Cohort study examining the association between vegetable consumption and weight gain in a single year among Japanese employees at a manufacturing company

Kimi Sawada MSc1, Nobuko Murayama PhD2, Yukari Takemi PhD3, Hiromi Ishida PhD3

Background and Objectives: Overweight and obesity increase the risk of hypertension, type 2 diabetes, and other metabolic disorders and are increasing in Japan, particularly among men. Several prospective studies have suggested that high vegetable intake is inversely associated with weight gain. Here, the association between vegetable consumption and weight gain in a group of food manufacturing workers over the course of one year was investigated. Methods and Study Design: The study was a one-year cohort study of the nutrition and lifestyle survey. The study population consisted of 900 and 910 Japanese employees (aged 19-60 years) from a manufacturing company located in Musashino City, Tokyo, Japan, that were administered the same validated brief self-administered diet history and dietary lifestyle questionnaire in 2006 and 2007, respectively. Clinical examinations of body weight were also performed to assess changes in weight. We analyzed participants who responded in both 2006 and 2007 (n=478). Results: Risk of weight gain of more than 3 kg was significantly lower in the group consuming the most vegetables than in the group consuming the least, and this difference remained significant after adjustment for baseline age, sex, and consumption of other foods (p for trend=0.028). Conclusions: Weight gain was inversely associated with high consumption of vegetables. Encouraging Japanese employees to consume more vegetables may be an important strategy in controlling weight gain and preventing metabolic syndrome.

Key Words: vegetable consumption, weight gain, Japanese employees, one-year cohort study

INTRODUCTION
The Japanese National Health and Nutrition Examination Survey reported that 31.7% of Japanese adults (20-69 years old) were overweight or obese.1 Overweight and obesity increase the risk of hypertension, type 2 diabetes, and other metabolic disorders. Many health insurance associations and clinics have recently implemented health guidance issued by Japan’s Ministry of Health, Labor, and Welfare for subjects over the age of 40 with metabolic syndrome, including specific weight loss goals at yearly checkups.1 One prominent risk factor for metabolic syndrome is a weight gain of more than 3 kg in a single year. Japanese physicians include this item in medical interviews conducted at all health centers, as recommended in “Health guidance and check-ups”, a national campaign promoted by health care insurers.

With regard to possible causation, several prospective studies have suggested that high vegetable intake is inversely associated with weight gain.2,8 Examples include an association between vegetable intake and weight gain over 12 years among middle-aged women2 and over 4 years among women and men in the US,5 and an association between high vegetable intake and a suppression of a weight gain of more than 3.14 kg over 10 years in Spanish adults.6 To date, however, no evidence has been published on the association between vegetable consumption and weight gain in Japanese workers.

Moreover, most evidence to date has been obtained using a follow-up of more than one year.4,9 Assessment of weight gain over short periods is important in Japan, however, because questionnaires used in health checkups nationwide to collect information on the prevention of metabolic syndrome assess “the presence or absence of a weight gain of 3 kg or more in one year”. To our knowl-
edge, the question of whether or not low vegetable intake
is a risk factor for a weight gain of 3 kg or more in one
year has not been investigated. Further, most studies have
been conducted in Western countries, and few studies
have addressed the association between vegetable intake
and weight gain in Asian populations.

Vegetable intake in Japan has declined in recent years
in all generations, from teens to the elderly, and unlike
other countries, the decline in Japan has been particularly
pronounced in men. Incrementing obesity rates have also
been greatest among men. That is, vegetable consumption
has decreased as obesity rates have increased in Japan. To
support the efforts of obesity prevention workers, evi-
dence on the association between diet or dietary behav-
iours and obesity is urgently required.

Here, to determine whether or not vegetable consump-
tion among Japanese workers is associated with a weight
gain of more than 3 kg in a single year, we examined the
association between vegetable intake and weight gain in
a population of Japanese workers using brief diet and life-
style questionnaires and data from a yearly health exami-
nation.

MATERIALS AND METHODS

Study population

This study was one-year cohort study of male and female
Japanese employees aged 19–60 years at study initiation
at a 2006 health check. The target company was a food
manufacturing company in Musashino City, Tokyo, with
1,250 employees. Of these workers, 900 participants were
recruited in May 2006 and 910 participants in May 2007.
We limited our analysis to participants who had received
annual health checkups and completed questionnaires in
both years. Information for the study was sent by inter-
office mail before the annual health check in both years,
and consent forms were collected from the participants
with the self-administered questionnaires. These ques-
tionnaires were collected at each annual health checkup
(n=801 in 2006 and n=810 in 2007). Responses were re-
cieved from 89% of participants in 2006 and 88% in 2007.
Three investigators independently checked each survey
for missing data and solicited information to complete the
questionnaires. For the present analyses, we included
those participants who responded in both 2006 and 2007
(n=478). This study was conducted in accordance with
the guidelines of the Declaration of Helsinki, and all pro-
cedures involving human subjects/patients were approved
by the Human Research Ethical Committee of the Uni-
versity of Kagawa (approval no. 257). Written informed
consent was obtained from all subjects/patients.

Questionnaires

We distributed a self-administered life-style question-
naire and a brief-type self-administered diet history ques-
tionnaire (BDHQ). The lifestyle questionnaire collected in-
formation on demographic factors, including sex, age,
marital status, job type, attitudes and behaviours regard-
ing food and quality of life, as well as knowledge of food
preparation and nutritional requirements. Job type was
characterized as management, supervisor, or regular em-
ployee.

The BDHQ was derived from the previously validated
self-administered diet history questionnaire (DHQ).10,11
Energy-adjusted food consumption used in the present
study, presented as grams of foods consumed per 4,184 kJ
(1,000 kilocalories), was validated against a 16-day
weighed dietary record as a gold standard in a previous
report.11 Differences in mean intakes were minimal, and
correlation coefficients between the two methods were
acceptable. Vegetable intake was assessed by asking re-
pondents to note the frequency with which they con-
sumed green and yellow vegetables, other vegetables,
pickled vegetables, mushrooms, and seaweed. Responses
were validated against the gold standard and found to
have a Spearman coefficient of correlation of 0.62 for
men and women, signifying moderate correlation.

Health check-up data

Body weight was measured in kilograms using electronic
weight scales with direct digital reading. Height was
measured in centimetres with the person standing without
shoes. Body mass index (BMI; weight [kg]/height [m]²)
calculated from weight and height measurements. All
participants were measured at the same clinic using the
same measurement equipment.

Statistical analysis

Questionnaires with incomplete or implausible infor-
mation (total daily energy intake <1/3 of the energy re-
quirement for each age and sex class, assuming a low
level of physical activity or >2/3 of the energy require-
ment for each age and sex class, assuming a high level of
physical activity; n=41) were excluded based on the ex-
clusion criteria of the preceding study.12 After exclusion,
a total of 437 respondents who provided information in
both 2006 and 2007 remained in the analysis. We con-
ducted a cross-sectional analysis of the associations be-
tween baseline covariates and the intake of vegetables.
Vegetable intake was categorized into quartiles, and mean
food consumption was calculated (g/4,184 kJ [1,000
cal]). Other categories were expressed as percentages.
Participants were divided into quartiles based on their
vegetable consumption adjusted for energy using the den-
sity method, where energy-adjusted values were calculat-
ed using the amount of each food group consumed daily
per 4,184 kJ (1,000 kcal) of daily energy intake. We per-
formed binomial logistic multiple regression analysis to
examine the association between vegetable consumption
and the risk for weight gain of 3 kg or more in one year,
adjusting for sex, age, weight, marital status, and intake
of food with the potential to cause weight gain. Statistical
tests were conducted using calorie-adjusted values. All
statistical analyses were performed using SPSS version
20.0 (SPSS Inc., Chicago, IL, USA). P-values were two-
tailed, and p<0.05 was considered significant.

RESULTS

The characteristics of participants, stratified by quartile
of vegetable consumption, are shown in Table 1. Mean en-
ergy-adjusted consumption of vegetables ranged from
57.2 g/4,184 kJ (1,000 kcal) in the lowest quartile to more
than 143.7 g/4,184 kJ (1,000 kcal) in the highest quartile
at baseline. Participants in the highest quartile of vegeta-
ble consumption were significantly older, more likely to
be women, and were more often married. Baseline and one-year body weight decreased in parallel with vegetable consumption. Weight change over a single year in participants in the highest quartile of vegetable intake was 0.6 kg less than that in participants in the lowest quartile (p for trend=0.029). BMI measured at both baseline and after one year did not differ by quartile (p for trend=0.089). The participants with a higher consumption of vegetables also consumed the greatest amounts of fish, milk and milk products, dressing, and Japanese sweets, but consumed less cereals, sweet beverages, sugar, and alcohol than participants in the lowest quartile (Table 2).

Higher vegetable consumption was associated with a reduced risk of rapid weight gain (Table 3). Compared with participants in the lowest quartile, crude odds of weight gain ≥3 kg in a single year did not differ by quartile (p for trend=0.016) after adjustment for sex, age, marriage status, baseline weight, and consumption of fish, cereals, fruits, milk, Japanese sweets, sweetened beverages, sugar, dressing, and alcohol (Model 4; p for trend=0.028). Compared to participants in the lowest quartile of vegetable consumption (<57.2 g/4,184 kJ [1,000 kcal], participants in the highest quartile (≥143.7 g/4,184 kJ [1,000 kcal]) had a 73% lower risk of gaining ≥3 kg weight in a single year (adjusted OR 0.27, 95% CI, 0.08-0.99). However, participants in the second quartile (57.2 - 93.6 g/4,184 kJ [1,000 kcal]) and third quartile (93.6 - 143.7 g/4,184 kJ [1,000 kcal]) did not have a significantly lower risk of rapid weight gain, with risk reductions of 31% (OR=0.69, 95% CI, 0.29-1.68) and 63% (OR=0.37, 95% CI, 0.13-1.07), respectively.

**DISCUSSION**

In this study, we confirmed that vegetable intake was inversely associated with the risk of a body weight increase of 3 kg or more over one year in Japanese employees. This association was not modified by adjustment for

---

### Table 1. Characteristics of the study population (n=437) by quartiles of vegetable intake at baseline

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Q1 (n=110)</th>
<th>Q2 (n=108)</th>
<th>Q3 (n=109)</th>
<th>Q4 (n=109)</th>
<th>p value†</th>
<th>p for trend‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>31.0 (9.7)</td>
<td>33.6 (10.3)</td>
<td>39.0 (11.3)</td>
<td>44.3 (12.7)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>63.0 (10.8)</td>
<td>62.5 (11.1)</td>
<td>60.4 (10.3)</td>
<td>57.6 (10.9)</td>
<td>0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>1-year weight gain (kg)</td>
<td>0.6 (2.3)</td>
<td>0.4 (2.5)</td>
<td>0.1 (2.2)</td>
<td>0.0 (2.2)</td>
<td>0.171</td>
<td>0.029</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.1 (3.4)</td>
<td>22.0 (3.6)</td>
<td>22.2 (3.2)</td>
<td>22.0 (3.5)</td>
<td>0.943</td>
<td>0.893</td>
</tr>
<tr>
<td>BMI after 1 year (kg/m²)</td>
<td>22.4 (3.4)</td>
<td>22.2 (3.6)</td>
<td>22.4 (3.3)</td>
<td>22.2 (3.5)</td>
<td>0.968</td>
<td>0.816</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>124 (13.3)</td>
<td>121 (12.4)</td>
<td>124 (13.5)</td>
<td>121 (13.0)</td>
<td>0.148</td>
<td>0.465</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>70.2 (11.3)</td>
<td>69.5 (11.6)</td>
<td>71.4 (11.5)</td>
<td>70.8 (10.5)</td>
<td>0.617</td>
<td>0.420</td>
</tr>
<tr>
<td>Proportion (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight gain ≥3 kg</td>
<td>14.5</td>
<td>11.1</td>
<td>7.3</td>
<td>5.6</td>
<td>0.107</td>
<td>0.015</td>
</tr>
<tr>
<td>Male</td>
<td>85.5</td>
<td>87.7</td>
<td>66.4</td>
<td>39.4</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Unmarried</td>
<td>72.7</td>
<td>63.0</td>
<td>50.0</td>
<td>47.2</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Regular employee†</td>
<td>94.5</td>
<td>95.4</td>
<td>96.4</td>
<td>97.2</td>
<td>0.961</td>
<td>0.080</td>
</tr>
</tbody>
</table>

Q1: <57.2 g/4,184 kJ [1,000 kcal]; Q2: 57.2 - 93.6 g/4,184 kJ [1,000 kcal]; Q3: 93.6 - 143.7 g/4,184 kJ [1,000 kcal]; Q4: ≥143.7 g/4,184 kJ [1,000 kcal].

DBP: diastolic blood pressure; SBP: systolic blood pressure.

†Quantity data: one-way analysis of variance; Categorical data: χ² test

‡Quantity data: trend test of general linear; Categorical data: χ² test

§Regular employee: indicates an employee in a non-managerial position

### Table 2. Nutrients and foods of participants (n=437) by quartiles of vegetables intake at baseline

<table>
<thead>
<tr>
<th>Nutrient/food type</th>
<th>Q1 (n=110)</th>
<th>Q2 (n=108)</th>
<th>Q3 (n=109)</th>
<th>Q4 (n=109)</th>
<th>p value†</th>
<th>p for trend‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>1884 (557)</td>
<td>1969 (613)</td>
<td>1971 (574)</td>
<td>1878 (536)</td>
<td>0.444</td>
<td>0.952</td>
</tr>
<tr>
<td>Food type (g/4184 kJ [1000 kcal])</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td>33.4 (15.9)</td>
<td>74.7 (9.8)</td>
<td>112 (14.0)</td>
<td>215 (55.1)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cereals</td>
<td>247 (83.4)</td>
<td>248 (64.3)</td>
<td>218 (63.4)</td>
<td>183 (67.1)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Meat</td>
<td>39.1 (25.4)</td>
<td>35.9 (17.0)</td>
<td>39.5 (17.4)</td>
<td>35.9 (20.4)</td>
<td>0.366</td>
<td>0.489</td>
</tr>
<tr>
<td>Fish</td>
<td>25.8 (27.0)</td>
<td>29.9 (17.6)</td>
<td>36.9 (18.7)</td>
<td>45.2 (24.2)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Milk/dairy products</td>
<td>48.4 (55.3)</td>
<td>46.0 (46.1)</td>
<td>55.1 (55.6)</td>
<td>71.7 (58.5)</td>
<td>0.002</td>
<td>0.001</td>
</tr>
<tr>
<td>Fruits</td>
<td>12.3 (12.8)</td>
<td>13.5 (12.6)</td>
<td>20.8 (18.8)</td>
<td>32.1 (27.6)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Western sweets</td>
<td>25.2 (25.9)</td>
<td>26.0 (19.7)</td>
<td>22.8 (20.1)</td>
<td>15.1 (15.9)</td>
<td>0.520</td>
<td>0.157</td>
</tr>
<tr>
<td>Japanese sweets</td>
<td>2.5 (4.1)</td>
<td>3.0 (3.7)</td>
<td>3.6 (4.3)</td>
<td>3.5 (4.8)</td>
<td>0.194</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sweetened beverages†</td>
<td>125 (136)</td>
<td>77.8 (87.4)</td>
<td>49.3 (56.5)</td>
<td>30.4 (50.4)</td>
<td>&lt;0.001</td>
<td>0.045</td>
</tr>
<tr>
<td>Sugar</td>
<td>2.9 (3.7)</td>
<td>2.7 (3.1)</td>
<td>2.5 (3.1)</td>
<td>1.8 (2.6)</td>
<td>0.053</td>
<td>0.009</td>
</tr>
<tr>
<td>Dressing</td>
<td>2.3 (2.7)</td>
<td>3.1 (2.2)</td>
<td>4.1 (2.4)</td>
<td>4.2 (3.6)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Alcohol</td>
<td>7.0 (10.4)</td>
<td>5.8 (8.0)</td>
<td>5.0 (7.0)</td>
<td>3.2 (6.5)</td>
<td>0.005</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Q1: <57.2 g/4,184 kJ [1,000 kcal]; Q2: 57.2 - 93.6 g/4,184 kJ [1,000 kcal]; Q3: 93.6 - 143.7 g/4,184 kJ [1,000 kcal]; Q4: ≥143.7 g/4,184 kJ [1,000 kcal].

†Sweetened beverages: include carbonated soda or coffee, such as cola, soft drink, canned coffee etc.

‡Quantity data: one-way analysis of variance.

§Quantity data: trend test of general linear.
Table 3. Odds ratios (95% CI) for weight gain (≥3 kg in 1 year) according to energy-adjusted quartiles of vegetable consumption

<table>
<thead>
<tr>
<th>Weight gain of ≥3 kg (n)</th>
<th>Q1 (n=110)</th>
<th>Q2 (n=108)</th>
<th>Q3 (n=110)</th>
<th>Q4 (n=109)</th>
<th>p for trend†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1†</td>
<td>1 (ref.)</td>
<td>0.73 (0.33, 1.16)</td>
<td>0.45 (0.18, 1.11)</td>
<td>0.39 (0.12, 0.93)</td>
<td>0.016</td>
</tr>
<tr>
<td>Model 2‡</td>
<td>1 (ref.)</td>
<td>0.73 (0.33, 1.16)</td>
<td>0.45 (0.18, 1.11)</td>
<td>0.39 (0.12, 0.93)</td>
<td>0.018</td>
</tr>
<tr>
<td>Model 3§</td>
<td>1 (ref.)</td>
<td>0.72 (0.32, 1.62)</td>
<td>0.44 (0.19, 1.33)</td>
<td>0.34 (0.12, 1.01)</td>
<td>0.036</td>
</tr>
<tr>
<td>Model 4¶</td>
<td>1 (ref.)</td>
<td>0.69 (0.29, 1.68)</td>
<td>0.37 (0.13, 1.07)</td>
<td>0.27 (0.08, 0.99)</td>
<td>0.028</td>
</tr>
</tbody>
</table>

Q1: <57.2 g/4,184 kJ [1,000 kcal]; Q2: 57.2 - 93.6 g/4,184 kJ [1,000 kcal]; Q3: 93.6 - 143.7 g/4,184 kJ [1,000 kcal]; Q4: ≥143.7 g/4,184 kJ [1,000 kcal].

CI: confidence interval; ref.: reference.
†Model 1: unadjusted
‡Model 2: gender adjusted
§Model 3: Model 2 + age adjusted
¶Model 4: Model 3 + all confounding factors (marriage status, weight at baseline, and energy-adjusted consumption of fish, cereals, fruits, milk, Japanese sweets, sweetened beverages, sugar, dressing, and alcohol)
††p for trend: the median intake values in each quartile were assigned and treated as a continuous variable.

baseline body weight and intake of foods other than vegetables. Our findings of an association between the risk of body weight increase and vegetable intake support the belief that high vegetable intake reduces the risk of obesity.

Vioque et al. reported an association between vegetable intake and weight gain over a period of 10 years. They found that as vegetable intake increased, the risk of gaining more than 3.41 kg over 10 years was reduced, with an odds ratio of a weight gain of more than 3.41 kg over 10 years between the group consuming the most vegetables and the group consuming the least of 0.18 (95% CI 0.05 to 0.73). In a long-term cohort study that followed middle-age women for 12 years, He et al. reported that the risk of a weight gain of 25 kg or more in the group consuming the most vegetables was 0.76 times that in the group consuming the least vegetables. Although these studies report a long-term and gradual association between a reduced risk of weight gain and high vegetable intake, the present study focused on weight gain in the much shorter period of one year.

Although the mechanism by which vegetable consumption might prevent weight gain has not been clarified, because fruits and vegetables are rich in vitamins, minerals, and dietary fibre, they have attracted considerable attention in recent years, and many studies have assessed the relation between combinations of fruits and vegetables and weight gain. However, fruits are mostly consumed raw and without the use of oil, and this type of consumption seems very different from that of vegetables, which are often fried or otherwise cooked and dressed with sauce. In addition, while vegetables are generally a side dish of the meal, fruits are often eaten as snacks, but not as substitutes for meals, and although fruits and vegetables might belong to the same group at the nutrient level, they should be classified as separate groups from the perspective of meals and eating habits. In previous studies, in cases where only vegetables or only fruits were investigated, or fruits and vegetables were distinguished as separate groups, results were not always the same as when fruits and vegetables were considered as a single food group. Therefore, we focused only on vegetable intake in the present study.

In previous studies that showed an association between vegetable intake and weight gain in long-term follow-up, significant decreases in the risk of body weight gain were observed in the group consuming the most vegetables (approximately 140 g/1000 kcal) in comparison with the group consuming the least vegetables, but no significantly reduced risk was observed in comparison with the other groups. In the present study, results after multivariate data adjustment showed no association of risk ratios in the second- or third-quartile intake groups in comparison with the first-quartile intake group. That is, the risk of body weight increase in the groups consuming 93.6 to 143.7 g of vegetables per 4,184 kJ (1,000 kcal) was not reduced compared with the group consuming the least amount of vegetables. Vergnaud et al. found no correlation between a vegetable intake of 100 g and body weight gain in persons other than those who had quit smoking.

In our study, no significant effect was observed in the second- or third-quartile intake groups. This finding suggests that the protective effect of high vegetable intake on short-term body weight gain may require an intake of more than 143.7/4,184 kJ (1,000 kcal). However, we cannot deny the possibility that the population sample size was too small to detect significant differences between the intake groups. Many recent intervention studies have assessed the benefit of high vegetable intake; however, most studies investigated vegetable intake of less than one serving. To be effective, obesity prevention programs must be based on components which reliable evidence has suggested as beneficial. Our study suggests that persons with relatively low vegetable intake (<57.2 g/4,184 kJ [1,000 kcal]) should be targeted and that daily vegetable intake should be increased to 143.7 g/4,184 kJ (1,000 kcal) or more.

Limitations and strengths

Our study has several limitations that warrant mention. Previous studies of the association between vegetable intake and long-term weight gain adjusted for exercise and smoking in their analyses. For participants who stopped smoking, vegetable intake was greater and the risk of weight gain was lower. However, we did not collect exercise or smoking data and were therefore unable to adjust for these factors. Second, as the population...
of our study was recruited from a single factory in Tokyo, caution should be taken in generalizing our results. In addition, because the number of subjects was insufficient to perform stratified analysis based on sex, we performed multiple regression analysis using sex as a confounding factor. Finally, use of a self-reported questionnaire instead of direct assessment of consumed food carries the risk of introducing response biases, including social desirability and recall biases.

The main strength of this study was that all participants were Asian people (Japanese). In addition, we consider that the use of validated self-report questionnaires was acceptable for the purposes of our study. Additionally, weight measurements, which were thought to be most susceptible to self-report bias, were taken at the health checkups by medical staff using the same scales for both checkups. Further, nutrition data were considered to be of high quality because data were collected and checked in triplicate by trained dieticians, and there were no missing data. Response rates were also good, with more than 80% of participating respondents answering to the questionnaires.

Allowing for the limitations above, the present study provides important data regarding the association between vegetable intake and a weight gain of 3 or more kg in a single year. As the tested association corresponds to the question used by physicians to assess the risk of metabolic syndrome in health checks throughout Japan, our research is more directly applicable to the development of programs to prevent metabolic syndrome in Japan than previous research on the association between vegetable intake and long-term weight gain. However, future longitudinal studies examining the potential association between increasing vegetable consumption and weight gain are needed to confirm these findings.

ACKNOWLEDGEMENTS
This study was partially funded by the Japan Society for the Promotion of Science (JSPS) Kakenhi (Grants-in-Aid for Scientific Research) (No. 15K00882) for fiscal years 2015 to 2017. This study was conducted as a part of the scientific research program of the Japanese Ministry of Health, Labour, and Welfare by the research leader (Dr Ishida) in the fiscal years 2006-2008.

AUTHOR DISCLOSURES
None of the authors have any conflicts of interest to declare.

REFERENCES
Original Article

Cohort study examining the association between vegetable consumption and weight gain in a single year among Japanese employees at a manufacturing company

Kimi Sawada MSc¹, Nobuko Murayama PhD², Yukari Takemi PhD³, Hiromi Ishida PhD³

¹Department of Health Policy, Research Institute, National Center for Child Health and Development, Tokyo, Japan
²Department of Health and Nutrition, Faculty of Human Life Studies, University of Niigata Prefecture, Niigata, Japan
³Department of Nutrition, Kagawa Nutrition University (Joshi Eiyo Daigaku), Saitama, Japan

队列研究：监测一家日本制造公司的员工中蔬菜摄入量和一年内增重的关系

背景与目的：超重和肥胖会增加高血压、2 型糖尿病和其他代谢性疾病的风 险，这种现象在日本呈现增加趋势，特别是男性。一些前瞻性研究表明，高的蔬菜摄入量与增重呈负相关。该研究对一家日本制造公司的员工蔬菜摄入量和增重之间的关系进行了为期一年的研究。方法与研究设计：该研究是一个为期一年的营养和生活方式的调查研究。在 2006 和 2007 年，对日本东京武藏野市 一家制造公司的 900 和 910 名日本员工（年龄在 19～60 岁）分别对其进行简 易饮食史和饮食生活方式的问卷调查，同时也进行体重的临床检查以便评估体重的变化。我们分析了在 2006 和 2007 均参与调查的 478 名对象。结果：摄入蔬菜最多的人群中，增重超过 3 千克的风险显著低于摄入蔬菜最少者；在调整基线年龄、性别和其他食品消费量的影响后，这种差异仍然存在（趋势

p=0.028）。结论：增重与高的蔬菜摄入量呈负相关。鼓励日本员工多吃蔬菜，可能是控制增重和预防代谢综合征的重要策略。

关键词：蔬菜消费量、增重、日本员工、一年的队列研究