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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-

vidualized counseling at the beginning of health promotion program, which was followed by mass-education, might be effective enough to give appropriate suggestions and to give motivation enough for modifying the dietary habits.

At the present time of Japan, most dietary counseling is performed without dietary assessment or with conventional dietary assessments. In the latter case, one-day or three-day dietary record has most often been used for this purpose. But two serious shortcomings have been pointed out : that dietary data of short-days do not represent subject' habitual intakes because of serious day-to-day variation of intakes in most nutrients (Nelson et al. 1989) and that it takes time to handle the data and to calculate nutrient intakes. In order to resolve these problems, brief dietary assessment questionnaires have often been used for this purpose. But validation studies are lacking in the most questionnaires. As a consequence, current dietary counseling is in Japan often held with poor scientific information of subject' dietary intakes.

In order to overcome the above-mentioned problems, some tailored dietary counseling methods have been developed in Western countries, and the usefulness of these methods have been reported (Brug et al. 1999). A tailored dietary counseling consists of two parts : dietary assessment and counseling based on the results obtained from the dietary assessment. For this purpose, we need a dietary assessment method that is highly valid and relatively easy to use. We also need a nutrient-calculation program and computer-assisted feedback system for a quick and systematic counseling.

Based on these backgrounds and needs, we first developed a self-administered diet history questionnaire (DHQ) with validity (Sasaki et al. 1998a ; Sasaki et al. 1998b ; Sasaki et al. 2000). Then, we developed a computer-assisted, tailored counseling system using DHQ. Then the effectiveness of the system was examined using the following three studies.

Subjects and Methods

1. Structure of the system

1) Self-administered diet history questionnaire (DHQ)

The DHQ is a 16-page questionnaire on one-month dietary habits. Questions about eating frequency of main staples, i.e., rice, bread, and noodles, at breakfast were included in DHQ. The DHQ has been validated using three different gold standards as following. Firstly we compared nutrient intakes assessed by DHQ with those assessed by 3-day dietary record among 47 middle-aged women. Pearson correlation coefficient ranged from 0.17 to 0.75 (mean was 0.48) in 17 energy-adjusted nutrients (Sasaki et al. 1998a). Also, the mean intakes assessed by two methods were similar (difference was 1 − 3% in macronutrients and 1 − 25% in micronutrients) (Sasaki et al. 1998a). Secondly we compared sodium and potassium intakes assessed by DHQ with those of 24-hour urinary excretions among 69 female university students. Although Pearson correlation for sodium was not significant ($r = 0.23$, $p = 0.06$), that for potassium was significantly positive ($r = 0.40$, $p < 0.001$) (Sasaki et al. 1998b). Thirdly we compared marine-origin n-3 polyunsaturated fatty acid (PUFA) and carotene intakes assessed by DHQ with those of serum concentrations, which have often been used as reliable biomarkers, among 44 middle-aged women. A significantly positive correlation was observed in both nutrients ($r = 0.60$ and 0.56 respectively, $p < 0.001$ for both) (Sasaki et al. 2000).

2) The tailored dietary counseling system

The tailored dietary counseling system developed and examined in the trials is briefly described as follows. As pre-intervention assessment, the subjects are requested to answer DHQ at home. The completed DHQ is checked by staff. When a missing and/or an illogical answer were found, the subjects are requested to re-answer. The data collected with DHQ are input, approximately 15 minutes per subject, to the attached computer file at a study site or in the staff-office. The data are automatically calculated and the individual nutrient intakes are printed out as feedback sheets. Four types of individualized feedback sheets are available : general nutrition, hypercholesterolemia, hypertension, or osteoporosis These results are used for counseling with the subjects. The individualized feedback sheets with nutrient intake by food group and by each food item are also available. These sheets are mainly used when a dietitian needs a closer look at the results. In Study 3 (see below), subjects were encouraged to set explicit and proximal subgoals from prelisted 50 items on check sheets. Furthermore, 40 different one-page leaflets were prepared to provide detailed nutrition information and helpful hints regarding cooking. The 4 to 5 leaflets were tailored to individual dietary intake levels and dietary patterns by computer program. Selected leaflets were checked by the trained dietitian and modified slightly when necessary.

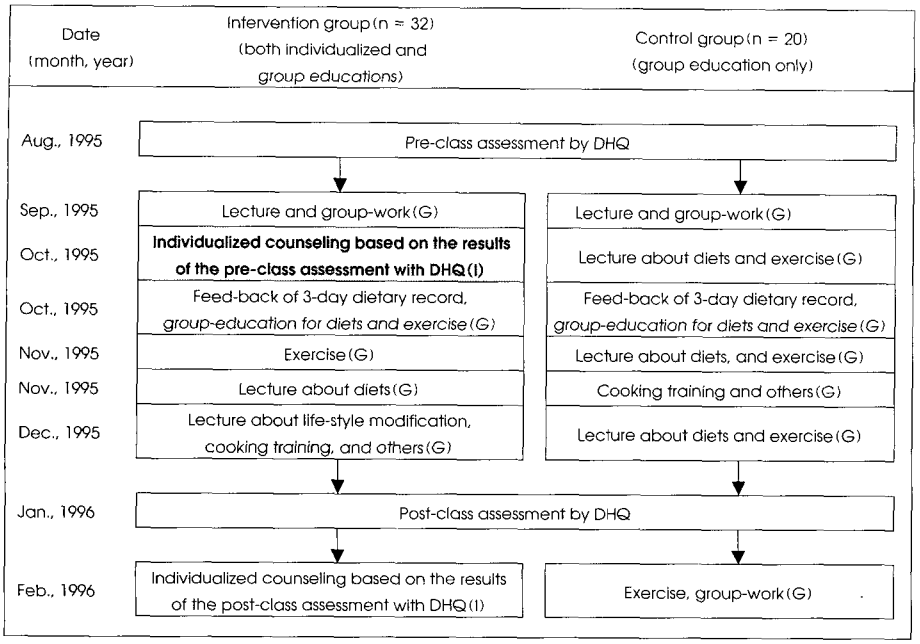

Fig. 1. Education plan in Study 1 (number of participants in parentheses). (I) and (G) indicate individualized and group education, respectively.

Similar tailored counseling systems, but less structures, were used in Studies 1 and 2 (see below).

Details of the questionnaire (DHQ) and the information about the system more in detail are available on request to the author.

2. Effectiveness studies

1) Study 1 (Sasaki et al. 1998c)

A 4-month health promotion class consisting of 7 sessions was conducted in two areas in Hikone, Japan among untreated mildly-hypercholesterolemic men and women, with serum cholesterol = 200 − 239mg/dl for men and women aged 49 years or less and 220 − 259mg/dl for women aged 50 years or over, who were screened at the city annual health checkup. Pre-class and post-class dietary assessments were done using DHQ in both groups. The results were used in a 15-minute individualized counseling about two months after the pre-class assessment in the intervention group. Conventional group education was given in both groups. The education schedule was summarized in Fig. 1. In the individualized counseling, individualized dietary modification suggestions to improve hypercholesterolemia based on the results of the assessment were provided by the staff.

2) Study 2 (Sasaki et al. 1999 ; Sasaki et al. 2000)

We invited men who were at high-risk for coronary heart disease, mainly hypercholesterolemia determined at their annual health-checkup to a 3-month health promotion class in Nagoya, Japan. The study design and the number of subjects are shown in Fig. 2. Among 320 eligible subjects, 80 participated in the class (intervention group). We assessed food and nutrient intakes with DHQ before and after class among the intervention group. We measured serum cholesterol at the post-class point and 1 year after the intervention was completed among both participants and non-participants (control group 1). In addition, at the pre- and post-class dietary assessment points, we asked 169 healthy workers at the jobsite to answer the DHQ (control group 2). In the intervention group, the results of the pre-class assessment were used in the 15- to 20-minute individualized counseling. During the following 3-months, the participants and staff exchanged short letters using a mailing system where the staff checked and counseled the participants' dietary behaviors. In order to examine recidivism, we assessed dietary habits one-year after the post-class assessment.

3) Study 3 (Takahashi et al. 2003)

We examined the effectiveness of the system in a 2-year community-based randomized cross-over trial with 550 healthy volunteers living in Akita, Japan, where the prevalence of stroke and stomach cancer mortality was high. The intervention aim was to decrease sodium, and to increase carotene and vitamin C intakes. In order not to induce carry-over effect, we examined the dietary change on the first half

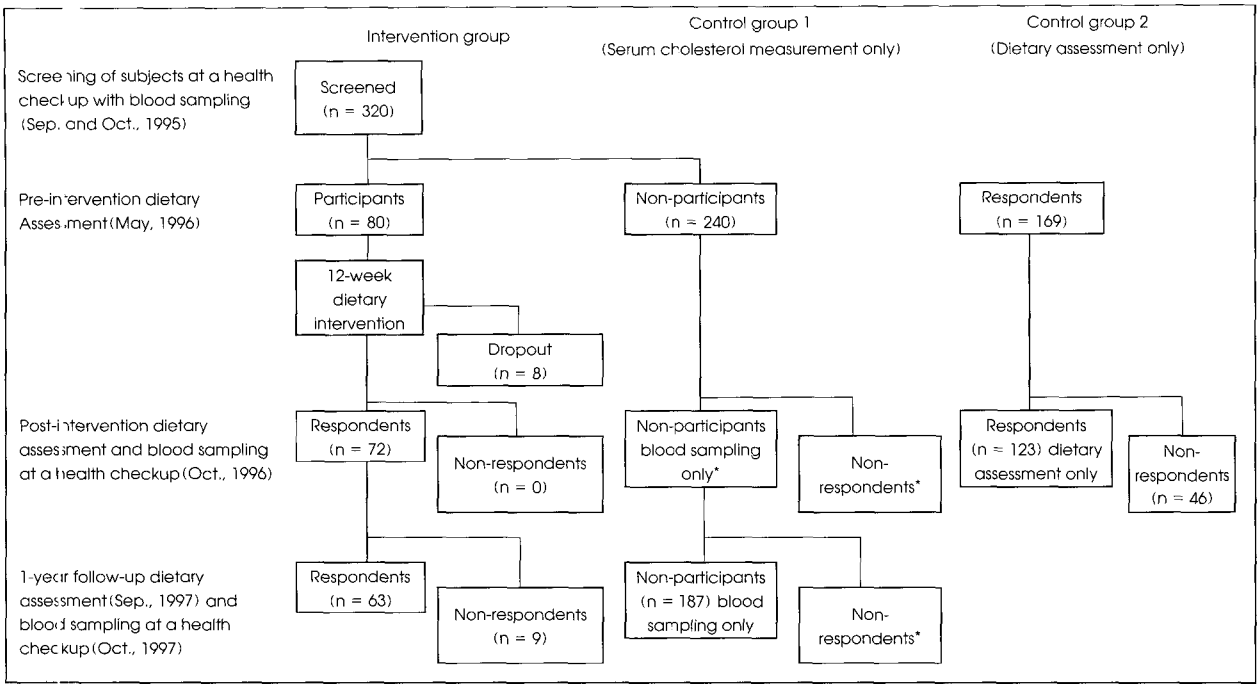

Fig. 2. The number of the male subjects (Study 2). *Number of subjects was not reported.

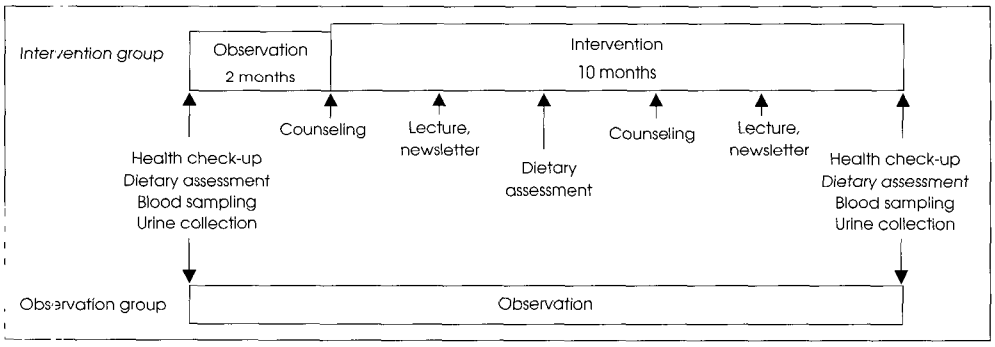

Fig. 3. Design of the first half of the 2 year cross-over trial (Study 3).

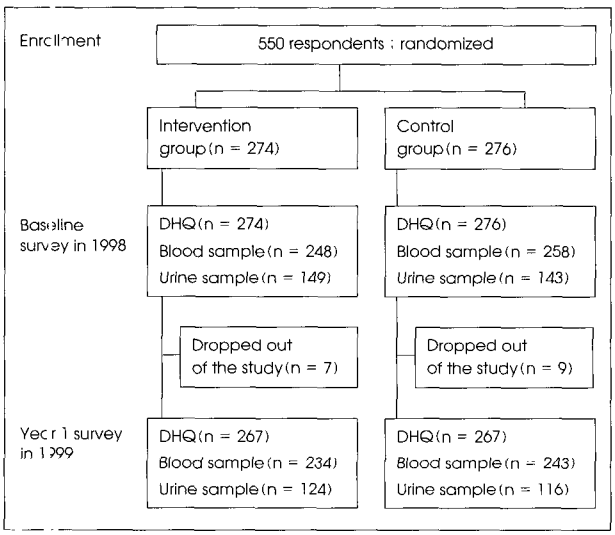

Fig. 4. The number of subjects in the trial (Study 3).

of the trial. The study design and the number of subjects are shown in Fig. 3, 4, respectively. We examined the effectiveness using not only dietary change assessed with DHQ, but also changes in corresponding biomarkers of nutrients of interest, i.e., serum carotene and vitamin C, and 24-hour urinary excretion of sodium. At baseline, dietary habits were assessed and serum and 24-urine were collected from all 550, 506, and 292 subjects, respectively.

Results

1. Study 1

Table 1 shows the change in nutrient intakes between the intervention and the control groups. Intake of saturated fatty acid (SFA), but not of cholesterol, significantly decreased in

Table 1. Mean nutrient intakes at pre- and post-intervention points, and the changes (Study 1)

	Intervention group (n = 32)			Control group (n = 20)		
	Pre-	Post-	Change	Pre-	Post-	Change
Energy (kcal/day)	1888	1865	−22	1725	1834	109
Selected nutrients						
Total fat (%E)	23	22	−1	23	23	0
SFA (%E)	7.0	6.0	$-1.0^{**,\#}$	6.4	6.4	0.0
MUFA (%E)	7.6	7.4	−0.2	7.9	7.8	-0.1
PUFA (%E)	5.2	5.4	0.1	6.0	6.1	0.2
P/S ratio	0.8	0.9	0.1^{**}	1.0	1.0	0.0
Cholesterol (mg/1000kcal)	183	169	−14	186	169	−18
Keys score (unit)	32	28	−4	29	28	−1
Protein (%E)	15	16	1	16	17	1
Carbohydrate (%E)	61	62	$1^{\#}$	61	60	−1
Calcium (mg/1000kcal)	315	306	−9	293	336	43
Iron (mg/1000kcal)	7.1	6.8	−0.3	7.2	7.4	0.2
Salt (g/1000kcal)	5.5	5.0	−0.4	4.3	4.5	0.2
Potassium (mg/1000kcal)	1479	1408	−71	1458	1543	85
Selected food groups (only food groups with significant results)						
Cereals (g/1000kcal)	274	297	$23^{*,\#\#}$	299	271	-27^{*}
Daily products (g/1000kcal)	105	83	$-22^{***,\#}$	82	102	20
Fruits (g/1000kcal)	68	103	35	78	117	39
Cooking oil (g/1000kcal)	2.1	2.1	0.0	2.4	1.8	-0.6^{*}

Significant change within group : *** : $p<0.001$, ** : $p<0.01$, * : $p<0.05$.
Significant difference of change between groups : # : $p<0.05$, ## : $p<0.01$.
%E : percentage of total energy, SFA : saturated fatty acid, MUFA : monounsaturated fatty acid, PUFA : polyunsaturated fatty acid, P/S ratio : PUFA to SFA ratio.

the intervention group when compared to the control group ($p < 0.05$). The differences in the change were marked ($p < 0.05$) for cereals and dairy products among 13 food groups examined. In addition, the participation rate through the 7 sessions was significantly ($p < 0.05$) higher in the intervention group (79%) than in the control group (65%).

2. Study 2

Table 2 shows the change in nutrient and food group intakes of the two groups (the intervention group and the control group 2). A significant difference was observed for the change in intakes of SFA, monounsaturated fatty acids, and cholesterol ($p < 0.05$). Although the data were available only from the intervention group, the favorable decrease in SFA observed at the post-class point was maintained until the 1-year after the counseling was completed. Among foods examined, marked decrease and increase were observed for full-fat and low-fat milk, respectively. This change was maintained for the 1 year after. Neither type of meats nor of fat-spread, such as butter and margarine, intake was significantly changed by the counseling (data not shown).

The change in serum cholesterol from the pre- to post-intervention point was 0.31 ± 0.63 mmol/L (mean ± SD) in the intervention group. Assuming that the change observed in the control group 1 was attributed to regression to the mean (Ederer 1972) and that the same level of regression to the mean occurred in the intervention group, the decrease in serum cholesterol expected from the change in the diets (Keys et al. 1964) and the change in the body weight (Dattilo et al. 1992) was very close to the observed value, i.e., −0.32mg/dl.

3. Study 3

The change in intakes was significantly different between the intervention and control groups for all the targeted nutrients : sodium ($p < 0.001$), carotene ($p < 0.05$), and vitamin C ($p < 0.05$) (Table 3). The changes in serum carotene and vitamin C were modest, and not statistically significant ($p = 0.09$ and 0.07, respectively). When both dietary and urinary sodium were examined between the two groups ($n = 191$), the changes were significantly different ($p < 0.001$). We observed no significant difference in the changes of all other

Table 2. Nutrient and food group intake at each point in Study 2

	Intervention group (n = 63)			Control group 2 (n = 123)		Change from the pre- to post-intervention points	
	Pre-intervention	Post-intervention	1-year follow-up	Pre-intervention	Post-intervention	Intervention group (n = 63)	Control group 2 (n = 123)
Energy (kcal/day)	2107 ± 426	1975 ± 454	1975 ± 412	2148 ± 472	1987 ± 497	−132 ± 489	−161 ± 520
Fats and cholesterol							
SFA (%E)	7.6 ± 1.9	6.0 ± 1.5***	6.3 ± 1.6***	7.7 ± 2.0	6.8 ± 2.0	−1.6 ± 1.8#	−0.9 ± 1.7
MUFA (%E)	8.5 ± 2.4	7.1 ± 1.7***	7.6 ± 2.0*	8.7 ± 2.4	8.2 ± 2.5	−1.4 ± 2.2#	−0.5 ± 2.3
Total fat (%E)	24.3 ± 5.7	21.1 ± 4.2**	22.3 ± 5.0	24.8 ± 5.8	23.6 ± 6.3	−3.2 ± 5.5#	−1.2 ± 5.8
Cholesterol (mg/1000kcal)	136 ± 56	129 ± 38	133 ± 45	126 ± 55	135 ± 57	−7 ± 52#	9 ± 49
Other nutrients							
Dietary fiber (g/1000kcal)	5.7 ± 2.0	6.3 ± 1.5	4.1 ± 1.2	5.7 ± 1.8	5.5 ± 1.6	0.5 ± 2.0##	−0.2 ± 1.3
Potassium (mg/1000kcal)	103 ± 244	1285 ± 320***	1250 ± 287**	1058 ± 241	1151 ± 302	202 ± 265##	93 ± 222
Calcium (mg/1000kcal)	257 ± 84	311 ± 103**	298 ± 98*	242 ± 75	260 ± 109	54 ± 85#	19 ± 89
Iron (mg/1000kcal)	3.6 ± 0.8	4.1 ± 0.9**	5.9 ± 1.6**	3.5 ± 0.8	3.8 ± 0.9	0.6 ± 0.8#	0.3 ± 0.8
Food groups (g/1000kcal)							
Pulses	23.7 ± 11.9	32.7 ± 15.7**	28.5 ± 13.8	23.5 ± 14.0	24.7 ± 16.2	8.9 ± 16.8##	1.0 ± 14.7
Green and yellow vegetables	31.1 ± 18.2	36.1 ± 20.6	35.2 ± 23.9	31.9 ± 22.0	28.5 ± 21.9	5.0 ± 19.4##	−3.4 ± 18.2
Confectioneries	11.7 ± 9.7	7.9 ± 6.3	9.0 ± 8.5	10.1 ± 8.6	11.1 ± 16.6	−3.9 ± 8.8##	0.9 ± 14.5
Other vegetables	71.7 ± 40.8	103.4 ± 45.6***	94.1 ± 42.7*	75.7 ± 44.1	89.2 ± 60.1	31.7 ± 48.1##	13.5 ± 40.9
Fats and oils	9.0 ± 6.3	7.5 ± 5.5	9.5 ± 6.9	9.1 ± 5.1	9.8 ± 6.7	−1.6 ± 6.6#	0.7 ± 6.2
Full-fat milk	34.2 ± 42.8	25.6 ± 44.7	22.4 ± 40.4	33.8 ± 48.4	34.4 ± 46.8	−8.6 ± 61.1	0.6 ± 46.8
Low-fat milk	12.8 ± 30.9	42.2 ± 58.1***	33.8 ± 50.3**	8.4 ± 27.1	11.3 ± 34.6	29.4 ± 63.5##	2.8 ± 37.1

Value is mean ± standard deviation.
See table 1 for abbreviations.
Significance for the change from the pre-intervention point within a group : * : $p<0.05$, ** : $p<0.01$, *** : $p<0.001$.
Significance for the comparison between groups for the change from the pre- to post-intervention point : # : $p<0.05$, ## : $p<0.01$.

nutrients examined including total energy (data not shown), although a modest difference was observed for water-soluble dietary fiber ($p=0.06$).

Discussion

The importance of health counseling aimed at lifestyle modification has long been emphasized for preventing and/or treating lifestyle-related diseases such as cardiovascular diseases. Although a number of dietary intervention studies exist in Japan, most of them have not reported their effectiveness using an appropriate study design. Only one study with DHQ (Sasaki et al, 2000) meets the necessary criteria in a recent systematic review about dietary intervention studies for chronic diseases (Bowen and Beresford 2002). This shortcoming makes it difficult to evaluate the health counseling methods developed in Japan.

Recently, tailored dietary counseling system, mostly attached with a dietary assessment questionnaire, has become popular in Western countries (Brug et al. 1999 ; Brug et al. 2003). Several studies reported the usefulness and the effectiveness of the systems (Brug et al. 1996 ; Kristal et al. 2000). But, to our knowledge, only one trial besides three reports presented in this review examined the effectiveness of a similar system in Japan (Amano et al. 2002).

Another interesting point observed in these effectiveness studies is the relatively low drop-out rates : 10% and 3% in Studies 2 and 3, respectively. In Study 1, a significantly higher participation rate was observed in the intervention group than in the control group. We pointed-out a few, five at maximum, important dietary problems, based on the results of the pre-counseling assessment, for each subject, and recommended them to resolve these individualized and limited dietary problems. We assume that this could give high mo-

Table 3. Changes in dietary intake and the corresponding biomarkers in Study 3

	Intervention group			Control group			Between-group
	Baseline	Year 1	Change[a]	Baseline	Year 1	Change[a]	
	Mean	Mean		Mean	Mean		P^b
All subjects	(n = 231)			(n = 239)			
Dietary intake							
Sodium (mg/day)	5432	5049	−384	5305	5560	255	<0.001
Carotene (mg/day)[c]	2128	2549	418	1840	2033	220	0.032
Alpha-carotene (mg/day)[c]	203	255	78	156	168	41	0.013
Beta-carotene (mg/day)[c]	1861	2219	340	1624	1798	178	0.048
Vitamin C (mg/day)[c]	105	120	13	97	102	2	0.023
Serum concentration							
Total carotene (mg/L)	560	573	13	549	519	−25	0.092
Alpha-carotene (mg/L)	79	84	10	80	76	−3	0.001
Beta-carotene (mg/L)	475	480	3	462	436	−22	0.196
Vitamin C (mg/L)	14.6	14.8	0.1	14.8	14.4	−0.5	0.070
Subjects with 24-hour urine	(n = 96)			(n = 95)			
Dietary sodium (mg/day)	5551	5146	−406	5253	5836	583	<0.001
Urinary sodium excretion[d]	5625	4622	−1003	5830	5746	−84	<0.001

[a] Difference between baseline and Year 1.
[b] *P*-values for comparison between intervention group and control group by t-test after adjustment for baseline intake.
[c] Values at each point were transformed by the natural logarithm before computation because of the skewed distributions. They were then back-transformed.
[d] Expected intake was considered to be observed urinary excretion divided by 0.86 (Holbrook et al. 1984).

tivation to the subjects and lead it to a low drop-out rate. The potential to motivate subject would be as important as the observed favorable changes in nutrient intakes through counseling.

Tailored dietary counseling systems developed in Western countries have mostly been built upon behavioral change theory such as "stage of change" model (Brug et al. 1999 ; Brug et al. 2003). Some of them reported the difference of effectiveness of a tailored dietary counseling by "stage of change" model (Brug and van Assema 2000). The appropriate use of individual behavioral counseling based on the stage of change model has been reported to be effective (Steptoe et al. 2003). The use of stage of change model to this counseling system may be one of the future research fields. We expect better effectiveness when stage of change model can be introduced appropriately to the system.

The intervention is done according to the results assessed with DHQ meaning that the reliability of the results is the key to the intervention. However, DHQ does not measure dietary intake directly : the assessment is based on memory rather than direct observation of foods eaten. A validation study is necessary to examine the applicability and limitation for the questionnaire. DHQ has been validated against dietary record and serum/urine biomarkers (Sasaki et al. 1998a ; Sasaki et al. 1998b ; Sasaki et al. 2000). Although these validation studies have examined validity at one point, validity to assess change in intakes (called responsiveness) would also be necessary. Responsiveness was examined using Keys score (Keys et al. 1964) against change in serum cholesterol in Study 2 (Sasaki et al. 1999).

The three studies presented in this review bear some limitations. The first two studies were not randomized controlled trial. In Study 1, effectiveness was evaluated using dietary change without observing changes in serum cholesterol. In Study 2, when recidivism was examined after the intervention was completed, no control group was prepared. The Study 3 examined the effectiveness with a randomized controlled trial, including a reasonably large number of subjects. However, significant changes in serum biomarkers could not be detected, although a significant improvement was observed in the dietary intakes assessed with DHQ and in the urinary excretion of sodium.

Despite some shortcomings, there are several findings that are significant to studies. All these studies showed significantly favorable changes in the targeted nutrients. No unfavorable change was observed in other nutrients examined. These results indicated the ability of this system to change the intake of a specific nutrient of interest. When the change

was significant in untargeted nutrients, it was in the favorable directions such as those observed in dietary fiber and calcium in Study 2 (Table 2). This observation also shows one of the characteristics of this system where the intakes of several nutrients besides the targeted ones can be assessed.

The current dietary counseling system with DHQ would be a promising tool for modifying dietary habits at an individual level. The applicability of the assessment tool to other diseases and populations should further be examined.

Conclusion

We developed a computer-assisted dietary counseling system in which nutrient intakes and dietary behaviors are assessed with DHQ. We examined the effectiveness in three studies. We observed significant changes in the intakes of targeted nutrients in all three studies and observed favorable changes in the corresponding biomarkers of two studies. One study maintained a modified dietary habit until one-year after the counseling was completed. No unfavorable change was observed for non-targeted nutrients. The dietary counseling system with DHQ was concluded to be effective at least among motivated high-risk and healthy subjects.

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