Dietary Patterns and Incident Functional Disability in Elderly Japanese: The Ohsaki Cohort 2006 Study

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Background. To date, little is known about the association between dietary pattern and disability in older adults. The present prospective cohort study investigated the association between dietary patterns and incident functional disability.

Methods. Information on food consumption and other lifestyle factors was collected from Japanese older persons aged ≥65 years via a questionnaire. Three dietary patterns (Japanese pattern, animal food pattern, and high dairy pattern) were derived using principal component analysis of the consumption of 39 food and beverage items. Data on functional disability were retrieved from the public Long-term Care Insurance database, in which participants were followed up for 5 years. The Cox model was used to estimate the multivariate-adjusted hazard ratios of incident functional disability.

Results. Among 14,260 participants, the 5-year incidence of functional disability was 16.6%. The Japanese pattern score was associated with a lower risk of incident functional disability (hazard ratio of the highest quartile vs the lowest, 0.77; 95% confidence interval: 0.68–0.88; p trend <.001). An animal food pattern and a high dairy pattern tended to have a higher risk of incident functional disability, but not to a significant degree.

Conclusions. In Japanese older persons, the Japanese dietary pattern is associated with a decreased risk of incident functional disability.

Key Words: Epidemiology—Functional performance—Nutrition.

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Dietary patterns are widely employed in studies of the relationship between diet and health (1–3). Previously, epidemiological observations have indicated that the Mediterranean diet and the Japanese diet are associated with health benefits such as lower rates of mortality, cardiovascular disease, and depression (4–9).

With the aging of the populations of developed countries, a rapid increase in the proportion of elderly individuals with disability is imposing a large burden on social security systems worldwide (10). To date, three studies about the Mediterranean diet and three studies about the healthy dietary pattern (Healthy Eating Index) have investigated the association with the risk of functional decline (11–16). However, their sample sizes were not large, and only one study had a prospective design. Additionally, to our knowledge, the association between other dietary patterns and the risk of functional limitation has never been reported.

Japan has not only the longest life expectancy (79 years for men and 86 years for women), but also the longest healthy life expectancy (73 years for men and 78 years for women) of any country in the world (17). This may be partly attributable to the dietary patterns of the Japanese population, in particular, the Japanese diet. Therefore, the aim of the present analysis was to determine the association between dietary patterns and incident functional disability in elderly individuals in Japan.

Methods

Study Cohort

The design of the Ohsaki Cohort 2006 Study has been described in detail elsewhere (18). In brief, the source population for the baseline survey comprised all older citizens in Ohsaki City, Miyagi Prefecture, northeastern Japan, on December 1, 2006; 31,694 men and women aged ≥65 years. The survey included questions about the frequency of recent average consumption of 39 food items, as well as items on history of disease, blood pressure, education level, smoking, alcohol drinking, body weight, height, psychological distress score (K6) (19,20), time spent walking per day, and motor function score of the Kihon Checklist (21).

The baseline survey was conducted between December 1, 2006 and December 15, 2006. A questionnaire was distributed by the heads of individual administrative districts, and then collected by mail. For this analysis, 23,091 individuals...
who provided valid responses formed the study cohort. We excluded 6,333 individuals who did not provide written consent for review of their Long-term Care Insurance (LTCI) information, 1,979 persons who had already been certified as having a disability by the LTCI at the time of the baseline survey, five persons who had died or moved during the period of the baseline survey, and 514 persons who left blank more than 24 of the 39 food items on the food frequency questionnaire (FFQ). Thus, 14,260 responses were analyzed for the purpose of this study.

During the 5-year period covered by the study, only 121 individuals were lost to follow-up because they moved away from the study area, without developing any functional disability; thus, the follow-up rate was 99.2%. From 62,755 person-years, incident functional disability was determined in 2,360 persons, and the number of all-cause deaths without incident functional disability was 842.

Dietary Assessment

We asked about the average frequency of consumption of each food using a 39-item FFQ, for which we had previously conducted a validation study in the same region (the precinct of Ohsaki Public Health Center, Miyagi) (22). In brief, 113 participants (55 men and 58 women) provided four 3-day diet records within a 1-year period and subsequently responded to the FFQ. The method used for calculating food and nutrient intake from the FFQ was developed in this study. Based on these data, we calculated the volume of consumption of individual foods according to the FFQ. For estimation of energy and protein intake from the food consumption volume based on the FFQ, we used a food composition table that corresponded to the items listed in the questionnaire. This food composition table was developed by using the Standard Tables of Food Composition published by the Science and Technology Agency of Japan (22).

Dietary Pattern Derivation

To derive dietary patterns, we used two methods: (i) factor analysis (principal component analysis) and (ii) confirmatory factor analysis. The factor analysis was conducted by using the daily consumption (weight in grams) of 39 food items from the FFQ. If the reported frequency was blank, we assumed that the item was never consumed. We used the PROC FACTOR procedure in SAS version 9.3 to obtain a three-factor score. To achieve a simpler structure with greater interpretability, the factors were rotated by an orthogonal transformation (varimax rotation function in SAS). This allowed three major dietary patterns to be identified. We named them (i) the Japanese pattern, (ii) the animal food pattern, and (iii) the high dairy pattern. For each pattern and each participant, we calculated a factor score by summing the consumption of each food item weighted by its factor loading.

In order to strengthen our dietary pattern analysis, we further used confirmatory factor analysis, which is characterized by hypothesis-oriented approach. Recently, confirmatory factor analysis has been used increasingly as a major analytical method in dietary pattern research, such as studies of the Mediterranean diet (23–25). We identified nine food items that formed the Japanese Diet Index Score: rice, miso soup, seaweeds, pickles, green and yellow vegetables (green vegetables, carrot, pumpkin, tomato), fish (raw fish, fish boiled with soy, roast fish, boiled fish paste, dried fish), green tea, beef and pork (beef, pork, ham, sausage), and coffee. In a previous study based on the dietary record method, these items had been reported to have higher absolute factor scores for the traditional Japanese pattern (26). Another study has also reported that these items are characteristic of the traditional Japanese diet (27). For each of the seven positive components (rice, miso soup, seaweeds, pickles, green and yellow vegetables, fish, and green tea), participants received 1 point if their intake was more than or equal to the sex-specific median. For each of the two negative components (beef and pork, and coffee), participants received 1 point if their intake was below the sex-specific median. Thus, the Japanese Diet Index Score ranged from 0 to 9, with higher scores indicating greater dietary conformity.

Covariate

Body mass index was calculated as the self-reported body weight (kg) divided by the square of the self-reported body height (m).

The K6 was used as an indicator of psychological distress (19,20). Respondents were asked about their mental status over the last month by using six questions. Total point scores ranged from 0 to 24. As the optimal cutoff point for mental illness in the validation study, we classified individuals with scores of ≥13 as having psychological distress (20).

The Kihon Checklist was developed to predict functional decline in community-dwelling elderly individuals. With regard to the motor function score in the Kihon Checklist, respondents were asked about their current motor function status by using five binary questions yielding total point scores ranging from 0 to 5. As the optimal cutoff point for functional decline suggested in the validation study, we classified individuals with scores of <3 as having better motor function (21).

LTCI System in Japan

In this study, we defined incident functional disability as certification for LTCI in Japan, which uses a nationally uniform standard of functional disability. LTCI is a mandatory form of social insurance to assist daily activity in the frail elderly individuals (28–32). Everyone aged ≥40 years pays premiums, and everyone aged ≥65 years is eligible for
formal caregiving services. When a person applies to the municipal government for benefits, a care manager visits his or her home and assesses the degree of functional disability using a questionnaire developed by the Ministry of Health, Labor, and Welfare. Then, the municipal government calculates the standardized scores for physical and mental functions on the basis of the questionnaire and assesses whether the applicant is eligible for LTCI benefits (certification). There are a total of 74 items in the questionnaire, and these are classified into six dimensions: motor function (13 items), activity of daily living (12 items), cognitive function (9 items), mental and behavioral disorders (15 items), adaptation to social life (6 items), and use of medical procedures (12 items). If a person is judged to be thus eligible, the Municipal Certification Committee decides on one of seven levels of support, ranging from Support Level 1, Support Level 2, and Care Level 1 to Care Level 5. In brief, LTCI certification levels are defined as follows. Support Level 1: “limited in instrumental activities of daily living but independent in basic activities of daily living (ADLs)”; Care Level 2: “requiring assistance in at least one basic ADL task”; Care Level 5: “requiring care in all ADL tasks”. A community-based study has shown that levels of LTCI certification are well correlated with ability to perform activities of daily living, and with Mini-Mental State Examination scores (33). LTCI certification has already been used as a measure of incident functional disability in the elderly individuals (34–36).

Follow-up and Case Details
Incident functional disability was set as our endpoint, which was defined as LTCI certification. The primary outcome was LTCI certification (Support Level 1 or higher), in which deaths without LTCI certification were treated as censored. In the subanalysis, we set the criteria of disability toward a more severe level, that is, Care Level 2 (requiring assistance with one basic activities of daily living task) or higher.

We obtained a data set that included information on the date of LTCI certification, death, or emigration from Ohsaki City Government based on an agreement about the secondary use of data. With regard to LTCI certification, information on care level was also provided. All data were transferred from the Ohsaki City Government under the agreement related to Epidemiologic Research and Privacy Protection yearly each December.

Ethical Issues
We considered the return of completed questionnaires to imply consent to participate in the study involving the baseline survey data and subsequent follow-up of death and emigration. We also confirmed information regarding LTCI certification status after obtaining written consent along with the questionnaires returned from the participants at the time of the baseline survey. The Ethics Committee of Tohoku University Graduate School of Medicine (Sendai, Japan) reviewed and approved the study protocol.

Statistical Analysis
We counted the person-years of follow-up for each participant from December 16, 2006 until the date of incident functional disability, date of emigration from Ohsaki City, date of death, or the end of the study period (November 30, 2011), whichever occurred first.

We used the multiple adjusted Cox proportional hazard model to calculate the hazard ratios (HRs) and 95% confidence intervals (CIs) for incident functional disability according to quartiles of the dietary pattern score. Dummy variables were created for the quartiles of each dietary pattern score, and the lowest quartile of a dietary pattern score was used as a reference category. Multivariate models were adjusted for the following variables. Model 1 was sex and age adjusted. To examine whether the association between the dietary patterns and functional disability was attributable to a healthy physical status or other lifestyle factors, Model 2 was further adjusted for history of stroke, myocardial infarction, hypertension (individuals with self-measured systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg were also defined as hypertensive), arthritis, osteoporosis and fracture, education level, smoking status, alcohol consumption, body mass index, psychological distress score, time spent walking per day, and motor function score. Model 3 was fully adjusted and included energy and protein intake (category of sex-specific tertile).

All data were analyzed using SAS version 9.3 (SAS Inc., Cary, NC). All statistical tests described here were two sided, and differences at p < .05 were accepted as significant.

Results
Among 14,260 participants, the proportion of men was 44.8%, mean (SD) age was 73.9 (6.0) years, and mean (SD) body mass index was 23.6 (3.4). The number of participants for whom data on the FFQ were any missing was 7,352 (the distribution of missing shows in Supplementary Figure 1).

Table 1 shows factor loadings, which are equivalent to simple correlations between the food items and dietary patterns. A positive loading indicates that a food item is positively associated with the dietary pattern, and a negative loading indicates an inverse association with the dietary pattern. That is, food items highly loaded within a dietary pattern are highly correlated with each other.

The Japanese pattern was loaded heavily on fish, vegetables, mushrooms, potato, seaweeds, pickles, soybean and fruits, whereas the animal food pattern was loaded heavily on various animal-derived foods (beef, pork, ham, sausage, chicken, liver, eggs, and butter). The high dairy pattern was loaded on dairy products (yoghurt, cheeses, and butter), margarine, and...
black tea, and negatively loaded on rice. These three dietary patterns explained 26.1% of the variance.

Table 2 compares the characteristics of participants according to the quartiles of each dietary pattern score. Participants with a higher Japanese pattern score were less likely to be male, to be current smokers and drinkers, and to suffer from psychological distress. Additionally, participants with a higher Japanese pattern score were more likely to have ≥19 years of education, to walk ≥1 h/d, and to have greater intake of energy and protein. Conversely, participants with a higher animal food pattern score were more likely to be male, to be current smokers and drinkers. Additionally, participants with a higher animal food pattern score were more likely to walk ≥1 h/d, to have better motor function, and to have greater intake of energy and protein, and were less likely to suffer from psychological distress and to have ≥19 years of education. Participants with a high dairy pattern score tended to be female, and were similar to those with a higher Japanese dietary pattern score except for psychological distress, time spent walking, and intake of energy and protein.

The association between the dietary patterns and functional disability, along with HRs and associated 95% CIs, are shown in Table 3. We found that a higher Japanese pattern score was inversely associated with the incident risk of functional disability (p-trend < .001 in Model 3). This inverse association did not differ between the sexes (p = .057 for interaction with sex; data not shown). On the other hand, the animal food pattern and the high dairy pattern were not significantly associated with functional disability in any of the models.

Even when we set stricter criteria for disability (basic activities of daily living impairment), the results for the
Japanese pattern score did not change. In Model 3, the multivariate HRs (95% CI) for the successive categories of the Japanese pattern score were: 1 (reference), 0.87 (0.73–1.03), 0.71 (0.59–0.86), and 0.74 (0.61–0.90) \( (p \text{ trend } < .001; \text{ data not shown}) \). To examine possible reverse causality, we reanalyzed the association after excluding 900 participants who experienced incident functional disability in the first 2 years of follow-up, but the results did not change substantially in Model 3 \( (p \text{ trend } < .001; \text{ data not shown}) \). Additionally, when we excluded participants who had any history of disease that might have affected dietary habit (stroke, myocardial infarction, diabetes, arthritis, osteoporosis, fracture, cancer, kidney disease, and hepatic disease), the results did not change substantially in Model 3 \( (p \text{ trend } = .007; \text{ data not shown}) \). The Japanese pattern score was also inversely associated with all-cause mortality \( (p \text{ trend } = .028 \text{ in Model } 3; \text{ data not shown}) \).

Table 4 shows the results of incident functional disability according to the quartiles of the Japanese Diet Index Score. In this analysis, we included 514 persons who left...
Table 3. Association Between Dietary Pattern Scores and Incident Functional Disability (n = 14,260)

<table>
<thead>
<tr>
<th>Dietary Pattern Score Quartiles</th>
<th>1 (Low)</th>
<th>2</th>
<th>3</th>
<th>4 (High)</th>
<th>p trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese pattern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of event</td>
<td>711</td>
<td>591</td>
<td>522</td>
<td>536</td>
<td></td>
</tr>
<tr>
<td>Person-years</td>
<td>15,159</td>
<td>15,649</td>
<td>15,948</td>
<td>15,999</td>
<td></td>
</tr>
<tr>
<td>Model 1*</td>
<td>1.00 (reference)*</td>
<td>0.83 (0.75–0.93)</td>
<td>0.72 (0.64–0.81)</td>
<td>0.65 (0.58–0.72)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Model 2*</td>
<td>1.00 (reference)</td>
<td>0.90 (0.80–1.00)</td>
<td>0.80 (0.71–0.89)</td>
<td>0.75 (0.67–0.84)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Model 3*</td>
<td>1.00 (reference)</td>
<td>0.91 (0.82–1.02)</td>
<td>0.82 (0.73–0.92)</td>
<td>0.77 (0.68–0.88)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Animal food pattern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of event</td>
<td>616</td>
<td>620</td>
<td>557</td>
<td>567</td>
<td></td>
</tr>
<tr>
<td>Person-years</td>
<td>15,601</td>
<td>15,730</td>
<td>15,767</td>
<td>15,657</td>
<td></td>
</tr>
<tr>
<td>Model 1*</td>
<td>1.00 (reference)</td>
<td>1.04 (0.93–1.16)</td>
<td>0.97 (0.86–1.09)</td>
<td>1.00 (0.88–1.13)</td>
<td>.697</td>
</tr>
<tr>
<td>Model 2*</td>
<td>1.00 (reference)</td>
<td>1.08 (0.96–1.21)</td>
<td>1.03 (0.91–1.16)</td>
<td>1.09 (0.96–1.23)</td>
<td>.313</td>
</tr>
<tr>
<td>Model 3*</td>
<td>1.00 (reference)</td>
<td>1.10 (0.98–1.23)</td>
<td>1.07 (0.95–1.21)</td>
<td>1.16 (1.02–1.31)</td>
<td>.053</td>
</tr>
<tr>
<td>High dairy pattern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of event</td>
<td>615</td>
<td>611</td>
<td>558</td>
<td>576</td>
<td></td>
</tr>
<tr>
<td>Person-years</td>
<td>15,502</td>
<td>15,618</td>
<td>15,905</td>
<td>15,730</td>
<td></td>
</tr>
<tr>
<td>Model 1*</td>
<td>1.00 (reference)</td>
<td>0.96 (0.85–1.07)</td>
<td>0.89 (0.79–1.00)</td>
<td>0.98 (0.87–1.10)</td>
<td>.465</td>
</tr>
<tr>
<td>Model 2*</td>
<td>1.00 (reference)</td>
<td>0.99 (0.89–1.11)</td>
<td>0.95 (0.84–1.07)</td>
<td>1.10 (0.98–1.24)</td>
<td>.217</td>
</tr>
<tr>
<td>Model 3*</td>
<td>1.00 (reference)</td>
<td>0.99 (0.88–1.11)</td>
<td>0.95 (0.84–1.07)</td>
<td>1.11 (0.99–1.26)</td>
<td>.158</td>
</tr>
</tbody>
</table>

*Adjusted for age (65–69, 70–74, 75–79, 80–84, and ≥85 y) and sex.
†HR (95% CI).
‡Adjusted for model 1 + history of disease (stroke, myocardial infarction, hypertension, arthritis, osteoporosis, fracture [yes, no]), educational level (age when last graduation of school <16, 16–18, ≥19 y, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (in kg/m²: <18.5, 18.5–24.9, ≥25.0, missing), psychological distress score (<13, ≥13, missing), time spent walking (<30 min/d, 30 min to 1 h/d, ≥1 h/d, missing), and motor function score (<3, ≥3, missing).
§Adjusted for model 2 + tertile categories of energy intake and protein intake (sex-specific tertile, missing).

Table 4. Confirmatory Factor Analysis: Association Between Japanese Diet Index Score and Incident Functional Disability (n = 10,148)

<table>
<thead>
<tr>
<th></th>
<th>1 (Low)</th>
<th>2</th>
<th>3</th>
<th>4 (High)</th>
<th>p trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese Diet Index Score (quartiles)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index score</td>
<td>&lt;4</td>
<td>4</td>
<td>5</td>
<td>≥6</td>
<td></td>
</tr>
<tr>
<td>Number of event</td>
<td>374</td>
<td>333</td>
<td>374</td>
<td>481</td>
<td></td>
</tr>
<tr>
<td>Person-years</td>
<td>9,793</td>
<td>9,293</td>
<td>10,661</td>
<td>15,261</td>
<td></td>
</tr>
<tr>
<td>Model 1*</td>
<td>1.00 (reference)*</td>
<td>0.88 (0.76–1.02)</td>
<td>0.82 (0.71–0.94)</td>
<td>0.72 (0.63–0.83)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Model 2*</td>
<td>1.00 (reference)</td>
<td>0.92 (0.79–1.07)</td>
<td>0.87 (0.76–1.01)</td>
<td>0.77 (0.67–0.88)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Model 3*</td>
<td>1.00 (reference)</td>
<td>0.94 (0.81–1.09)</td>
<td>0.90 (0.77–1.05)</td>
<td>0.79 (0.68–0.92)</td>
<td>.002</td>
</tr>
</tbody>
</table>

*Index score was constituted by nine food items that reported to have higher absolute factor scores for the traditional Japanese pattern. For each of the seven positive components (rice, miso soup, seaweeds, pickles, green and yellow vegetables, fish, and green tea), participants received 1 point if their intake was more than or equal to the sex-specific median. For each of the two negative components (beef and pork and coffee), participants received 1 point if their intake was below the sex-specific median.
†Adjusted for age (65–69, 70–74, 75–79, 80–84, and ≥85 y) and sex.
‡HR (95% CI).
§Adjusted for model 1 + history of disease (stroke, myocardial infarction, hypertension, arthritis, osteoporosis, fracture [yes, no]), educational level (age when last graduation of school <16, 16–18, ≥19 y, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (in kg/m²: <18.5, 18.5–24.9, ≥25.0, missing), psychological distress score (<13, ≥13, missing), time spent walking (<30 min/d, 30 min to 1 h/d, ≥1 h/d, missing), and motor function score (<3, ≥3, missing).
§Adjusted for model 2 + tertile categories of energy intake and protein intake (sex-specific tertile, missing).

Blank more than 24 items on the FFQ and then excluded 4,626 persons for whom data on items of the Japanese Diet Index Score were missing (10,148 persons were included in the analysis). We found a significant inverse association between the Japanese Diet Index Score and functional disability (p trend = .002 in Model 3).

**Discussion**

In this population-based cohort study, we identified three dietary patterns derived by factor analysis among the Japanese population: the Japanese pattern, animal food pattern, and high dairy pattern, which were consistent with our previous study using the same FFQ, except for the third pattern because in the present study the volume of alcohol consumption was not available (6). The Japanese pattern was associated with a decreased risk of incident functional disability. No apparent association was observed for either the animal food pattern or the high dairy pattern. To our knowledge, this is the first study to have proved the association between the Japanese dietary pattern and incident risk of functional disability.
Our study had a number of strengths: (i) it was a large population-based cohort study of 14,260 persons; (ii) it had a follow-up rate of almost 100%; (iii) many confounding factors were taken into account.

We also considered the effects of reverse causality. Even after excluding individuals who experienced incident functional disability in the first 2 years of follow-up, the strong inverse association between the Japanese pattern and functional disability persisted. The earlier findings suggest that the present results are unlikely to be explained by reverse causality.

This inverse association between the Japanese pattern and functional disability was consistent with previous studies of the Mediterranean diet and Healthy Eating Index (11–16). The Japanese pattern has some characteristics in common with the Mediterranean diet, for instance, high intake of vegetables, fruits, legumes, and fish, and low intake of meat and dairy products (4,37). Thus, the mechanism of this association might be similar to that reported in the previous studies of the Mediterranean diet. On the other hand, the Healthy Eating Index pattern in three previous studies may not be fully consistent with Japanese pattern because meat, but not fish, was recommended in the Healthy Eating Index. Furthermore, vegetables, fruits, and legumes are common components of the above three patterns. Previous studies have reported that a plant-based diet reduces cardiovascular risk, type 2 diabetes, and bone loss (37–42). Although a diet consisting only of plant-based foods may lack certain nutrients (42), a dietary pattern including an abundant amount of these plant-based items may decrease the risk of functional disability.

On the other hand, the Japanese pattern is reported to differ from the Mediterranean diet in that energy intake is lower (43). The Japanese pattern score was positively correlated with energy intake (Table 2), but the results did not change substantially even when energy intake and body mass index were added in the multivariate model. The inverse association seems difficult to explain in terms of energy intake alone, and micronutritional components might have a role. Because the Japanese pattern included a variety of foods that explained 12.8% of the overall variance, this pattern may contain various micronutritional components and have a good nutrient balance.

In the present study, we used two different dietary pattern derivation methods to strengthen the reliability of our results. When we repeated the analysis by using confirmatory factor analysis, higher conformity with the Japanese Diet Index Score was also associated with a decreased risk of incident functional disability. Because these factors in the Japanese Diet Index Score were based on nationwide validity studies of dietary pattern, the Japanese Diet Index Score may represent the most common diet items in Japanese population. However, the Japanese diet also varies in several aspects according to region. For example, residents of Okinawa, who are known for their longer average life expectancy, often eat the traditional Okinawan diet that includes unique food items such as bitter melon, mugwort, and turmeric (44).

Additionally, in the analysis using each item from the Japanese Diet Index Score as an exposure variable (dichotomous variable by sex-specific median), a significant inverse association was observed for items other than fish and vegetables (data not shown). These results suggested that traditional Japanese foods were also associated with a decreased risk of incident functional disability. Previous studies have also examined the health impact of individual Japanese foods and their nutritional components, including soybeans (as well as miso soup), seaweed, and green tea (45–49).

This study had several limitations. First, we did not investigate the causes of functional disability in participants who received LTCI certification. Thus, the mechanism responsible for reduction of functional disability by intake of a Japanese diet remained unidentified. Second, not all potential confounding factors were considered, as we used only indirect measures of physical and cognitive function for adjustment. Third, because not all candidates applied for LTCI certification, this study may not have been completely free from detection bias. The degree of this bias remains to be verified.

In conclusion, the findings of this cohort study indicate that higher conformity with the Japanese dietary pattern is significantly associated with a lower risk of incident functional disability. This result suggests that the Japanese dietary pattern contributes to extended healthy life expectancy.

Supplementary Material
Supplementary material can be found at: http://biomedgerontology.oxfordjournals.org/

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Conflict of Interest
There are no potential conflicts of interest that relate to the manuscript.

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