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# Prevalence of lifestyle-related chronic diseases among agricultural and non-agricultural workers in rural areas of Japan: the Shimane CoHRE study

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## Abstract

**Objective:** Engaging in agriculture greatly affects workers' lifestyles, particularly related to physical activity. This study aimed to clarify the prevalence of lifestyle-related chronic diseases among workers engaging and not engaging in agriculture in rural areas of Japan.
**Methods:** A total of 4,666 consecutive participants aged ≥40 years (1,929 men and 2,737 women) were recruited during health examinations conducted from 2006 to 2014. For analysis, the participants were divided by sex and age into those engaging in agriculture and those not engaging in agriculture.
**Results:** Engaging in agriculture may be contributing with a low prevalence of dyslipidemia, a constitutive factor of metabolic syndrome, in both sexes between the ages of 40 and 64 years. In the elderly aged ≥65 years, engaging in agriculture may influence the low prevalence of hypertension in men. Hypertension, a strong risk factor for stroke and cardiovascular disease, is very frequent among the Japanese elderly and, therefore, engaging in agriculture may have a significant impact on its prevention and control.
**Conclusion:** In rural areas of Japan, engaging in agriculture may contribute to the control of lipid metabolism in middle-aged individuals and blood pressure in the elderly.

**Key words:** agricultural workers, dyslipidemia, hypertension, cross-sectional study

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## Introduction

Currently, Japan is facing new problems with its medical insurance and nursing care systems for the elderly brought about by the rapid aging of the population[1]. Based on statistical data, the proportion of the Japanese population aged ≥75 years is expected to increase by 25% by 2025[2]. In particular, in rural areas of Japan, the increase in the ageing population is remarkable, and the demand for care is high and still rising. Considering that the current situation may threaten the sustainability of health insurance[3], there is an urgent need for effective strategies to overcome these issues, that is, the elderly individuals are strongly required to maintain a healthy lifestyle and prolong the healthy life expectancy.

Health promotion activities have become increasingly popular in developed countries, including Japan, and are gaining importance[4] as they have the potential to improve quality of life. This potential is based on the fact that most of the leading causes of poor health and short healthy life expectancy are avoidable or controllable. This particularly applies to lifestyle-related diseases such as hypertension,

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diabetes, hyperlipidemia, bone and musculoskeletal disease, and some forms of heart disease[5]. Few studies have reported the prevalence of cardiovascular risk factors in middle-aged and elderly workers in Japan. Kuwahara *et al*.[6] recently reported on the health status of several categories of industry workers based on their health examination as mandated in the Industrial Safety and Health Act. They reported that the prevalence of cardiometabolic risk factors, including hypertension, dyslipidemia, diabetes, obesity, and metabolic syndrome, increased with aging both in men and women. Suka *et al*.[7] also reported a higher prevalence of hypertension, hyperlipidemia, diabetes, and obesity in middle-aged male workers than in middle-aged female workers. In addition, similar trends and prevalence have been shown in the National Health and Nutrition Survey conducted by the Ministry of Health, Labor and Welfare of Japan[8]. In a super-aging society, the promotion of health depending on the life stage of each person becomes important. In rural areas of Japan, the agricultural working population is relatively larger than that in the urban areas, and middle-aged and elderly workers account for a large proportion[9]. Engaging in agriculture involves many physical activities and may contribute to the promotion of health among middle-aged and elderly individuals, thus leading to the extension of a healthy life expectancy[10]. This study aimed to investigate the prevalence of each lifestyle-related chronic disease to clarify the health status of individuals who engage and do not engage in agriculture.

## Methods

### Participants

A total of 4,778 Japanese adults (men: 1,985, women: 2,793) aged ≥40 years were recruited during health examinations conducted by the National Health Insurance in nine rural communities in Unnan city, Izumo city, Ohnan county and Oki county in Shimane Prefecture, Japan, from 2006 to 2014: Kakeya-cho (2006), Mitoya-cho (2007), Daito-cho (2009), Kamo-cho (2009), Kisuki-cho (2012), and Yoshida-cho (2013) in Unnan City;, Sada (2008) in Izumo City;, Ohnan-cho in Ouchi county;, and Okinoshima-cho (2010 and 2014) in Oki county. The Ethics Committee of the Japanese Association of Rural Medicine (no.13) and Shimane University Faculty of Medicine (no.3446) approved all the study protocols, and all participants provided written informed consent.

### Health status interview

Data on each participant's health status were obtained through a face-to-face interview, including questions regarding diagnosis and prescription medicines for diseases such as hypertension, dyslipidemia, diabetes, hyperuricemia, cerebrovascular disease, heart disease, nephropathy, hepatic disease, endocrine disease, and musculoskeletal disease. With regard to lifestyle habits, current smoking and the presence or absence of smoking history, and alcohol consumption were addressed[11]. A total of 102 individuals with missing variables were excluded from the study. The remaining 4,666 individuals (men: 1,929, women: 2,737) were included in the study.

### Anthropometric measurements

Body weight was measured to the nearest −0.5 kg with the participant wearing very light clothing. BMI was computed as weight (kg) divided by height in meters squared ($m^2$), and obesity was defined using a BMI cut-off point of ≥25 kg/$m^2$.

### Statistical analysis

Individuals working in agriculture full-time and part-time were divided into two groups: individuals who engage in agriculture, and individuals who do not engage in agriculture including those who grow a small vegetable garden. All analyses were performed by stratifying the participants by age (those aged 40–64 years and those aged ≥65 years) and sex. The $\chi^2$ test was used to analyze the prevalence of each disease between participants engaged and not engaged in agriculture. Odds ratio and 95% confidence intervals (CI) for the prevalence of each disease were calculated by binomial logistic regression analysis after controlling simultaneously for potential confounders. In all binomial logistic regression analyses, the group of participants engaging in agriculture was used as a reference group. The covariates included in model 1 was age, those in model 2 were age and lifestyle habits (current smoking/smoking history and alcohol consumption), and those in model 3 were age, lifestyle habits, and BMI values. All statistical analyses were performed using IBM® SPSS® Statistics software package version 22.0 for Windows. A $P$ value of <0.05 was considered statistically significant.

## Results

### Prevalence of lifestyle-related chronic disease in the 40- to 64-year age group

Table 1 shows the results of the frequency of obesity and low weight and the prevalence of lifestyle-related chronic diseases in middle-aged participants who are engaging or not engaging in agriculture. Among middle-aged all participants surveyed, obesity (BMI ≥ 25) was widespread in both sexes, with a frequency of 27.5% for men and 19.7% for women. In men, the frequency of obesity in participants engaged in agriculture was 24.2%, which is significantly lower than that in participants not engaged in agriculture (31.6%) ($P$ = 0.03). Subsequently, Table 3 shows the results of the odds ratios for obesity, calculated after adjusting for age in

**Table 1** Prevalence of diseases and lifestyle habits among workers engaged in agriculture and those not engaged in agriculture aged 40–64 years

| | Men, 40–64 years old | | | | Women, 40–64 years old | | | |
|---|---|---|---|---|---|---|---|---|
| | ALL | Engaging in agriculture | No engaging in agriculture | *P* | ALL | Engaging in agriculture | No engaging in agriculture | *P* |
| | n=670 | n=376 | n=294 | | n=837 | n=233 | n=604 | |
| Age (years old, ±SD) | 56.5 ± 6.2 | 56.8 ± 5.8 | 56.2 ± 6.6 | NS | 57.6 ± 6.1 | 57.6 ± 5.9 | 57.6 ± 6.1 | NS |
| Physical parameter | | | | | | | | |
| BMI (kg/$m^2$) | 23.4 ± 3.2 | 23.1 ± 3.1 | 23.7 ± 3.3 | <0.01 | 22.6 ± 3.2 | 22.6 ± 3.0 | 22.5 ± 3.3 | NS |
| Obesity (BMI ≥ 25) (%) | 184 (27.5) | 91 (24.2) | 93 (31.6) | 0.03 | 165 (19.7) | 44 (18.9) | 121 (20.0) | NS |
| Under weight (BMI < 18.5) (%) | 26 (3.9) | 19 (5.1) | 7 (2.4) | NS | 52 (6.2) | 12 (5.2) | 40 (6.6) | NS |
| Disease | | | | | | | | |
| Hypertension (%) | 126 (18.8) | 63 (16.8) | 63 (21.4) | NS | 154 (18.4) | 38 (16.3) | 116 (19.2) | NS |
| Dyslipidemia (%) | 69 (10.3) | 29 (7.7) | 40 (13.6) | 0.01 | 150 (17.9) | 24 (10.3) | 126 (20.9) | <0.01 |
| Diabetes (%) | 54 (8.1) | 30 (8.0) | 24 (8.2) | NS | 27 (3.2) | 12 (5.2) | 15 (2.5) | NS |
| Hyperuricemia · Gout (%) | 37 (5.5) | 22 (5.9) | 15 (5.1) | NS | 9 (1.1) | 0 (0.0) | 9 (1.5) | NS |
| Cerebrovascular disease (%) | 6 (0.9) | 2 (0.5) | 4 (1.4) | NS | 8 (1.0) | 2 (0.9) | 6 (1.0) | NS |
| Heart disease (%) | 24 (3.6) | 13 (3.5) | 11 (3.7) | NS | 22 (2.6) | 5 (2.1) | 17 (2.8) | NS |
| Nephropathy · Urinary disease (%) | 22 (3.3) | 8 (2.1) | 14 (4.8) | NS | 12 (1.4) | 4 (1.7) | 8 (1.3) | NS |
| Hepatic disease (%) | 33 (4.9) | 19 (5.1) | 14 (4.8) | NS | 22 (2.6) | 4 (1.7) | 18 (3.0) | NS |
| Gastropathy · Enteropathy (%) | 38 (5.7) | 21 (5.6) | 17 (5.8) | NS | 43 (5.1) | 9 (3.9) | 34 (5.6) | NS |
| Endocrine disease (%) | 4 (0.6) | 2 (0.5) | 2 (0.7) | NS | 41 (4.9) | 12 (5.2) | 29 (4.8) | NS |
| Bone · Musculoskeletal disease (%) | 63 (9.4) | 40 (10.6) | 23 (7.8) | NS | 130 (15.5) | 39 (16.7) | 91 (15.1) | NS |
| Lifestyle habit | | | | | | | | |
| Smoking · Smoking history (%) | 502 (74.9) | 281 (74.7) | 221 (75.2) | NS | 35 (4.2) | 5 (2.1) | 30 (5.0) | NS |
| Alcohol drinking (every day, %) | 370 (55.2) | 209 (55.6) | 161 (54.8) | NS | 56 (6.7) | 14 (6.0) | 42 (7.0) | NS |

*P* values for age and BMI were calculated using the Student's t-test, while *P* values for other parameters were calculated using the $\chi^2$ test.

**Table 2** Prevalence of diseases and lifestyle habits among workers engaged in agriculture and those not engaged in agriculture aged over 65 years

| | Men, over 65 years old | | | | Women, over 65 years old | | | |
|---|---|---|---|---|---|---|---|---|
| | ALL | Engaging in agriculture | No engaging in agriculture | *P* | ALL | Engaging in agriculture | No engaging in agriculture | *P* |
| | n=1259 | n=617 | n=642 | | n=1910 | n=496 | n=1414 | |
| Age (years old, ± SD) | 73.0 ± 5.5 | 72.4 ± 4.9 | 73.6 ± 6.0 | <0.01 | 72.9 ± 5.5 | 71.7± 4.5 | 73.4 ± 5.7 | <0.01 |
| Physical parameter | | | | | | | | |
| BMI (kg/$m^2$) | 22.7 ± 2.8 | 22.5 ± 2.8 | 22.8 ± 2.8 | NS | 22.5 ± 3.2 | 22.6 ± 3.1 | 22.5 ± 3.2 | NS |
| Obesity (BMI ≥ 25) (%) | 235 (18.7) | 110 (17.8) | 125 (19.5) | NS | 396 (20.7) | 105 (21.2) | 291 (20.6) | NS |
| Under weight (BMI < 18.5) (%) | 180 (6.9) | 50 (8.1) | 37 (5.8) | NS | 180 (9.4) | 47 (9.5) | 133 (9.4) | NS |
| Disease | | | | | | | | |
| Hypertension (%) | 507 (40.3) | 221 (35.8) | 286 (44.5) | <0.01 | 850 (44.5) | 201 (40.5) | 649 (45.9) | 0.04 |
| Dyslipidemia (%) | 182 (14.5) | 90 (14.6) | 92 (14.3) | NS | 546 (28.6) | 137 (27.6) | 409 (28.9) | NS |
| Diabetes (%) | 132 (10.5) | 55 (8.9) | 77 (12.0) | NS | 135 (7.1) | 43 (8.7) | 92 (6.5) | NS |
| Hyperuricemia · Gout (%) | 70 (5.6) | 27 (4.4) | 43 (6.7) | NS | 19 (1.0) | 3 (0.6) | 16 (1.1) | NS |
| Cerebrovascular disease (%) | 71 (5.6) | 31 (5.0) | 40 (6.2) | NS | 63 (3.3) | 13 (2.6) | 50 (3.5) | NS |
| Heart disease (%) | 133 (10.6) | 57 (9.2) | 76 (11.8) | NS | 168 (8.8) | 38 (7.7) | 130 (9.2) | NS |
| Nephropathy · Urinary disease (%) | 133 (10.6) | 61 (9.9) | 72 (11.2) | NS | 58 (3.0) | 17 (3.4) | 41 (2.9) | NS |
| Hepatic disease (%) | 41 (3.3) | 23 (3.7) | 18 (2.8) | NS | 47 (2.5) | 14 (2.8) | 33 (2.3) | NS |
| Gastropathy · Enteropathy (%) | 106 (8.4) | 57 (9.2) | 49 (7.6) | NS | 134 (7.0) | 31 (6.3) | 103 (7.3) | NS |
| Endocrine disease (%) | 12 (1.0) | 5 (0.8) | 7 (1.1) | NS | 101 (5.3) | 21 (4.2) | 80 (5.7) | NS |
| Bone · Musculoskeletal disease (%) | 216 (17.2) | 113 (18.3) | 103 (16.0) | NS | 565 (29.6) | 129 (26.0) | 436 (30.8) | 0.04 |
| Lifestyle habit | | | | | | | | |
| Smoking · Smoking history (%) | 747 (59.3) | 332 (53.8) | 415 (64.6) | <0.01 | 38 (2.0) | 5 (1.0) | 33 (2.3) | NS |
| Alcohol drinking (every day, %) | 604 (48.0) | 315 (51.1) | 289 (45.0) | 0.04 | 83 (4.3) | 18 (3.6) | 65 (4.6) | NS |

*P* values for age and BMI were calculated using the Student's t-test, while *P* values for other parameters were calculated using the $\chi^2$ test.

**Table 3** Adjusted odds ratio for obesity and disease among participants not engaged in agriculture aged 40–64 years

| | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Regression coefficient | Ajusted OR | 95% CI | *P* | Regression coefficient | Ajusted OR | 95% CI | *P* | Regression coefficient | Ajusted OR | 95% CI | *P* |
| Men, 40–64 years old | | | | | | | | | | | | |
| Obesity | 0.350 | 1.42 | 1.01–2.00 | <0.05 | 0.350 | 1.42 | 1.01–2.00 | <0.05 | | | | |
| Hypertension | 0.353 | 1.42 | 0.96–2.12 | NS | 0.351 | 1.42 | 0.96–2.11 | NS | 0.286 | 1.33 | 0.89–1.99 | NS |
| Dyslipidemia | 0.646 | 1.91 | 1.15–3.17 | 0.01 | 0.650 | 1.92 | 1.15–3.18 | 0.01 | 0.596 | 1.81 | 1.09–3.03 | 0.02 |
| Diabetes | 0.045 | 1.05 | 0.60–1.83 | NS | 0.049 | 1.05 | 0.60–1.84 | NS | –0.008 | 0.99 | 0.56–1.75 | NS |
| Hyperuricemia · Gout | –0.139 | 0.87 | 0.44–1.71 | NS | –0.139 | 0.87 | 0.44–1.71 | NS | –0.243 | 0.79 | 0.40–1.56 | NS |
| Cerebrovascular disease | 0.965 | 2.63 | 0.48–14.45 | NS | 0.966 | 2.63 | 0.48–14.47 | NS | 1.074 | 2.93 | 0.53–16.3 | NS |
| Heart disease | 0.113 | 1.12 | 0.49–2.55 | NS | 0.112 | 1.12 | 0.49–2.55 | NS | 0.060 | 1.06 | 0.46–2.43 | NS |
| Nephropathy · Urinary disease | 0.855 | 2.35 | 0.97–5.69 | NS | 0.885 | 2.42 | 0.99–5.91 | NS | 0.839 | 2.31 | 0.94–5.67 | NS |
| Hepatic disease | –0.063 | 0.94 | 0.46–1.91 | NS | –0.058 | 0.94 | 0.46–1.92 | NS | –0.081 | 0.92 | 0.45–1.88 | NS |
| Gastropathy · Enteropathy | 0.045 | 1.05 | 0.54–2.02 | NS | 0.045 | 1.05 | 0.54–2.02 | NS | 0.096 | 1.10 | 0.57–2.14 | NS |
| Endocrine disease | 0.270 | 1.31 | 0.18–9.36 | NS | 0.250 | 1.28 | 0.18–9.25 | NS | 0.302 | 1.35 | 0.18–9.92 | NS |
| Bone · Musculoskeletal disease | –0.325 | 0.72 | 0.42–1.24 | NS | –0.325 | 0.72 | 0.42–1.24 | NS | –0.344 | 0.71 | 0.41–1.12 | NS |
| Women, 40–64 years old | | | | | | | | | | | | |
| Obesity | 0.073 | 1.08 | 0.73–1.58 | NS | 0.097 | 1.1 | 0.75–1.62 | NS | | | | |
| Hypertension | 0.200 | 1.22 | 0.81–1.84 | NS | 0.219 | 1.25 | 0.83–1.88 | NS | 0.206 | 1.23 | 0.81–1.87 | NS |
| Dyslipidemia | 0.845 | 2.33 | 1.46–3.72 | <0.01 | 0.851 | 2.34 | 1.46–3.75 | <0.01 | 0.851 | 2.34 | 1.46–3.76 | <0.01 |
| Diabetes | –0.768 | 0.46 | 0.21–1.01 | NS | –0.776 | 0.46 | 0.21–1.01 | NS | –0.816 | 0.44 | 0.20–0.97 | 0.04 |
| Hyperuricemia · Gout | – | – | – | – | – | – | – | – | | | | |
| Cerebrovascular disease | 0.142 | 1.15 | 0.23–5.76 | NS | 0.109 | 1.12 | 0.22–5.61 | NS | 0.043 | 1.04 | 0.20–5.33 | NS |
| Heart disease | 0.274 | 1.31 | 0.48–3.61 | NS | 0.269 | 1.31 | 0.48–3.60 | NS | 0.253 | 1.29 | 0.47–3.55 | NS |
| Nephropathy · Urinary disease | –0.264 | 0.77 | 0.23–2.58 | NS | –0.235 | 0.79 | 0.24–2.66 | NS | –0.242 | 0.79 | 0.23–2.64 | NS |
| Hepatic disease | 0.562 | 1.75 | 0.59–5.25 | NS | 0.545 | 1.72 | 0.57–5.17 | NS | 0.540 | 1.72 | 0.57–5.15 | NS |
| Gastropathy · Enteropathy | 0.395 | 1.49 | 0.70–3.15 | NS | 0.397 | 1.49 | 0.70–3.16 | NS | 0.394 | 1.48 | 0.70–3.15 | NS |
| Endocrine disease | –0.076 | 0.93 | 0.47–1.85 | NS | –0.089 | 0.91 | 0.46–1.83 | NS | –0.100 | 0.90 | 0.45–1.81 | NS |
| Bone · Musculoskeletal disease | –0.127 | 0.88 | 0.58–1.33 | NS | –0.111 | 0.9 | 0.59–1.35 | NS | –0.120 | 0.89 | 0.59–1.34 | NS |

OR: odds ratio; CI: confidence interval. Adjusted odds ratios were estimated by binomial logistic regression analysis. $P<0.05$ was significant. Model 1 was adjusted for age. Model 2 was adjusted for age and age, smoking status, and alcohol consumption. Model 3 was adjusted for age and age, smoking status, alcohol consumption and BMI.

model 1, and age, smoking status, and alcohol consumption in model 2. In model 2, the odds ratio for participants who were not engaged in agriculture was 1.42 (95% CI: 1.01–2.00; $P < 0.05$), in comparison to the odds ratio for those who were engaged in agriculture, who had similar trends in model 1, which was only adjusted for age. In women, there was no significant difference in the frequencies of obesity. Hypertension was determined as the most widespread lifestyle-related chronic disease in middle-aged male and female participants, and there was no significant difference in the prevalence between participants engaged in agriculture and those not engaged in agriculture. Dyslipidemia, mainly hypercholesterolemia and hypertriglyceridemia, was also widespread in all middle-aged participants. Notably, its prevalence was 17.9% in women. The prevalence of dyslipidemia in participants engaged in agriculture was significantly lower than that in those not engaged in agriculture for both sexes (men: 7.7% vs. 13.6%, $P = 0.01$, women: 10.3% vs. 20.9%, $P \leq 0.01$). In model 2, the odds ratios for participants who were not engaged in agriculture were 1.92 (95% CI: 1.15–3.18; $P = 0.01$) in men and 2.34 (95% CI: 1.46–3.75; $P < 0.01$) in women. These trends were similar to those observed in the age-adjusted model 1 for both sexes. Analyses with adding BMI values as a covariate was performed in model 3, since the onset of many lifestyle-related chronic diseases was affected by BMI. There were still significant differences between participants engaged in agriculture and those not engaged in agriculture, even though the BMI was adjusted. Furthermore, the odds ratios were 1.81(95% CI: 1.09–3.03; $P = 0.02$) in men and 2.34 (95% CI: 1.46–3.76; $P < 0.01$) in women. None of the other lifestyle-related chronic disease showed statistically significant differences between participants engaged and those not engaged in agriculture among middle-aged participants.

### Prevalence of lifestyle-related chronic diseases among participants aged ≥65 years

The same analyses were performed in participants aged ≥65 years (Table 2). Remarkably, there were significant difference in the trends in prevalence among participants aged 40–64 years and those aged ≥65 years. Hypertension was extremely prevalent in men and women aged ≥65 years (men: 40.3%, women 44.5%). In men, the prevalence of hypertension for participants engaged in agriculture was

**Table 4** Adjusted odds ratio for obesity and disease of subject who no engageing agriculture, aged 65 and over 65 years old

| | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Regression coefficient | Ajusted OR | 95% CI | *P* | Regression coefficient | Ajusted OR | 95% CI | *P* | Regression coefficient | Ajusted OR | 95% CI | *P* |
| Men, over 65 years old | | | | | | | | | | | | |
| Obesity | 0.145 | 1.16 | 0.87–1.54 | NS | 0.120 | 1.13 | 0.85–1.50 | NS | | | | |
| Hypertension | 0.299 | 1.35 | 1.07–1.70 | 0.01 | 0.312 | 1.37 | 1.08–1.73 | <0.01 | 0.262 | 1.30 | 1.02–1.65 | 0.03 |
| Dyslipidemia | –0.055 | 0.95 | 0.69–1.30 | NS | –0.070 | 0.93 | 0.68–1.23 | NS | –0.135 | 0.87 | 0.63–1.21 | NS |
| Diabetes | 0.342 | 1.41 | 0.98–2.03 | NS | 0.308 | 1.36 | 0.94–1.97 | NS | 0.308 | 1.36 | 0.94–1.97 | NS |
| Hyperuricemia · Gout | 0.471 | 1.60 | 0.97–2.63 | NS | 0.528 | 1.70 | 1.03–2.80 | 0.04 | 0.496 | 1.64 | 0.99–2.72 | NS |
| Cerebrovascular disease | 0.133 | 1.14 | 0.70–1.86 | NS | 0.118 | 1.13 | 0.69–1.85 | NS | 0.085 | 1.09 | 0.66–1.79 | NS |
| Heart disease | 0.204 | 1.23 | 0.85–1.77 | NS | 0.131 | 1.14 | 0.79–1.66 | NS | 0.098 | 1.10 | 0.76–1.60 | NS |
| Nephropathy · Urinary disease | 0.072 | 1.08 | 0.75–1.55 | NS | 0.052 | 1.05 | 0.73–1.52 | NS | 0.035 | 1.04 | 0.72–1.50 | NS |
| Hepatic disease | –0.274 | 0.76 | 0.41–1.43 | NS | –0.333 | 0.72 | 0.38–1.35 | NS | –0.314 | 0.73 | 0.39–1.38 | NS |
| Gastropathy · Enteropathy | –0.215 | 0.81 | 0.54–1.21 | NS | –0.239 | 0.78 | 0.53–1.18 | NS | –0.181 | 0.84 | 0.55–1.26 | NS |
| Endocrine disease | 0.354 | 1.43 | 0.45–4.53 | NS | 0.395 | 1.48 | 0.46–4.77 | NS | 0.417 | 1.52 | 0.47–4.90 | NS |
| Bone · Musculoskeletal disease | –0.226 | 0.78 | 0.59–1.07 | NS | –0.235 | 0.79 | 0.56–1.07 | NS | –0.247 | 0.78 | 0.58–1.06 | NS |
| Women, over 65 years old | | | | | | | | | | | | |
| Obesity | –0.009 | 0.99 | 0.77–1.28 | NS | –0.008 | 0.99 | 0.77–1.28 | NS | | | | |
| Hypertension | 0.126 | 1.13 | 0.92–1.40 | NS | 0.122 | 1.13 | 0.91–1.40 | NS | 0.127 | 1.14 | 0.91–1.41 | NS |
| Dyslipidemia | 0.085 | 1.09 | 0.87–1.37 | NS | 0.086 | 1.09 | 0.87–1.37 | NS | 0.084 | 1.09 | 0.86–1.37 | NS |
| Diabetes | –0.261 | 0.77 | 0.53–1.13 | NS | –0.274 | 0.76 | 0.52–1.12 | NS | –0.275 | 0.76 | 0.52–1.11 | NS |
| Hyperuricemia · Gout | 0.625 | 1.87 | 0.54–6.49 | NS | 0.599 | 1.82 | 0.52–6.34 | NS | 0.659 | 1.93 | 0.54–6.86 | NS |
| Cerebrovascular disease | 0.147 | 1.16 | 0.62–2.18 | NS | 0.154 | 1.17 | 0.62–2.19 | NS | 0.153 | 1.17 | 0.62–2.19 | NS |
| Heart disease | 0.068 | 1.07 | 0.73–1.57 | NS | 0.081 | 1.09 | 0.74–1.59 | NS | 0.077 | 1.08 | 0.74–1.59 | NS |
| Nephropathy · Urinary disease | –0.274 | 0.76 | 0.42–1.37 | NS | –0.277 | 0.76 | 0.42–1.36 | NS | –0.279 | 0.76 | 0.42–1.36 | NS |
| Hepatic disease | –0.112 | 0.89 | 0.47–1.69 | NS | –0.094 | 0.91 | 0.48–1.72 | NS | –0.100 | 0.91 | 0.48–1.72 | NS |
| Gastropathy · Enteropathy | 0.117 | 1.12 | 0.74–1.71 | NS | 0.122 | 1.13 | 0.74–1.72 | NS | 0.120 | 1.13 | 0.74–1.72 | NS |
| Endocrine disease | 0.330 | 1.40 | 0.85–2.29 | NS | 0.347 | 1.42 | 0.86–2.32 | NS | 0.345 | 1.41 | 0.86–2.32 | NS |
| Bone · Musculoskeletal disease | 0.126 | 1.14 | 0.90–1.44 | NS | 0.139 | 1.15 | 0.91–1.45 | NS | 0.137 | 1.15 | 0.91–1.45 | NS |

OR: odds ratio; CI: confidence interval. Adjusted odds ratios were estimated by binomial logistic regression analysis. $P$<0.05 was significant. Model 1 was adjusted for age. Model 2 was adjusted for age and age, smoking status, and alcohol consumption. Model 3 was adjusted for age and age, smoking status, alcohol consumption and BMI.

35.8%, which is significantly lower than that in participants not engaged in agriculture (44.5%) ($P < 0.01$). Subsequently, binomial logistic regression analyses were performed (Table 4). The odds ratios for male participants who did not engage in agriculture, after adjusting for age in model 1, and age, smoking status, and alcohol drinking in model 2, were 1.35 (95% CI: 1.07–1.70; $P = 0.01$) and 1.37 (95% CI: 1.08–1.73; $P < 0.01$) respectively, compared with the odds ratios for participants who were engaged in agriculture. From the results of additional analyses using BMI values (model 3), a significant difference was observed, and the odds ratio was 1.30 (95% CI: 1.02–1.65; $P = 0.03$). In women, a similar trend was observed in the prevalence of hypertension (40.5% vs. 45.9%, $P = 0.04$); however, no significant difference was found after adjusting for covariates.

## Discussion

The highlight of the current study was to clarify the prevalence of lifestyle-related chronic diseases among workers engaged and not engaged in agriculture in the rural areas in Japan by sex and age (40–64 years and ≥65 years). By comparing the results of the participants who were engaged in agriculture with those who were not engaged in agriculture, we were able to confirm the prevalence of middle-aged obesity, dyslipidemia, and old-aged hypertension. For middle-aged obesity, the frequencies were still high in both sexes (men 27.5%, women 19.7% in this study), despite the implementation of political countermeasures in the past two decades, such as “Healthy Japan 21” in 2000 and the Health Promotion law in 2003, declared by the Japanese Ministry of Health, Labor and Welfare[5, 12]. Considering these backgrounds, our findings, that the frequency of obesity in middle-aged men and dyslipidemia in middle-aged women were lower among workers engaged in agriculture, suggest considered to have a great of impact on the prevention of obesity and obesity-related diseases. Furthermore, the odds ratio of dyslipidemia among participants not engaged in agriculture remained high even after adjusting for BMI value (model 3 in Table 3). This result lead us that engaging in agriculture could be associated with dyslipidemia in middle-aged participants through mechanisms that could partly be independent of its effect on BMI.

Among the elderly people in Japan, hypertension is the most widespread chronic disease; in our study, the prevalence rates of hypertension aged ≥65 years were 40.3% in men and 44.5% in women (Table 2). In such situation, it was quite beneficial in terms of results for prevention of hypertension and control of blood pressure that the frequency of hypertension among participants engaged in agriculture was lower than that among those who were not engaged in agriculture in both sexes. In particular, among elderly men, the odds ratio for hypertension among participants not engaged in agriculture remained high, after adjusting for age, smoking status, and alcohol consumption (model 2 in Table 4). Furthermore, in model 3 shown in Table 4, the odds ratio for hypertension among participants who did not engage in agriculture remained high even after adjusting for BMI value. These findings suggest that engaging in agriculture could be associated with hypertension in elderly men, through mechanisms that could partly be independent of its effect on BMI. Hamano *et al.*[13, 14] previously reported that social contexts contributed to the control of blood pressure. The social contexts related to agriculture may be one of the factors that can potentially control blood pressure, which is not affected by BMI.

It was also found that the prevalence of bone and musculoskeletal disease, primarily knee and lower back pain, were not significantly different, but slightly higher among the participants engaged in agriculture, except for elderly women. It seemed necessary to provide care for the knees and lower back of participants engaged in agriculture. On the contrary, women were relatively more likely to develop bone and musculoskeletal diseases than men and had higher risk of osteoporosis.

The strengths of the current study were as follows: data on the participants' diagnosis and prescription medicines for each disease were used in this study, although these data were only obtained through face-to-face interviews. There are also limitations to the current study. The cross-sectional design of this study prevents it from inferring with any causal relationship. The sample size was relatively small, although the prevalence of major chronic diseases among all participants showed trends similar to those reported in several investigations in Japan[6, 15, 16]. A selection bias might be present, since the participants were recruited during health examinations conducted by the National Health Insurance. In addition, potential confounding factors, such as socioeconomic status[17], diet composition, and exercise habit, as well as other physical habits, were not included; hence, the findings from this study should be cautiously interpreted. Although cancer[18] is a growing concern in Japan, we did not perform a systematic analysis of the collected data because patients with cancer do not tend to participate in a general medical checkup. Future studies should elucidate the current situations of these issues.

In conclusion, this study confirmed that engaging in agriculture may contribute to the control of lipid metabolism in middle-aged individuals and blood pressure in the elderly individuals.

**Conflict of interest:** The authors declare that they have no conflicts of interest.

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