

BMJ Open Social participation and risk of influenza infection in older adults: a cross-sectional study

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ABSTRACT

Objectives Influenza infection can cause severe pneumonia, which is sometimes fatal, particularly in older adults. Influenza results in 3–5 million cases of severe illness and about 250 000 to 500 000 deaths annually worldwide. Social participation in the context of influenza infection is controversial because, although social participation is beneficial in maintaining physical function and mental health, it also increases the risk of contact with infected people. This study examined the association between social participation and influenza infection in Japanese adults aged 65 years or older.

Design Cross-sectional study.

Setting Japanese functionally independent adults aged 65 years or older.

Participants Among the respondents to the Japan Gerontological Evaluation Study (JAGES) 2013 survey, which took place during the period from October to December 2013, 12 231 men and 14 091 women responded to questions on influenza vaccination and influenza infection.

Outcome measures Using JAGES data for 12 231 men and 14 091 women aged ≥65 years, we examined the association between social participation and influenza infection. The association between influenza infection and number of groups in which respondents participated was investigated among adults aged ≥65 years, stratified by vaccination status and sex.

Results Unvaccinated women who participated in two or more social activities were 2.20 times (95% CI 1.47 to 3.29) as likely to report an influenza infection as those who reported no social participation. In contrast, vaccinated women who participated in two or more social groups had no additional risk of influenza infection as compared with female elders with no social participation. Among men, participation in social activities was not significantly associated with influenza infection, regardless of vaccination status.

Conclusions Social participation was associated with a higher risk of influenza infection among unvaccinated older women, which suggests a need for further efforts to promote influenza vaccination, particularly among socially active elderly women.

INTRODUCTION

Influenza epidemics are estimated to result in 3–5 million cases of severe illness and about 250 000 to 500 000 deaths annually worldwide.¹

Strengths and limitations of this study

- Although social participation is highly recommended for older adults, this study is the first to examine the association between social participation and influenza infection among this population.
- A strength of this study is that it used data from a large-scale social survey, which yielded information on influenza infection, influenza vaccination status and social participation.
- The study is based on cross-sectional data, which do not allow determination of causal relationships between influenza infection and social participation.

Older adults are disproportionately affected,^{2–4} as they are vulnerable to influenza infection and development of secondary bacterial pneumonia due to complications of chronic conditions such as congestive heart failure and chronic obstructive pulmonary disease.⁵ Influenza infection may also result in declines in critical physical functions in frail elders.⁶ Influenza infection is thus one of the most important causes of death in an ageing society.

Influenza infection is transmitted from person to person; therefore, social contact increases the risk of influenza infection.^{7–10} However, social participation, which increases social contact, is beneficial for the physical and mental health of older adults.^{11–13} Previous research on social participation showed wide-ranging health benefits for older adults. Older adults who participate in social activities have better self-rated health,¹¹ lower risks of disability, functional decline, mobility decline, depression, generalised anxiety disorders, cognitive decline and dementia,^{14–19} and longer lifespans.¹² To our knowledge, no study has investigated the association between social participation and influenza infection among older adults.

Influenza vaccination status must be considered in any study of the association between influenza infection and social participation

among adults aged ≥ 65 years. Influenza vaccination is recommended for older adults,^{20,21} as it decreases the risk of preventable death.¹ For elders in Japan, vaccination fees are partly subsidised by the local government, to increase vaccination coverage.^{14,15} The influenza vaccine must be altered to remain effective against currently circulating strains. The effectiveness of influenza vaccinations varies because the circulating type and subtype of the virus change every year. Thus, protection is sometimes greatly reduced or absent, especially in older adults.²² This study is one of the few to show the effectiveness of influenza vaccination in older adults. Because social participation is positively associated with influenza vaccination,²³ the association between social participation and influenza infection might vary in relation to vaccination status. In addition, modes of contact during social participation might differ between men and women.

The Japan Gerontological Evaluation Study (JAGES) project is one of the largest cohort studies of social determinants of health among Japanese adults aged ≥ 65 years. This study used part of the 2013 wave data from the 138 294 respondents to the survey (response rate, 70.8%). This study is the first to examine the association between social participation and influenza infection among elders stratified by influenza vaccination status and sex. In addition, we attempted to identify social activities that were associated with influenza infection.

METHODS

Study population

This study used data from the JAGES project, an ongoing prospective cohort study of the social determinants of health among functionally independent adults aged ≥ 65 years. Several studies have used data from this large-scale nationwide project.^{24,25} The cohort covers 30 municipalities in 13 prefectures in Japan. We used the 2013 wave of JAGES, in which questionnaires were mailed to a random sample of approximately 200 000 community-dwelling individuals aged 65 years and older from October to December 2013. In addition to the basic items, five survey modules covered a variety of other topics. Module A covered nursing care, medical care and lifestyle; module B assessed oral hygiene, optimism and subjective health; module C covered social capital and history of abuse; module D evaluated subjective quality of life, sleep and influenza infection; and module E assessed physical activity. We used module D, which included questions on influenza vaccination and influenza infection. All valid responses (from 12 231 men and 14 091 women) to module D were analysed.

Influenza infection and vaccination

Influenza infection status was determined by participant response to a self-administered questionnaire. To determine influenza infection status, respondents were asked, "Were you infected with influenza during the previous year? (yes, no)". Vaccination status was evaluated by

asking respondents, "Did you receive an influenza vaccination during the previous year? (yes, no)".

Social participation

Social participation was defined as involvement in any social activity during the study period.²⁶ Respondents were asked how often they took part in volunteer groups, sport groups or clubs, leisure activity groups, senior citizen clubs, neighbourhood associations, study or cultural groups, nursing care prevention for health promotion groups, in teaching skills or passing on experiences to others, local events, protection for older people, assistance for older people, child-rearing support, local environment improvement activities and other groups (frequency of participation: ≥ 4 times per week, 2–3 times per week, once a week, 1–3 times per month, several times per year or never). We defined a participation frequency of at least 1–3 times per month as participation in a group, counted the number of groups in which the respondent participated and categorised participation as 0, 1 or ≥ 2 groups.

Covariates

Physical health status, particularly presence of respiratory disease, might be associated with social participation and influenza infection.^{27,28} Self-rated health and respiratory disease as an underlying medical condition were assessed via questionnaire. Self-rated health was assessed by the question, "What is your current health status? (excellent, good, fair or poor)". Responses of excellent and good were classified as 'good' and responses of fair and poor as 'not good'. Presence of grandchildren in the household, which might be associated with social participation and influenza infection, was ascertained via questionnaire. Socioeconomic status was analysed as a possible confounder. Educational attainment was categorised as < 6 years, 6–9 years, 10–12 years, ≥ 13 years and other. Household income was equalised by the square root of the number of household members and classified as < 1.99 million yen, 2–3.99 million yen and > 4 million yen. Age was categorised into five groups: 65–69, 70–74, 75–79, 80–84 and ≥ 85 years.

Analysis

Logistic regression analysis was used to examine the association between social participation and influenza infection. When an interaction term between a factor and social participation was significantly associated with influenza infection, analyses were done after stratifying respondents by that factor. We adjusted for the following possible confounding factors: age, self-rated health, underlying respiratory disease, living with grandchildren, educational attainment and equivalent income.

Additional analysis

To determine whether certain types of social activity were more likely to result in influenza infection, we set participation in each activity as an explanatory variable, instead of participation in any social activity, and this

yielded 14 models. Data from all the respondents were analysed. Number of participating activities was included as a covariate, to measure the effect of participating in each activity. ORs for influenza infection were calculated in relation to participation in each activity, stratified by vaccination status and sex. All analyses were performed with STATA SE V.13 (StataCorp).

Ethical considerations

The questionnaire and an explanation of the study were sent to participants via mail. The recipients were informed that participation was voluntary and that returning the self-administered questionnaire would be interpreted as consent to participate. Ethical approval for the study was obtained from the ethics committee at Nihon Fukushi University.

RESULTS

The interaction term between vaccination status and social participation was significantly associated with influenza infection, as was the interaction term between sex and social participation. Thus, all analyses of the groups were stratified by vaccination status and sex. The characteristics of the study sample, stratified by vaccination status and sex, are shown in [table 1](#). The vaccinated group was older than the unvaccinated group, and this was true for men and women. In particular, 49.5% of vaccinated men and 32.9% of unvaccinated men were 75 years or older; the respective values were 48.0% and 34.7% for women. Approximately one-third of vaccinated men (29.1%) and vaccinated (33.3%) women participated in two or more groups, while less than one-fourth (22.6%) of unvaccinated men participated in two or more groups.

A total of 355 cases (5.5%) and 372 cases (4.2%) of influenza infection were observed among vaccinated men and women, respectively, and 136 cases (2.4%) and 124 cases (2.3%) of influenza infection were observed in unvaccinated men and women, respectively. The proportion of respondents with respiratory diseases was higher among vaccinated elders (7.6% in men and 5.0% in women, $P<0.001$) than among unvaccinated elders (4.0% in men and 3.4% in women, $P<0.001$). Vaccinated elders were more likely than unvaccinated elders to live with grandchildren (men: 16.2% vs 11.2%, $P<0.001$; women: 21.1% vs 13.3%, $P<0.001$).

[Table 2](#) shows the results of logistic analysis of influenza infection in respondents stratified by influenza vaccination status and sex. Overall, unvaccinated women who participated in two or more social activities were more likely to develop influenza than were unvaccinated women who did not participate in such activities (OR 2.20; 95% CI 1.47 to 3.29), after adjustment for age, self-rated health, presence of respiratory disease, living with grandchildren and socioeconomic status (educational attainment and equivalent income). However, among vaccinated women, social participation in two or more activities was not associated with

influenza infection after adjustment (OR 1.06; 95% CI 0.83 to 1.36). Social participation was not associated with influenza infection among vaccinated or unvaccinated men. Participation in one group was not associated with influenza infection in either group. Presence of respiratory disease was significantly associated with influenza infection among vaccinated men (OR 1.94; 95% CI 1.40 to 2.71), unvaccinated men (OR 2.44; 95% CI 1.28 to 4.68) and vaccinated women (OR 1.89; 95% CI 1.31 to 2.73). Poor self-rated health was significantly associated with influenza infection in vaccinated (OR 1.49; 95% CI 1.15 to 1.92) and unvaccinated women (OR 1.80; 95% CI 1.12 to 2.87).

Each social participation was not associated with influenza infection among vaccinated elderly men or women ([figures 1 and 2](#)). Among unvaccinated elders ([figures 3 and 4](#)), only men who participated in a leisure activity group had a significantly decreased risk of influenza infection (OR 0.56; 95% CI -0.33 to 0.94; [figure 3](#)).

DISCUSSION

In this study, risk of influenza infection was higher for unvaccinated elders, particularly women, than for vaccinated Japanese elders. This suggests that influenza vaccination is effective in preventing influenza infection among active older adults and highlights the urgent need for additional efforts to promote influenza vaccination among socially active elders, especially women.

In an analysis of upper respiratory tract viruses, such as rhinovirus, in a quarantine setting, Cohen *et al* found that for unknown reasons individuals with diverse social networks had greater resistance to upper respiratory illnesses.²⁹ It is hypothesised that certain immune mechanism operates as pathways and that behaviour affects release of cytokines in nasal passages. Similarly, establishing a social network through group activities might prevent viral infection. However, frequent contact with infected persons could result in infection even among people with robust social networks. In our study, the risk of influenza infection was not higher among vaccinated elders when the likelihood of contact increased. When available, vaccines might help prevent transmission of infectious respiratory agents other than influenza virus, as is the case for the pneumococcal vaccine.³⁰ However, when no vaccine is available, non-pharmaceutical interventions such as respiratory hygiene and cough etiquette^{31 32} may be effective preventive measures. Future studies should investigate infections other than influenza.

In this study, participation in social activities did not increase the risk of influenza infection among vaccinated elders, even after adjustment for confounding factors. In general, influenza vaccines provide protection against influenza infection.^{21 33} Several previous studies reported that vaccination reduced hospitalisations and deaths in older adults.^{34–36} Our results

Table 1 Characteristics of vaccinated and unvaccinated elders stratified by sex

Variables	Men (n=12231)						Women (n=14091)					
	Vaccinated (n=6502)			Unvaccinated (n=5729)			Vaccinated (n=8801)			Unvaccinated (n=5290)		
	n	%	n	%	n	%	n	%	n	%	n	%
Age, years												
65–69	1438	(22.1)	2067	(36.1)			1916	(21.8)	1876	(35.5)		
70–74	1845	(28.4)	1776	(31.0)			2663	(30.3)	1578	(29.8)		
75–79	1658	(25.5)	1030	(18.0)			2163	(24.6)	989	(18.7)		
80–84	1067	(16.4)	580	(10.1)			1376	(15.6)	526	(9.9)		
≥85	494	(7.6)	276	(4.8)			683	(7.8)	321	(6.1)		
Participation in social activity, no of groups												
0	3391	(52.2)	3408	(59.5)			4058	(46.1)	2813	(53.2)		
1	1219	(18.7)	1026	(17.9)			1812	(20.6)	974	(18.4)		
≥2	1892	(29.1)	1295	(22.6)			2931	(33.3)	1503	(28.4)		
Influenza infection in past year												
Not infected	6147	(94.5)	5593	(97.6)			8429	(95.8)	5166	(97.7)		
Infected	355	(5.5)	136	(2.4)			372	(4.2)	124	(2.3)		
Self-rated health												
Good	4972	(76.5)	4494	(78.4)			6911	(78.5)	4227	(79.9)		
Not good	1328	(20.4)	1036	(18.1)			1558	(17.7)	824	(15.6)		
Missing	202	(3.1)	199	(3.5)			332	(3.8)	239	(4.5)		
Any respiratory disease												
No	6009	(92.4)	5500	(96.0)			8357	(95.0)	5111	(96.6)		
Yes	493	(7.6)	229	(4.0)			444	(5.0)	179	(3.4)		
Living with grandchild												
No	5447	(83.8)	5088	(88.8)			6948	(78.9)	4587	(86.7)		
Yes	1055	(16.2)	641	(11.2)			1853	(21.1)	703	(13.3)		
Educational attainment, years												
<6	89	(1.4)	72	(1.3)			195	(2.2)	113	(2.1)		
6–9	2431	(37.4)	2115	(36.9)			3847	(43.7)	2111	(39.9)		
10–12	2271	(34.9)	1970	(34.4)			3308	(37.6)	2045	(38.7)		
≥13	1602	(24.6)	1446	(25.2)			1243	(14.1)	834	(15.8)		
Others	40	(0.6)	39	(0.7)			51	(0.6)	40	(0.8)		
Missing	69	(1.1%)	87	(1.5)			157	(1.8)	147	(2.8)		
Equivalent income, million yen												
<1.99	2875	(44.2)	2418	(42.2)			3595	(40.8)	2111	(39.9)		

Continued

Enseignement Supérieur (ABES).
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Table 1 Continued

Variables	Men (n=12231)				Women (n=14091)				P Value*
	Vaccinated (n=6502)		Unvaccinated (n=5729)		Vaccinated (n=8801)		Unvaccinated (n=5290)		
	n	%	n	%	n	%	n	%	
2-3.99	2222	(34.2)	1749	(30.5)	2421	(27.5)	1304	(24.7)	
>4	654	(10.1)	462	(8.1)	692	(7.9)	353	(6.7)	
Missing	751	(11.6)	1100	(19.2)	2093	(23.8)	1522	(28.8)	<0.001

* χ^2 test.

Bold indicates statistically significant at 5% level.

confirm the effectiveness of influenza vaccines, but only in women. Protection is sometimes greatly reduced or absent, especially in older adults.²² This study is one of the few that have confirmed the effectiveness of influenza vaccination in older adults.

Respondents were stratified by vaccination status because it may modify the association between social participation and influenza infection. Older people who participate in two or more groups are more likely to be vaccinated than are those who do not participate in such activities. It is believed that elders who participate in social activities have good access to health information, including how and where they can receive influenza vaccinations.^{20 37 38} Gathering for any group activity means sharing information in participant interests, such as health information, even when the aim of the activity may not be directly related to such interests. In addition, socially active persons have better medical access, which includes vaccinations and consultation with physicians.²⁰ This suggests that social persons who participate in groups are more likely than non-social persons to see a doctor when they develop a fever, especially in Japan, where medical resources are accessible to the entire population.

We also stratified respondents by sex. Evidence indicates that antibody responses after vaccination are stronger for women than for men.³⁹ Such differences in response were observed for various vaccines, including influenza vaccine.^{40 41} This could explain the sex differences observed in this study. Behavioural differences between men and women may also have a role. Women tend to talk more than men during social activities. The risk of influenza infection was higher in unvaccinated women who participated in two or more groups.

The risk of influenza infection varied in relation to the type of social activity and by sex, but most activities did not significantly increase infection risk in vaccinated or unvaccinated elders. Only participation in a leisure activity group was associated with decreased risk for infection, among unvaccinated men, perhaps because such groups have less opportunities for close contact.²³ However, reason why a significant association was observed only in unvaccinated men was unclear. One reason for the lack of a significant association with most activities was larger effect of number of participation rather than type of social activity. Transmission of the influenza virus between humans is mainly by respiratory droplets, although airborne transmission is possible.^{42 43} Thus, activities with fewer opportunities for conversation and direct contact have less infection risk. Similarly, the risk of transmission is higher for larger groups.^{43 44} In our study, group size and number of people gathered were unknown. Future studies should investigate why infection risk varies by group type and sex.

Our study has several limitations. First, because it is cross-sectional, causality cannot be inferred. A longitudinal study or a randomised controlled trial is

Table 2 Risk of influenza infection in men and women stratified by influenza vaccination status

Variables	Men				Women			
	Vaccinated		Unvaccinated		Vaccinated		Unvaccinated	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Participation in social activities (no of groups)								
0	Reference		Reference		Reference		Reference	
1	1.02	(0.76 to 1.37)	0.94	(0.58 to 1.53)	1.14	(0.86 to 1.50)	0.95	(0.54 to 1.67)
≥2	1.08	(0.84 to 1.39)	1.27	(0.85 to 1.91)	1.06	(0.83 to 1.36)	2.20	(1.47 to 3.29)
Age, years								
65–69	Reference		Reference		Reference		Reference	
70–74	1.15	(0.85 to 1.56)	0.80	(0.53 to 1.22)	0.94	(0.71 to 1.25)	0.39	(0.24 to 0.63)
75–79	0.94	(0.68 to 1.30)	0.98	(0.61 to 1.58)	0.84	(0.62 to 1.14)	0.54	(0.32 to 0.91)
80–84	0.95	(0.66 to 1.36)	0.69	(0.35 to 1.35)	0.54	(0.37 to 0.80)	0.60	(0.31 to 1.17)
≥85	0.81	(0.50 to 1.31)	0.69	(0.27 to 1.76)	0.62	(0.38 to 1.00)	–	
Self-rated health								
Good	Reference		Reference		Reference		Reference	
Not good	0.98	(0.74 to 1.29)	0.80	(0.49 to 1.31)	1.49	(1.15 to 1.92)	1.80	(1.12 to 2.87)
Missing	1.54	(0.92 to 2.59)	1.41	(0.60 to 3.29)	1.59	(0.98 to 2.59)	1.06	(0.38 to 2.93)
Any respiratory disease								
No	Reference		Reference		Reference		Reference	
Yes	1.94	(1.40 to 2.71)	2.44	(1.28 to 4.68)	1.89	(1.31 to 2.73)	1.14	(0.45 to 2.87)
Living with grandchild								
No	Reference		Reference		Reference		Reference	
Yes	1.21	(0.92 to 1.60)	1.56	(0.97 to 2.49)	0.98	(0.75 to 1.28)	0.91	(0.51 to 1.61)
Educational attainment, years								
<6	Reference		Reference		Reference		Reference	
6–9	0.87	(0.37 to 2.04)	0.38	(0.11 to 1.29)	0.90	(0.43 to 1.89)	1.30	(0.17 to 9.76)
10–12	0.73	(0.31 to 1.75)	0.58	(0.17 to 1.96)	0.77	(0.36 to 1.64)	1.20	(0.16 to 9.14)
≥13	0.80	(0.33 to 1.91)	0.39	(0.11 to 1.36)	0.74	(0.33 to 1.64)	1.03	(0.13 to 8.14)
Others	1.20	(0.28 to 5.11)	1.07	(0.17 to 6.86)	0.75	(0.15 to 3.68)	1.86	(0.11 to 31.34)
Missing	0.84	(0.23 to 3.14)	0.26	(0.03 to 2.57)	1.09	(0.39 to 3.01)	0.57	(0.03 to 9.36)
Equivalent income, million yen								
<1.99	Reference		Reference		Reference		Reference	
2–3.99	0.87	(0.68 to 1.12)	0.87	(0.58 to 1.31)	1.09	(0.84 to 1.41)	1.09	(0.72 to 1.67)
>4	0.67	(0.43 to 1.03)	1.17	(0.65 to 2.11)	0.79	(0.50 to 1.25)	0.58	(0.25 to 1.39)
Missing	0.66	(0.84 to 1.62)	0.66	(0.39 to 1.12)	0.94	(0.71 to 1.24)	0.62	(0.37 to 1.03)

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Vaccinated men (N=6,502)

Social activity	OR	95%CI
Volunteer group	0.89	(0.58 - 1.36)
Sport group or club	1.03	(0.74 - 1.42)
Leisure activity group	0.82	(0.59 - 1.14)
Senior citizen club	1.43	(0.96 - 2.12)
Neighbourhood association	1.44	(0.98 - 2.10)
Study or cultural group	1.10	(0.67 - 1.82)
Nursing care prevention for health-building	0.78	(0.44 - 1.36)
Teaching skills or passing on experiences to others	1.19	(0.71 - 1.98)
Local events	0.78	(0.36 - 1.71)
Protection for older people	0.63	(0.30 - 1.33)
Assistance for older people	0.60	(0.26 - 1.36)
Child-rearing support	0.85	(0.44 - 1.65)
Local environment improvement	0.85	(0.49 - 1.49)
Other	1.04	(0.65 - 1.68)

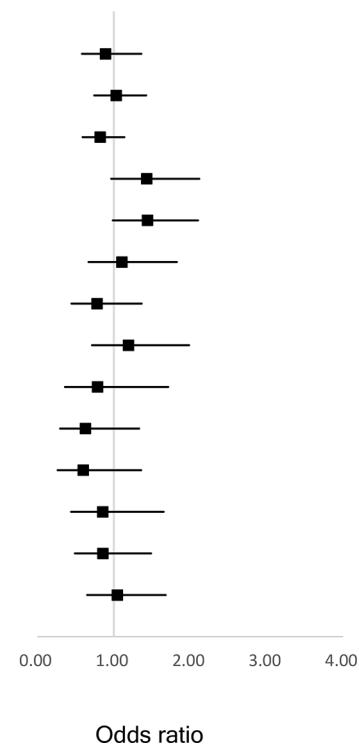


Figure 1 ORs for influenza infection in relation to participation in specific social activities among vaccinated men. Logistic regression was adjusted for age, number of participating groups, self-rated health, respiratory disease, living with grandchildren and socioeconomic status.

Vaccinated women (N=8,801)

Social activity	OR	95%CI
Volunteer group	0.82	(0.53 - 1.29)
Sport group or club	1.03	(0.75 - 1.41)
Leisure activity group	1.04	(0.76 - 1.40)
Senior citizen club	0.99	(0.66 - 1.48)
Neighbourhood association	1.15	(0.73 - 1.82)
Study or cultural group	0.85	(0.55 - 1.31)
Nursing care prevention for health-building	1.30	(0.87 - 1.96)
Teaching skills or passing on experiences to others	0.69	(0.37 - 1.30)
Local events	1.38	(0.60 - 3.19)
Protection for older people	0.52	(0.25 - 1.08)
Assistance for older people	0.97	(0.52 - 1.81)
Child-rearing support	1.13	(0.61 - 2.10)
Local environment improvement	1.23	(0.71 - 2.14)
Other	1.32	(0.80 - 2.18)

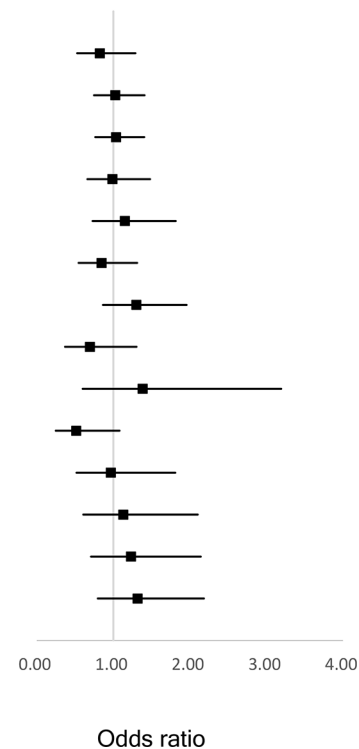


Figure 2 ORs for influenza infection in relation to participation in specific social activities among vaccinated women. Logistic regression was adjusted for possible confounders.

Unvaccinated men (N=5,729)

Social activity	OR	95%CI
Volunteer group	1.16	(0.59 - 2.26)
Sport group or club	1.55	(0.95 - 2.54)
Leisure activity group	0.56	(0.33 - 0.94)
Senior citizen club	1.10	(0.54 - 2.24)
Neighbourhood association	0.71	(0.36 - 1.40)
Study or cultural group	0.99	(0.45 - 2.20)
Nursing care prevention for health-building	1.04	(0.43 - 2.51)
Teaching skills or passing on experiences to others	1.14	(0.54 - 2.43)
Local events	1.13	(0.42 - 3.08)
Protection for older people	1.18	(0.42 - 3.28)
Assistance for older people	1.52	(0.55 - 4.20)
Child-rearing support	0.82	(0.29 - 2.31)
Local environment improvement	0.95	(0.43 - 2.10)
Other	0.83	(0.40 - 1.71)

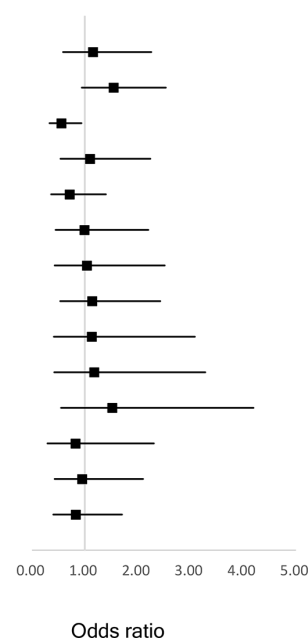


Figure 3 ORs for influenza infection in relation to participation in specific social activities among unvaccinated men. Logistic regression was adjusted for possible confounders.

Unvaccinated women (N=5,290)

Social activity	OR	95%CI
Volunteer group	0.65	(0.31 - 1.36)
Sport group or club	0.93	(0.55 - 1.55)
Leisure activity group	1.11	(0.69 - 1.81)
Senior citizen club	1.74	(0.91 - 3.31)
Neighbourhood association	1.07	(0.54 - 2.14)
Study or cultural group	0.78	(0.39 - 1.54)
Nursing care prevention for health-building	1.19	(0.60 - 2.36)
Teaching skills or passing on experiences to others	0.44	(0.18 - 1.09)
Local events	0.69	(0.19 - 2.47)
Protection for older people	1.13	(0.48 - 2.62)
Assistance for older people	1.53	(0.69 - 3.39)
Child-rearing support	0.64	(0.24 - 1.69)
Local environment improvement	0.84	(0.34 - 2.07)
Other	1.23	(0.61 - 2.46)

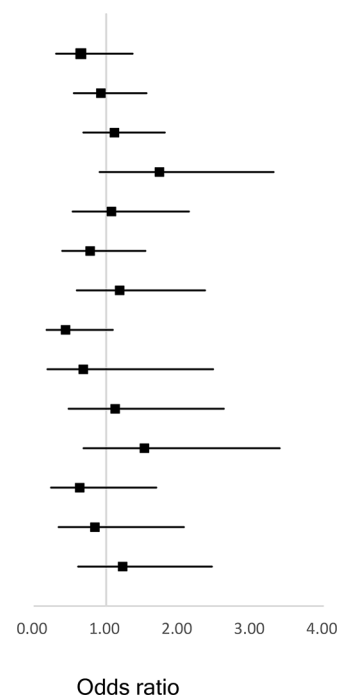


Figure 4 ORs for influenza infection in relation to participation in specific social activities among unvaccinated women. Logistic regression was adjusted for possible confounders.

needed in order to prove a causal relationship between social participation and influenza infection. Second, diagnosis of influenza infection was based on self-reports rather than on the results of laboratory testing. However, in Japan, commercial rapid diagnostic test kits are commonly used in clinical settings such as outpatient clinics. These kits have high sensitivity

and specificity in the diagnosis of influenza infection.^{45 46} In addition, medical access is good because of the universal health insurance system in Japan.⁴⁷ Older adults with an influenza-like illness in Japan are generally tested with rapid diagnostic tests.^{45 48} Third, vaccination history was self-reported. Fourth, previous influenza infection was not assessed.

In conclusion, social participation increased the risk of influenza infection among unvaccinated elders, particularly women, which suggests that additional efforts are needed in order to encourage influenza vaccination among socially active elders.

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Contributors All authors met the International Committee of Medical Journal Editors criteria for authorship. YS and TF contributed to the study design. YS performed statistical analysis and drafted the manuscript. TF advised on data analysis and interpretation. RS, KK and TF revised the manuscript. KK is the principal investigator of the JAGES project. AT helped to develop the idea of the study. All authors read and approved the final manuscript.

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