japanese · review.

Introduction

Since lifestyle-related chronic diseases such as stroke, coronary heart disease, and cancer have been the main causes of death in Japan as well as other developed countries, prevention, early detection and treatment, through dietary counseling is an important tool against these diseases. Several dietary counseling methods have therefore been developed and used in Japan to promote healthier diets. However, few methods have been examined their effectiveness by using appropriate study designs.

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Individualized counseling is thought to be more effective than group counseling in clinical settings provided that the patients are highly motivated. This is also expected in the counseling among motivated high-risk and even healthy subjects. However, nutrition counseling is mostly performed at public health centers where less number of staff is involved as compared to that in hospitals. In order to make it possible to use individualized counseling at public health centers, we need a highly-structured counseling system, assisted by personal computer, consisting of dietary assessment method, feedback sheets of nutrient intakes of subjects, and educational materials such as leaflets specialized for the system. In addition, at public health centers, a health promotion program consisting of individualized counseling only, without any mass-education such as lectures, seems to be nearly impossible and impractical due to small number of staff. We thought that brief, such as 15 – 20 minute, indi-