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Original article

Negative association of vegetable cultivation with the proportion of severely insufficient vegetable intake both directly and indirectly: A cross-sectional study in a city in Gunma, Japan

Daisuke Machida[1, 2], and Tohru Yoshida[2]

[1] *Department of Health and Nutrition, Takasaki University of Health and Welfare, Japan*
[2] *Gunma University Graduate School of Health Sciences, Japan*

Abstract

Objective: To clarify the relationship between the proportion of severely insufficient vegetable intake frequency and 1) vegetable cultivation, 2) frequency of receiving vegetable among non-cultivators.

Materials and Methods: Residents aged 20 to 74 years in three areas of a city in Gunma Prefecture, Japan, were invited to participate. In September 2016, two sets of self-administered questionnaires were mailed to all 2,260 households in the three areas. The survey items covered the frequency of vegetable intake, vegetable cultivation (as a farmer, as a non-farmer, or no-cultivation), frequency of receiving vegetable, and basic characteristics. For vegetable cultivators, we asked the proportion of cultivated vegetables for home consumption and for giving to neighbors. Binomial logistic regression models were used to analyze the data collected. The respondents were classified into two groups according to their vegetable intake frequency: fewer than three times per day (severely insufficient), and at least three times per day.

Results: We had 796 valid responses. Using the no-cultivation group as reference, both of the other groups —vegetable cultivation as a farmer, and as a non-farmer— had a significantly smaller proportion of severely insufficient vegetable intake frequency. Among the no-cultivation group, using those who had never received vegetable in the past month as reference, those who rarely, sometimes, or often received vegetables had a significantly smaller proportion of severely insufficient vegetable intake frequency. These associations were similar in cases where vegetable juice was or was not included. The proportion of those who cultivated vegetables for home consumption was 96% among farmers and 100% among non-farmers, respectively, and for giving to neighbors was 84% among farmers and 62% among non-farmers, respectively.

Conclusion: A negative association of the proportion of severely insufficient vegetable intake with vegetable cultivation, and with receiving vegetable among non-cultivators, was suggested.

Key words: vegetable cultivation, receiving vegetables, vegetable intake, locally grown vegetables

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Introduction

Increased fruit and vegetable intake reduces the risk of chronic diseases or of all-cause mortality[1, 2]. Meta-analyses of prospective cohort studies indicated a negative relationship between total fruit and vegetable intake and cardiovascular disease[1, 2] or all-cause mortality[2]. In the meta-analyses, it was commonly reported that people with severely insufficient fruit and vegetable intake have a particularly high risk of cardiovascular disease or all-cause mortality[1, 2]. Therefore, it is particularly important to implement countermeasures for people with severely insufficient fruit and vegetable intake.

It has been suggested that fruit and vegetable cultivation increase fruit and vegetable intake[3–14]. The relationship between fruit and/or vegetable intake and fruit and/or vegetable cultivation has been studied in 11 cross-sectional studies[3–5, 7–14] and 1 pre-post designed study[6] among adults living in developed countries. With the exception of one[13], all the studies reported a positive relationship between fruit

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Correspondence: Daisuke Machida, M.S., Department of Health and Nutrition, Takasaki University of Health and Welfare, 37-1 Nakaorui, Takasaki, Gunma 370-0033, Japan
E-mail: machiad-d@takasaki-u.ac.jp

and/or vegetable cultivation and fruit and/or vegetable intake[3–12, 14]. Two among these studies also examined the relationship between fruit and/or vegetable intake and receiving fruit and/or vegetables that might have been acquired from fruit and/or vegetable cultivation from neighbors; both the studies have reported a positive relationship[13, 14]. However, these previous studies[3–14] did not focus specifically on the impact on people with severely insufficient fruit and/or vegetable intake.

In Japan, we need to focus primarily on vegetable intake rather than fruit intake. This is because, even though there is more intake[15] and cultivation[16, 17] of vegetables than that of fruits in Japan, the mean vegetable intake among Japanese adults[15] is not enough as per the recommended amount[18].

In the present study, we sought to determine the relationship between severely insufficient vegetable intake frequency and vegetable cultivation. Among those who did not cultivate vegetables, we sought to determine the relationship between severely insufficient vegetable intake frequency and receiving vegetable from neighbors. Overall, we discuss the relationship of vegetable cultivation and the proportion of severely insufficient vegetable intake, both directly and indirectly.

Materials and Methods

Study participants and design

We used the same dataset as that described in a previous article[19]. The participants in this cross-sectional study were residents aged 20 to 74 years living in three areas of a city within Gunma Prefecture, Japan. This city is located in the center of Gunma, covers 459.2 km^2, and has a population of approximately 370,000 residents. Within this city, we identified three geographic regions, each with a population of about 1,000 people aged 20 to 74 years, which could be classified as rural, suburban, and urban, respectively.

We collected the survey data in September and October 2016 via a self-administered questionnaire. We mailed two sets of questionnaires to all households in the three areas on September 12, using Town Plus by Japan Post Co., Ltd.; this service makes it possible to send mail to all households in selected areas, even without knowing the specific addresses. An explanatory letter and a stamped, self-addressed return envelope were enclosed with the questionnaire. The explanatory letter stated the following: "(1) there is no need to reply if there are no residents aged 20 to 74 years in the household; (2) two residents should reply if there are three or more residents aged 20 to 74 years in the household; (3) the survey is anonymous, and we regard the submission of a response to the questionnaire as consent". In addition, we numbered each questionnaire so that we could identify from which of the three geographic areas each response was received.

This study was approved by the Gunma University Ethical Review Board for Medical Research Involving Human Subjects (submission no. 160074, approved August 16, 2016).

Survey tool

Dependent variables: Vegetable intake frequency was assessed using four items, based on the Behavioral Risk Factor Surveillance System (BRFSS)[20]. We carefully selected four items appropriate for evaluating the vegetable intake of Japanese people (vegetable juice; dark green vegetables; red, yellow, and orange vegetables; and other vegetables), because the BRFSS was originally developed for the American context. For each vegetable category, the questionnaire asked, "How many times per day, on average, have you eaten the following vegetables for the past month?" Participants were provided with examples of the vegetables included in each of the four categories; however, they were not given a definition of the serving size. The examples were based on the categories of the Japanese National Health and Nutrition Examination Survey[15]. Among the yellow and green vegetables, the green ones were referred to as "dark green vegetables", and red, yellow, and orange vegetables were referred to as "red, yellow, and orange vegetables". Other vegetables were referred to as "other vegetables". BRFSS categorized "green beans" as an independent item[20]. However, in the present study, "green beans" was excluded as an independent item because there is not much intake of this product in the Japanese population and was included in the category of "dark green vegetables". Vegetable juice was counted among "other vegetables" by the BRFSS[20]. Here, however, it was regarded as an independent item to allow for an analysis excluding juice. From these responses, we created two indexes of vegetable intake (total number of times per day). One was termed the "vegetable intake frequency" and was created by summing the intake data for all the four items. The other was "vegetable intake frequency excluding juice", created by summing the intake data for the three items excluding vegetable juice.

We divided the data on the frequency of vegetable intake into the following two categories: fewer than three times per day (severely insufficient), and at least three times per day. Average vegetable intake of Japanese adults was 276.5 g[15]. The proportion of those who did not reach 140 g that was about a half of the average intake was 21.7%[15]. According to the distribution of the vegetable intake frequency in this survey, the proportion of those with less than three times per day of "vegetable intake frequency" was 12.9%, and of "vegetable intake frequency excluding juice" was 14.6%. Here, therefore, we regarded fewer than three times per day

as severely insufficient.

Primary independent variables: To understand self-perceptions about vegetable cultivation, we asked participants, "Do you or your household members grow vegetables?" Participants who answered "yes" were further asked whether they grew the vegetables as a farmer, home gardener, or community gardener or in some other role. From these responses, we divided the respondents into three groups: vegetable cultivation as a farmer, vegetable cultivation as a non-farmer, or no-cultivation. We also asked the participants, "During the past month, how often have you received vegetables?" Participants gave responses in one of four categories (never, rarely, sometimes, and often).

Other variables: We assessed subjective difficulty in food-store access by using a single item from a previous study, which asked the participants about their subjective difficulty in food-store access on a scale from 0 (very difficult) to 3 (very easy)[21]. We assessed the respondents' economic circumstances by using a single item that asked them to indicate their economic situation on a scale of 1 (very poor) to 5 (very good). This item was confirmed as having a positive relationship with household income in a previous study[22]. We assessed health attitude using a single item: "Are you usually health-conscious?" Participants answered on a scale of 0 (not at all) to 3 (often or all the time). Demographic questions covered the respondents' sex (women, men), age group (in years: 20–29, 30–39, 40–49, 50–59, 60–69, 70–74), educational background (elementary or junior high school, high school, vocational school or junior college, university or graduate school), and employment status (unemployed or retired, part-time, full-time).

In addition, we asked the vegetable cultivators about the proportion of vegetables cultivated for home consumption, and for giving to neighbors.

Analyses

We used binomial logistic regression models. We used the responses without it had missing values for these models. If two people responded in a household and both of them had no missing value, we used both of the two responses. We adjusted for all the other variables. Adjusted odds ratios (AORs) and 95% confidence intervals (95% CI) were calculated, using the respondents with a vegetable intake frequency of at least three times per day as the reference group. Prior to the logistic regression analyses, we assessed univariate relationships between vegetable cultivation status and participants' characteristics using the chi-square test. We then analyzed the relationship between vegetable cultivation and proportion of severely insufficient vegetable intake using binomial logistic regression models. Additionally, within the no-cultivation group, we analyzed the relationship between frequency of receiving vegetable from neighbors and proportion of severely insufficient vegetable intake using binomial logistic regression models. Geographic area (reference: rural), sex (reference: women), age group (reference: 20–29 years), educational background (reference: elementary or junior high school), employment status (reference: unemployed or retired), vegetable cultivation (reference: no-cultivation), and frequency of receiving vegetables (reference: never) were used as categorical scales for the binomial logistic regression models. For the subjective difficulty in food-store access, economic circumstances, and health attitude, it was confirmed that the absolute value of skewness and kurtosis was less than 2; hence, they were used as interval scales for the binomial logistic regression models. Statistical models were checked for interactive effects between geographic areas and with all independent variables, and they were found to be acceptable. A two-tailed p-value less than 0.05 was considered statistically significant.

The proportion of vegetables cultivated for home consumption and for giving to neighbors was calculated for vegetable cultivation as a farmer and as a non-farmer. Since two copies of the questionnaire were distributed to each household, if two people responded in a household, only one answer was randomly selected and was used for the calculation. Therefore, they were not weighted on the households who responded from two people.

All analyses were performed using the statistical software package IBM SPSS Statistics, version 23.

Results

We mailed questionnaires to 2,260 households and received responses from 586 households (household response rate: 25.9%). 873 individual residents provided information (295 rural, 295 suburban, 283 urban). We excluded responses that contained missing data (total: 73 (8 for sex, 7 for age group, 26 for educational background, 29 for employment status, 13 for subjective difficulty in food-store access, 10 for economic circumstance, 18 for health attitude, 23 for frequency of receiving vegetables, 9 for vegetable cultivation, and 20 for vegetable intake frequency)) or were provided by people older than age 74 years (4), leaving 796 responses (261 rural, 264 suburban, 271 urban) for statistical analysis.

The results of the chi-square tests (Table 1) showed significant relationships with the vegetable cultivation status for the variables of geographic area ($p < 0.001$), age group ($p < 0.001$), educational background ($p < 0.001$), employment status ($p = 0.001$), economic circumstances ($p = 0.016$), and subjective difficulty in food-store access ($p = 0.025$).

As for the results of the binomial logistic regression models when using the vegetable intake frequency as a de-

Table 1 Participants' characteristics according to vegetable cultivation

	No-cultivation (n = 399)		Cultivation as a non-farmer (n = 290)		Cultivation as a farmer (n = 107)		*p*-value*
	n	%	n	%	n	%	
Area							
Rural	64	16	120	41	77	72	< 0.001
Suburban	113	28	124	43	27	25	
Urban	222	56	46	16	3	3	
Sex							
Women	215	54	164	57	57	53	0.743
Men	184	46	126	43	50	47	
Age group							
20–29	14	4	8	3	3	3	< 0.001
30–39	65	16	16	6	12	11	
40–49	126	32	41	14	14	13	
50–59	95	24	63	22	18	17	
60–69	67	17	118	41	45	42	
70–74	32	8	44	15	15	14	
Educational background							
Elementary/junior high	15	4	25	9	12	11	< 0.001
High school	114	29	135	47	52	49	
Vocational/junior college	109	27	74	26	26	24	
University/graduate school	161	40	56	19	17	16	
Employment status							
Unemployed/retired	104	26	112	39	43	40	0.001
Part-time	63	16	50	17	15	14	
Full-time	232	58	128	44	49	46	
Economic circumstances							
Very poor	17	4	9	3	2	2	0.016
Poor	76	19	59	20	19	18	
Fair	140	35	99	34	41	38	
Good	106	27	99	34	40	37	
Very good	60	15	24	8	5	5	
Health attitude ("Are you health-conscious?")							
Not at all	20	5	6	2	4	4	0.133
Little	110	28	66	23	27	25	
Occasionally	183	46	138	48	44	41	
Often/all the time	86	22	80	28	32	30	
Subjective difficulty in food-store access							
Very difficult	13	3	4	1	4	4	0.025
Difficult	98	25	73	25	30	28	
Easy	176	44	140	48	60	56	
Very easy	112	28	73	25	13	12	
Frequency of receiving vegetables							
Never	97	24	48	17	22	21	0.075
Rarely	113	28	77	27	38	36	
Sometimes	121	30	109	38	29	27	
Often	68	17	56	19	18	17	

* Chi-square test.

pendent variable (Table 2), among respondents engaged in vegetable cultivation as a non-farmer, the AOR of severely insufficient vegetable intake was 0.55 (95% CI: 0.32–0.96). For those involved in vegetable cultivation as a farmer, the AOR of severely insufficient vegetable intake was 0.38 (95% CI: 0.16–0.93). Similar trends were also obtained when using the vegetable intake frequency excluding juice as a dependent variable (non-farmer: AOR = 0.56, 95% CI: 0.33–

Table 2 Relationship between vegetable cultivation and severely insufficient vegetable intake frequency

	Severely insufficient				
	n	%	AOR	95% CI	*p*-value
Vegetable cultivation	(Vegetable intake frequency)				
No cultivation	64	16	1.00	Reference	
Cultivation as a non-farmer	31	11	0.55	0.32–0.96	0.036
Cultivation as a farmer	8	7	0.38	0.16–0.93	0.035
	(Vegetable intake frequency excluding juice)				
No cultivation	73	18	1.00	Reference	
Cultivation as a non-farmer	35	12	0.56	0.33–0.96	0.033
Cultivation as a farmer	9	8	0.40	0.17–0.94	0.035

N = 796. Severely insufficient: vegetable intake < 3 times per day. AOR: adjusted odds ratio, 95% CI: 95% confidence interval. Adjusted for area: rural (ref), suburban, urban. Sex: women (ref), men. Age group: 20–29 (ref), 30–39, 40–49, 50–59, 60–69, 70–74 years. Educational background: elementary/junior high (ref), high school, vocational/junior college, university/graduate school. Employment status: unemployed/retired (ref), part-time, full-time. Economic circumstance: very poor = 1, very good = 5. Health attitude ("Are you health-conscious?"): not at all = 0, often/all the time = 3. Subjective difficulty in food-store access: very difficult = 0, very easy = 3. Frequency of receiving vegetable: never (ref), rarely, sometimes, often.

Table 3 Relationship between frequency of receiving vegetables and severely insufficient vegetable intake frequency among no cultivation group

	Severely insufficient				
	n	%	AOR	95% CI	*p*-value
Frequency of receiving vegetable	(Vegetable intake frequency)				
Never	25	26	1.00	Reference	
Rarely	14	12	0.43	0.19–0.97	0.042
Sometimes	16	13	0.35	0.16–0.79	0.011
Often	9	13	0.37	0.14–0.98	0.045
	(Vegetable intake frequency excluding juice)				
Never	28	29	1.00	Reference	
Rarely	15	13	0.36	0.17–0.81	0.013
Sometimes	21	17	0.43	0.21–0.90	0.025
Often	9	13	0.31	0.12–0.82	0.018

N = 399. Severely insufficient: vegetable intake < 3 times per day. AOR: adjusted odds ratio, 95% CI: 95% confidence interval Adjusted for area: rural (ref), suburban, urban. Sex: women (ref), men. Age group: 20–29 (ref), 30–39, 40–49, 50–59, 60–69, 70–74 years. Educational background: elementary/junior high (ref), high school, vocational/junior college, university/graduate school. Employment status: unemployed/retired (ref), part-time, full-time. Economic circumstance: very poor = 1, very good = 5. Health attitude ("Are you health-conscious?"): not at all = 0, often/all the time = 3. Subjective difficulty in food-store access: very difficult = 0, very easy = 3.

0.96; farmer: AOR = 0.40, 95% CI: 0.17–0.94).

The results of the analyses of the relationship between the frequency of receiving vegetable from neighbors and the proportion of severely insufficient vegetable intake frequency among the no-cultivation group are shown in Table 3. People who rarely, sometimes, and often received vegetables had smaller proportions of severely insufficient vegetable intake frequency than those who never received vegetables (never: reference, rarely: AOR = 0.43 (95% CI: 0.19–0.97), sometimes: AOR = 0.35 (95% CI: 0.16–0.79), often: AOR = 0.37 (95% CI: 0.14–0.98)). Similar trends were also found when vegetable intake frequency excluding juice

Table 4 The uses of cultivated vegetables

	Cultivation as a farmer (n=75)		Cultivation as a non-farmer (n=212)	
	Mean (n)	SD (%)	Mean (n)	SD (%)
For home consumption	42.2	4	77.6	1.7
0%	(3)	(4)	(0)	(0)
more than 0%	(72)	(96)	(212)	(100)
For giving to neighbors	15.3	2.2	17.3	1.4
0%	(12)	(16)	(81)	(38)
more than 0%	(63)	(84)	(131)	(62)

SD: Standard Deviation.

was taken as a dependent variable (never: reference, rarely: AOR = 0.36, 95% CI: 0.17–0.81; sometimes: AOR = 0.43, 95% CI: 0.21–0.90; often: AOR = 0.31, 95% CI: 0.12–0.82).

The results of the calculation of the proportion of vegetables cultivated for home consumption and for giving to neighbors are shown in Table 4. We used responses of 287 households that were cultivators (vegetable cultivation as a farmer: n = 75, vegetable cultivation as a non-farmer: n = 212). The average proportion of vegetables cultivated for home consumption was 42.2% among vegetable cultivation as a farmer, and 77.6% as a non-farmer. The number of those who cultivated vegetables for home consumption was 72 (96%) among vegetable cultivation as a farmer, and 212 (100%) among as a non-farmer. The average proportion of vegetables cultivated for giving to neighbors was 15.3% among vegetable cultivation as a farmer, and 17.3% as a non-farmer. The number of those who cultivated vegetables for giving to neighbors was 63 (84%) among vegetable cultivation as a farmer, and 131 (62%) among as a non-farmer.

Discussion

Our results indicated that the proportion of people with severely insufficient frequency of vegetable intake was smaller among vegetable cultivators than non-cultivators, regardless of whether they were farmers or non-farmers. Within non-cultivators, the proportion of people with severely insufficient frequency of vegetable intake was smaller among those who rarely, sometimes, and often received vegetable than those who never received any. In addition, almost all cultivators answered they were growing the vegetable for home consumption whether they were farmers or non-farmers. Moreover, 84% of farmers and 62% of non-farmers cultivated the vegetables for giving to neighbors. Previous studies also showed a positive relationship between vegetable intake and vegetable cultivation[3–12, 14] or received vegetables[13, 14]. The results of this study, therefore, confirm these previous findings. In addition, we newly found a negative relationship between vegetable cultivation and the proportion of people with severely insufficient vegetable intake. Furthermore, we found a negative relationship between receiving vegetables that might be derived from vegetable cultivation and the proportion of people with severely insufficient vegetable intake among non-cultivators. Taking into account the proportion of vegetable cultivators growing the vegetables for giving to neighbors, it was suggested that vegetable cultivation is negatively related not only to the proportion of severely insufficient vegetable intake frequency of the vegetable cultivators, but also to that of neighboring residents through receiving vegetables.

This was cross-sectional study; therefore, it was not possible to determine the causal relationship only by the results of this study. However, it was suggested that the proportion of severely insufficient vegetable intake frequency decreases with vegetable cultivation based on previous studies[4, 6, 8, 23]. In one of these studies[6], a positive causal relationship between vegetable cultivation and vegetable intake was suggested in the pre-post design study. In addition, the other studies discussed the following: improvement of the accessibility of vegetables and fruits due to the existence of the community garden[4], improvement in the availability of vegetables due to having a vegetable garden[23], and using vegetables naturally for daily meals as a result of participation in community gardens[8]. Conversely, when the vegetable cultivation decreases, the proportion of people with severely insufficient vegetable intake may increase. Less convenient access to vegetables grown by themselves or received from neighbors may be associated with a greater tendency toward severely inadequate vegetable intake. This conjecture has a policy implication: so as not to increase the proportion of people with severely insufficient vegetable intake in a particular area, we should promote and sustain the cultivation of vegetables in that area. Agricultural populations in Japan are decreasing[24]. It may be necessary to increase the number of farmers and to maintain the cultivation of vegetables in rural areas. This can include the establishment of community gardens in urban areas and securing an environment where vegetables can be cultivated and shared

with those who cannot cultivate them at home. Some reports have found a positive relationship between the utilization of community gardens and vegetable intake[4, 5, 8–10]. An attempt has also been made to give products grown in a community garden set up in an urban outpatient clinic not only to those who visited the community garden but also to other patients who visited the clinic[25]. This study indicated that 18% of patients received products from the community garden[25]. In this way, by practicing planned cultivation of vegetables and giving harvested vegetables to neighboring residents, is a promising way to increase the vegetable intake of neighboring residents as well as those who participate in community gardens.

The study does have several limitations. First, response bias and sampling bias are both possibilities, since the response rate was only 25.9% and the nature of the sampling was non-random. Second, it is not known whether the number of vegetable intake times per day reported by respondents reflects their actual vegetable intake because criterion-related validity has not been verified. Although we estimated the severely insufficient vegetable intake from the percentage of responses, there was little evidence that these people indeed had severely insufficient vegetable intake. It is necessary to measure the vegetable intake using an accurate method and to identify the relationship that was suggested in this study. Third, since we did not include psychological factors that affect vegetable intake (primarily, whether one likes to eat vegetables) in this study, their influence cannot be ruled out. Fourth, we did not research a direct relationship that non-cultivators received vegetables from vegetable cultivators. In rural areas of Japan, it is being seen that people received many vegetables from neighboring farmers and to share them with friends and colleagues. Henceforth, it is necessary to examine in detail the influence of vegetable acquisition directly and indirectly from vegetable cultivators. Finally, as mentioned previously, this was a cross-sectional study, and longitudinal studies would be needed to reveal causal relationships.

Conclusion

This study found a negative association of the proportion of severely insufficient vegetable intake frequency with vegetable cultivation. Among those who do not cultivate vegetables, frequency of receiving vegetables from neighbors was negatively related with the proportion of severely insufficient vegetable intake frequency. In addition, almost all cultivators were growing the vegetable for home consumption, and majority of cultivators cultivated the vegetables for giving to neighbors, whether they were farmers or non-farmers. Over all, it was suggested that vegetable cultivation is negatively related not only to the proportion of severely insufficient vegetable intake frequency of the vegetable cultivators, but also that of neighboring residents through receiving vegetables.

Conflict of Interest: The authors have no conflict of interest to report.

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