Validation of Simplified Diet History Questionnaire

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Simplified methods to estimate long term nutrient intakes would be needed for not only nutritional epidemiologic studies but also other ones.

Based on data of diet history questionnaires (DHQ) which ask frequency and portion size for 169 items from 2,371 participants randomly selected from our cohort study in a rural city of Japan, we simplified the DHQ by eliminating some items using stepwise regression method. To examine the validity of the simplified DHQ (SDHQ), we obtained the SDHQs from 31 volunteers who had finished to complete one-day records once a month during the previous year, we calculated Pearson's correlation coefficient and calorie-adjusted correlation coefficient between the SDHQ and twelve one-day records for each nutrient intake value. Thirty one items were selected for our SDHQ. The mean values of most nutrient intakes from the SDHQ were more than those from twelve one-day records. The correlation coefficients between the SDHQ and twelve one-day records were more than 0.30 except for fat and monounsaturated fat. Calorie adjustment increased in the correlation coefficients for some nutrients. Our results suggest that the SDHQ is a validated and easy-to-use method for assessing long term 17 selected nutrient intakes. J Epidemiol, 1997; 7: 33-41.

diet history questionnaire, one-day records, stepwise regression, validation

Epidemiologic studies have indicated relationships between nutrient or food intakes and chronic diseases. Not only nutritional epidemiologic studies but also other ones should include some validated nutrient or food intake assessment methods in their researches. Hankin et al. developed the diet History Questionnaire (DHQ). It has been modified and used to estimate average food intakes of the residents in a rural city of Japan. However, the DHQ asked average frequency and quantity in the previous year for 169 foods and dishes and it took about one hour to complete it. Such a long questionnaire might not be suitable in epidemiologic studies where major interests are not in nutrition. We developed a shorter version of the DHQ, i.e., the simplified Diet History Questionnaire (SDHQ) to estimate 17 selected nutrient intakes. This study aims to know the validity of the SDHQ by comparing with mean estimated nutrient intake values from twelve one-day records.

MATERIALS AND METHODS

Development of the SDHQ

In September 1992, we distributed the DHQs to all residents aged 35 years old and over in a rural city of Gifu prefecture, Japan, at the beginning of our cohort study. We received the DHQs from 34,018 among 36,990 residents (response rate: 92%). We randomly selected 2,371 subjects from 23,708 respondents who met our conditions and aged under 64 years old, and utilized the DHQ data from these subjects (They were 1,137 males including 58 subjects who had missing values in body mass index (BMI) (with mean age = 49.6 years; SD = 8.4, mean BMI = 22.8 kg/m²; SD = 2.8) and 1,234 females including 35 subjects who had missing values in BMI (with mean age = 49.3 years; SD = 8.3, mean BMI = 22.1 kg/m²; SD = 2.8) to develop the SDHQ.²

We modified the original DHQ by adding Japanese traditional foods (raw fish, tofu etc.) which resulted in 169 foods and dishes in our DHQ. The frequency was asked using 8 response categories except for alcohol beverages, coffee and tea, i.e., "never or hardly ever", "once a month", "2 to 3 times a
record the volume of each food stuff (e.g. half of carrot, etc.).

When they were not sure about the food weight, they were asked to record the volume of each food stuff (e.g., half of carrot, etc.) and later a dietician estimated the weight from the standard table. We did not ask quantity about coffee and tea.

The subjects were asked to mark their likely frequency and quantity after reading the instruction page. The DHQs were completed by the same volunteers and sent to our department. We scanned the DHQ data by an automatic optical card reader.

The SDHQs were distributed to the subjects by the volunteers. The volunteers were randomly selected day once a month just before the day and were asked to record each food item and the weight which they ate on the day. When they were not sure about the food weight, they were asked to record the volume of each food stuff (e.g., half of carrot, etc.) and later a dietician estimated the weight from the standard table. We did not ask quantity about coffee and tea.

The DHQs were distributed to the subjects by the volunteers. The subjects were asked to mark their likely frequency and quantity after reading the instruction page. The DHQs were completed by the same volunteers and sent to our department. We scanned the DHQ data by an automatic optical card reader.

The SDHQ included 31 food items (Table 1). Coefficients of determination (R²) were 0.8 and greater for all nutrients (for partial regression coefficients and partial R² for each nutrient, Appendix).

The mean of estimated nutrient intakes from the SDHQ were significantly higher than those from twelve one-day records (Table 2), except for retinol and vitamin D. Similar trends were observed in both sexes (data not shown). Pearson’s correlation coefficients between nutrient intakes from the SDHQ and twelve one-day records were calculated using the same food consumption table as for the DHQ. Mean values from twelve one-day records were used for the following validation assessment. Log transformation was employed for intake values except for total calorie, fat and carbohydrate. We compared means of each intake value between the twelve one-day records and the SDHQ by paired t-test. Pearson’s correlation coefficients between estimated intake values from one-day records and the SDHQ were calculated. Calorie-adjusted correlation coefficients were also obtained by calculating correlation coefficients between respective residuals from a regression model with total calorie intake as the independent variable and each absolute nutrient intake as the dependent variable. The analyses were performed by SAS Ver 5.18.

RESULTS

The SDHQ included 31 food items (Table 1). Coefficients of determination (R²) were 0.8 and greater for all nutrients (for partial regression coefficients and partial R² for each nutrient, Appendix).

The mean of estimated nutrient intakes from the SDHQ were significantly higher than those from twelve one-day records (Table 2), except for retinol and vitamin D. Similar trends were observed in both sexes (data not shown).

Pearson’s correlation coefficients between nutrient intakes from twelve one-day records and the SDHQ were greater than 0.30, except for fat and monounsaturated fat. Caloric adjustment increased the correlation coefficients, except for fat, carbohydrate, retinol, vitamin A, salt, polyunsaturated fat and monounsaturated fat. Correlation coefficients between nutrient intakes from the SDHQ and twelve one-day records were greater than 0.30 in each sex except for fat, retinol, vitamin A, saturated fat and monounsaturated fat. After caloric adjustment, such high correlations were observed in each sex except for fat, retinol, vitamin A, salt, polyunsaturated fat and monounsaturated fat (data not shown).
Table 1. 31 items in the SDHQ.

- The dishes of meat and vegetables
  1. combination dishes (beef and vegetables) 2. gyoza (sauteed meat dumpling)
- Meat (without dishes including vegetables)
  3. bacon 4. liver 5. fried chicken
- Fish
  6. grilled fishes 7. raw fishes 8. fried prawn 9. shellfishes
- Cereals
  10. white polished rice
- Eggs and soybean products
  11. egg 12. tofu 13. tamagoyaki (fried bean curd)
- Vegetables (without pickles and soups)
  14. cucumber 15. tomato 16. cabbage 17. broccoli
- Seaweed
  21. kelp or kelp boilt in sweetened soy sauce
- Juice
  22. apple or grape juice
- Fruits
  23. orange
- Milk and dairy products
  24. milk 25. low fat milk or yogurt
- Dessert and snack
  26. ice cream 27. dumpling
- Pickles
  28. pickled radish
- Seasoning
  29. soy sauce 30. mayonnaise
- Alcohol beverage
  31. beer

Table 2. Mean estimated intake values and S.D. of 17 nutrients from mean of twelve one day records and SDHQ and correlation coefficients (r) and calorie adjusted correlation coefficients (Adjusted r) between them.

| Nutrient          | One day records | SDHQ      | r         | Adjusted r |
|-------------------|----------------|-----------|-----------|------------|
|                   | Mean  | S.D.    | Mean  | S.D.    |           |           |
| Total calorie (kcal) | 2106.0 | 374.1   | 2512.0** | 602.3   | 0.55      | -         |
| Protein (g)       | 79.6  | 16.2    | 97.6**  | 25.3    | 0.45      | 0.57      |
| Fat (g)           | 57.7  | 10.3    | 66.1*   | 19.3    | 0.18      | -0.03     |
| Carbohydrate (g)  | 293.5 | 49.3    | 374.8** | 86.4    | 0.54      | 0.34      |
| Fiber (g)         | 4.3   | 1.4     | 5.8**   | 2.1     | 0.47      | 0.60      |
| Calcium (mg)      | 597.7 | 218.4   | 800.7** | 283.9   | 0.58      | 0.69      |
| Retinol (µg)      | 327.3 | 236.8   | 353.3   | 208.4   | 0.37      | 0.21      |
| Carotene (µg)     | 2583.0  | 1218.0 | 4631.0** | 2268.0 | 0.40      | 0.45      |
| Vitamin A (IU)    | 2030.0 | 819.9  | 3415.0** | 1489.0 | 0.31      | 0.22      |
| Vitamin C (mg)    | 61.5  | 25.4    | 152.4** | 71.9    | 0.33      | 0.44      |
| Vitamin D (IU)    | 95.9  | 60.1    | 101.2   | 35.5    | 0.53      | 0.53      |
| Vitamin E (mg)    | 7.7   | 1.3     | 9.1**   | 2.6     | 0.44      | 0.50      |
| Salt (g)          | 12.7  | 2.3     | 15.7**  | 5.1     | 0.54      | 0.33      |
| Cholesterol (mg)  | 311.5 | 110.0   | 371.1*  | 139.4   | 0.48      | 0.52      |
| Saturated fat (g) | 13.0  | 3.2     | 15.0*   | 4.3     | 0.32      | 0.51      |
| Polyunsaturated fat (g) | 12.4 | 2.1     | 15.4**  | 4.5     | 0.45      | -0.15     |
| Monounsaturated fat (g) | 16.3 | 3.5     | 18.8*   | 5.4     | 0.20      | 0.12      |

1 Both estimated intake values were transformed by using Log except for total calorie, fat and carbohydrate intakes to compare both and calculate correlation coefficients.

* P<0.05, ** P<0.01 (paired t test compared with values from one day records)
Appendix. Partial regression coefficients and partial coefficients of determination (R²) of each item and adjusted R² for 17 nutrients (1)

| Item            | Total calorie | Protein | Fat | Carbohydrate | Fiber |
|-----------------|---------------|---------|-----|--------------|-------|
| 1. combination  | 16.901        | 0.925   | 0.845 | 1.587        | 0.024 |
| 2. gyoza        | 54.343        | 2.193   | 2.274 | 6.317        | 0.063 |
| 3. bacon        | 33.120        | 1.341   | 1.803 | 2.997        | 0.025 |
| 4. liver        | 36.343        | 1.789   | 1.349 | 2.136        | 0.041 |
| 5. fried chicken| 35.875        | 1.918   | 2.233 | 2.500        | 0.024 |
| 6. grilled fishes| 8.430        | 0.948   | 0.269 | 0.410        | 0.013 |
| 7. raw fishes   | 12.694        | 0.901   | 0.219 | 0.616        | 0.003 |
| 8. fried prawn  | 32.495        | 1.716   | 1.425 | 3.627        | 0.028 |
| 9. shellfish    | 41.339        | 2.192   | 1.385 | 4.385        | 0.083 |
| 10. white polished rice | 15.944 | 0.298 | 0.053 | 3.265 | 0.032 |
| 11. egg         | 5.977         | 0.351   | 0.362 | 0.437        | 0.004 |
| 12. tofu         | 5.849         | 0.454   | 0.308 | 0.364        | 0.025 |
| 13. daikon       | 14.317        | 0.312   | 0.035 | 0.003        | 0.134 |
| 14. cucumber     | 0.402         | 0.095   | 0.008 | 0.033        | 0.013 |
| 15. tomato       | 0.044         | 0.026   | 0.001 | 0.027        | 0.004 |
| 16. cabbage      | 0.692         | 0.288   | 0.214 | 0.030        | 0.026 |
| 17. broccoli     | -1.595        | 0.375   | 0.003 | 0.336        | 0.134 |
| 18. green        | 1.873         | 0.215   | 0.031 | 0.356        | 0.059 |
| 19. carrot       | 2.290         | 0.210   | 0.079 | 0.079        | 0.057 |
| 20. pumpkin      | 8.606         | 0.356   | 0.064 | 2.026        | 0.169 |
| 21. radicchio    | 0.635         | 0.309   | 0.122 | 1.084        | 0.045 |
| 22. apple or grape juice | 7.724 | 0.132 | 0.087 | 1.977 | 0.090 |
| 23. orange       | 11.859        | 0.332   | 0.154 | 2.609        | 0.061 |
| 24. milk         | 4.851         | 0.336   | 0.241 | 0.484        | 0.063 |
| 25. low fat milk | 8.208         | 0.398   | 0.048 | 1.202        | 0.006 |
| 26. ice cream    | 15.179        | 0.232   | 0.339 | 2.914        | 0.013 |
| 27. dumpling     | 45.152        | 1.102   | 0.591 | 3.341        | 0.067 |
| 28. pickled radish| 0.573        | 0.034   | -0.001 | 0.153        | 0.019 |
| 29. soy sauce    | 0.097         | 0.013   | 0.006 | 0.075        | 0.001 |
| 30. mayonnaise   | 8.436         | 0.138   | 0.550 | 0.715        | 0.008 |
| 31. beer         | 6.435         | 0.074   | 0.018 | 0.415        | 0.001 |
| Intercept       | 420.541       | 14.860  | 11.044 | 66.694       | 0.902 |

Adjusted R² = 0.835, 0.876, 0.854, 0.832, 0.800

Partial R² in parenthesis
### Simplified Diet History Questionnaire

|                  | Calcium | Retinol | Carotene | Vitamin A |
|------------------|---------|---------|----------|-----------|
| 1. combination   | 4.186   | 1.423   | 42.384   | 23.867    |
| 2. pasta         | (0.045) | (0.032) | (0.028)  | (0.036)   |
| 3. bacon         | 8.496   | 3.851   | 52.433   | 18.091    |
| 4. liver         | 4.314   | 2.383   | 4.776    | 9.227     |
| 5. fried chicken | 3.255   | 5.716   | 12.974   | 22.251    |
| 6. grilled fish  | 4.837   | 1.288   | 11.032   | 8.108     |
| 7. raw fish      | 1.466   | 0.326   | 4.145    | 2.737     |
| 8. fried prawn   | 7.898   | 3.215   | 16.022   | 16.314    |
| 9. shellfishes   | 13.141  | 5.086   | 72.294   | 48.108    |
| 10. white polished rice | 0.315 | -0.215 | -0.042 | -0.586 |
| 11. egg          | 1.706   | 3.696   | 3.802    | 12.094    |
| 12. tofu         | 7.191   | 0.022   | 18.474   | 5.422     |
| 13. canardisi    | 10.489  | 1.089   | 11.795   | 8.120     |
| 14. cucumber     | 0.633   | 0.018   | 2.939    | 1.709     |
| 15. tomatos      | 0.424   | -0.004  | 13.895   | 7.354     |
| 16. cabbage      | 3.043   | 0.247   | 9.944    | 5.932     |
| 17. broccoli     | 7.057   | 0.544   | 65.931   | 34.256    |
| 18. green vegetables | 2.773 | 0.038   | 75.429   | 41.068    |
| 19. carrot       | 3.631   | 0.376   | 259.242  | 144.568   |
| 20. pumpkin      | 4.557   | 0.305   | 81.450   | 45.271    |
| 21. lard         | 5.504   | 0.412   | 26.998   | 14.057    |
| 22. apple or grape juice | 2.054 | 0.367 | 12.293 | 6.486 |
| 23. orange       | 3.424   | 0.465   | 17.814   | 10.167    |
| 24. milk         | 7.065   | 2.005   | 5.769    | 10.521    |
| 25. low fat milk or yogurt | 12.501 | 1.932 | 2.315 | 7.248 |
| 26. ice cream    | 5.743   | 1.653   | 6.847    | 9.999     |
| 27. dumpling     | 0.400   | 5.250   | 20.079   | 20.971    |
| 28. pickled radish | 1.120 | -0.099 | 3.424 | 1.339 |
| 29. soy sauce    | 0.009   | -0.034  | -0.706   | -0.491    |
| 30. mayonnaise   | 1.151   | 0.695   | 6.059    | 5.996     |
| 31. beer         | 0.346   | -0.077  | 0.341    | 0.439     |
| Intercept        | 92.923  | 38.348  | 508.179  | 347.435   |

Adjusted-\( R^2 \) = 0.934

Partial \( R^2 \) in parenthesis.
# Appendix. Partial regression coefficients and partial coefficients of determination ($R^2$) of each item and adjusted $R^2$ for 17 nutrients (3)

| Item                  | Vitamin C | Vitamin D | Vitamin E | Adjusted $R^2$ |
|-----------------------|-----------|-----------|-----------|----------------|
| 1. combination        | 0.596     | 0.525     | 0.063     | 0.138          |
| 2. raw nuts           | 0.123     | 1.086     | 1.169     | 0.176          |
| 3. bacon              | 0.304     | 0.510     | 0.081     | 0.236          |
| 4. liver              | 0.965     | 3.582     | 0.088     | 0.251          |
| 5. fried chicken      | 0.096     | 0.911     | 0.169     | 0.176          |
| 6. grilled fishes     | 0.161     | 4.294     | 0.085     | 0.118          |
| 7. raw fishes         | 0.174     | 7.537     | 0.055     | 0.088          |
| 8. fried prawn        | 0.688     | 1.536     | 0.216     | 0.187          |
| 9. shellfishes        | 1.528     | 1.872     | 0.228     | 0.308          |
| 10. white polished    | -0.003    | 0.008     | 0.013     | 0.005          |
| 11. egg               | 0.175     | 0.254     | 0.040     | 0.054          |
| 12. tofu              | 0.174     | 0.190     | 0.033     | 0.053          |
| 13. green vegetables  | 0.221     | 0.787     | 0.081     | 0.110          |
| 14. cucumber          | 0.387     | 0.062     | 0.008     | 0.006          |
| 15. carrots           | 0.553     | -0.031    | 0.026     | 0.006          |
| 16. cabbage           | 1.881     | 0.068     | 0.025     | 0.036          |
| 17. broccoli          | 11.238    | -0.195    | 0.106     | -0.022         |
| 18. green             | 1.732     | 0.198     | 0.067     | 0.023          |
| 19. carrot            | 0.693     | 0.263     | 0.041     | 0.033          |
| 20. pumpkin           | 2.175     | -0.075    | 0.201     | 0.011          |
| 21. buckwheat         | 0.578     | 0.366     | 0.024     | 0.126          |
| 22. apple or grape    | 0.797     | 0.086     | 0.018     | 0.014          |
| 23. orange            | 5.186     | 0.172     | 0.062     | 0.033          |
| 24. milk              | 0.080     | 0.034     | 0.011     | 0.010          |
| 25. low fat milk      | 0.426     | 0.059     | 0.013     | 0.002          |
| 26. ice cream         | 1.186     | -0.203    | 0.018     | 0.023          |
| 27. dumpling           | 2.403     | 0.804     | 0.127     | 0.259          |
| 28. pickled radish    | 0.214     | 0.064     | 0.001     | 0.071          |
| 29. soy sauce         | 0.019     | 0.011     | 0.000     | 0.046          |
| 30. mayonnaise        | 0.230     | 0.027     | 0.000     | 0.059          |
| 31. beer              | 0.061     | 0.032     | -0.009    | 0.029          |
| Intercept             | 12.519    | 8.429     | 1.554     | 3.054          |

Adjusted $R^2$ in parenthesis
### Appendix. Partial regression coefficients and partial coefficients of determination ($R^2$) of each item and adjusted $R^2$ for 17 nutrients (4)

| Item                          | Cholesterol | Saturated fat | Polyunsaturated fat | Monounsaturated fat |
|-------------------------------|-------------|---------------|--------------------|--------------------|
| 1. combination               | 0.131       | 0.214         | 0.122              | 0.237              |
|      (0.131)                  | (0.207)     | (0.066)       | (0.241)            |                   |
| 2. gyo-za                     | 0.949       | 0.396         | 0.399              | 0.660              |
|      (0.052)                  | (0.047)     | (0.040)       | (0.067)            |                   |
| 3. bacon                      | 4.084       | 0.488         | 0.224              | 0.604              |
|      (0.041)                  | (0.184)     | (0.038)       | (0.153)            |                   |
| 4. liver                      | 14.226      | 0.296         | 0.128              | 0.524              |
|      (0.169)                  | (0.131)     | (0.015)       | (0.020)            |                   |
| 5. fried chicken              | 5.391       | 0.299         | 0.292              | 0.664              |
|      (0.070)                  | (0.079)     | (0.108)       | (0.180)            |                   |
| 6. grilled fishes             | 2.744       | 0.057         | 0.059              | 0.091              |
|      (0.203)                  | (0.039)     | (0.034)       | (0.051)            |                   |
| 7. raw fishes                 | 3.717       | 0.047         | 0.027              | 0.076              |
|      (0.151)                  | (0.011)     | (0.005)       | (0.014)            |                   |
| 8. fried prawn                | 10.425      | 0.207         | 0.391              | 0.656              |
|      (0.218)                  | (0.039)     | (0.107)       | (0.111)            |                   |
| 9. shellfishes                | 9.938       | 0.321         | 0.244              | 0.387              |
|      (0.118)                  | (0.049)     | (0.024)       | (0.038)            |                   |
| 10. white polished rice       | 0.031       | 0.015         | 0.021              | -0.005             |
|      (0.000)                  | (0.017)     | (0.004)       | (0.001)            |                   |
| 11. egg                       | 8.634       | 0.079         | 0.099              | 0.125              |
|      (0.844)                  | (0.143)     | (0.151)       | (0.179)            |                   |
| 12. tofu                      | 0.372       | 0.044         | 0.167              | 0.071              |
|      (0.005)                  | (0.027)     | (0.247)       | (0.036)            |                   |
| 13. gammadhiti                | 1.219       | 0.130         | 0.137              | 0.163              |
|      (0.012)                  | (0.048)     | (0.120)       | (0.040)            |                   |
| 14. cucumber                  | -0.016      | 0.002         | 0.001              | 0.003              |
|      (0.000)                  | (0.000)     | (0.000)       | (0.000)            |                   |
| 15. tomato                    | 0.077       | 0.001         | 0.000              | -0.002             |
|      (0.000)                  | (0.000)     | (0.000)       | (0.000)            |                   |
| 16. cabbage                   | 0.998       | 0.042         | 0.032              | 0.033              |
|      (0.000)                  | (0.000)     | (0.000)       | (0.000)            |                   |
| 17. broccoli                  | -0.210      | 0.002         | 0.018              | 0.002              |
|      (0.016)                  | (0.010)     | (0.005)       | (0.009)            |                   |
| 18. green                     | 0.174       | 0.007         | 0.027              | 0.017              |
|      (0.001)                  | (0.000)     | (0.007)       | (0.002)            |                   |
| 19. carrot                    | 0.237       | 0.019         | 0.051              | 0.050              |
|      (0.000)                  | (0.001)     | (0.007)       | (0.002)            |                   |
| 20. pumpkin                   | 0.029       | 0.021         | 0.034              | 0.018              |
|      (0.000)                  | (0.002)     | (0.005)       | (0.001)            |                   |
| 21. tsukudani                 | 0.413       | 0.024         | 0.046              | 0.032              |
|      (0.004)                  | (0.004)     | (0.011)       | (0.003)            |                   |
| 22. apple or grape juice      | 0.148       | 0.021         | 0.010              | 0.015              |
|      (0.001)                  | (0.010)     | (0.002)       | (0.003)            |                   |
| 23. orange                    | 0.733       | 0.045         | 0.026              | 0.043              |
|      (0.008)                  | (0.010)     | (0.003)       | (0.006)            |                   |
| 24. milk                      | 0.753       | 0.143         | 0.008              | 0.074              |
|      (0.166)                  | (0.725)     | (0.027)       | (0.268)            |                   |
| 25. low fat milk              | 0.039       | 0.006         | 0.008              | 0.043              |
|      (0.003)                  | (0.001)     | (0.009)       | (0.026)            |                   |
| 26. ice cream                 | 0.040       | 0.042         | 0.012              | 0.033              |
|      (0.005)                  | (0.014)     | (0.001)       | (0.005)            |                   |
| 27. dumpling                  | 2.988       | 0.182         | 0.183              | 0.285              |
|      (0.023)                  | (0.031)     | (0.026)       | (0.024)            |                   |
| 28. pickled radish            | 0.053       | -0.001        | -0.002             | -0.006             |
|      (0.000)                  | (0.000)     | (0.000)       | (0.001)            |                   |
| 29. soy sauce                 | 0.054       | -0.000        | -0.002             | -0.002             |
|      (0.001)                  | (0.000)     | (0.001)       | (0.000)            |                   |
| 30. mayonnaise                | 0.412       | 0.033         | 0.032              | 0.046              |
|      (0.000)                  | (0.021)     | (0.001)       | (0.021)            |                   |
| 31. beer                      | 0.125       | 0.004         | 0.001              | 0.064              |
|      (0.006)                  | (0.003)     | (0.000)       | (0.001)            |                   |
| Intercept                    | 37.203      | 2.066         | 3.400              | 3.445              |
| Adjusted $R^2$               | 0.933       | 0.889         | 0.806              | 0.838              |

Partial $R^2$ in parenthesis
DISCUSSION

The correlation coefficients between the SDHQ and twelve one-day records were greater than 0.3 except for fat and monounsaturated fat. In previous reports, their results indicated almost same correlation coefficients (r, 0.17 - 0.75) between their short food frequency questionnaires and their food records as our results, and higher correlation coefficients for fat (r, 0.27 - 0.67) than our results. In general, our results suggest that the SDHQ is a valid method for estimating nutritional intakes. The SDHQ has some limitations. It estimates only 17 nutrients intakes and is not able to estimate long term food or food group intakes. However, it might reduce the burden on respondents. The SDHQ might be useful as an additional questionnaire to a long questionnaire of epidemiologic studies on respondents. The SDHQ might be useful as an additional questionnaire to a long questionnaire of epidemiologic studies in which nutrient intake is assessed as a covariate.

Many previous studies reported reduction of food items to develop their food frequency questionnaire. Most of them employed a stepwise linear regression method to reduce the number of items. The stepwise regression method would be useful to select food items which contribute to the between-person variance. However, it might select high correlating items which does not contain the target nutrient. We should be careful about this fact, but this procedure might be adequate to develop the SDHQ for classifying subjects according to nutrient intakes. We selected items whose cumulative R² exceed 0.6 for each nutrient. This cut-off value of R² was lower than those of previous reports. However, R² value of the final form of SDHQ which excluded duplication was 0.8 or greater for each nutrient, which seems comparable with these reports.

It has been suggested adjustment for total calorie intake improve the accuracy of specific nutrient measurements. We also observed increases in correlation coefficients for some nutrients as previous studies. However, the adjustment decreased in the correlation coefficients of fat related nutrients (fat, retinol, polyunsaturated fat and monounsaturated fat) and carbohydrate. Unadjusted correlation coefficients of these fat related nutrients also were lower than other nutrients. One reason might be due to measurement error by the subjects who reported higher calorie intakes in the SDHQ and / or one-day records. Heitmann et al. observed underreporting their calorie intakes especially their fat calorie intakes in obese peoples. The subjects who reported higher calorie intakes in the SDHQ also might underreported their food intakes containing much fat related nutrients or carbohydrate like obese peoples. We observed overreporting of their nutrients intakes in the SDHQ compared with one-day records. The subjects may recall more than usual intakes, because they concentrate on only 31 items in the SDHQ.

We validated the SDHQ using twelve one-day records which were conducted once a month during a year. We had not validated the one-day records method. The 24-hour recall method has been often employed in major nutritional investigations. Because our one-day records less depend on recall, our method might be less affected by bias and errors due to recall. We considered seasonal variations of food intakes also to estimate average intakes during the previous year. Oveoki et al. mentioned the importance of seasonal variations of some nutrient intakes for Japanese population. Twelve one-day records which we employed would cancel out seasonal variations of food intakes. Previous reports used 4 seven-day records recorded in four seasons and 2 seven-day records recorded in almost same season as a standard. Willett mentioned that canceling out day-to-day variation of food intake should be needed to estimate true long-term intake values especially in industrialized countries. Such long-term consecutive records of nutritional intakes might be a better standard to validate the questionnaire method. A further validation study is needed using dietary records for a longer term as a standard.

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