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ORIGINAL

Effectiveness of Influenza vaccines in reducing risk of acute febrile illness among community-dwelling elderly, 2006-07 seasons: Population-based cohort study in Japan

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ABSTRACT

Background: Annual vaccinations are recommended for groups with high-risk medical conditions, as well as the residents of nursing homes. In general, little is known about the vaccine effectiveness of vaccines for Influenza-like illness (ILI) in community-dwelling elderly.

Methods: A population based cohort study was conducted during the 2006-2007 (06/07) influenza season to examine the effectiveness of an influenza vaccine among community-dwelling elderly. We selected 1,000 elderly citizens ranging from 65 to 74 years old randomly from a population registry of Sapporo in September 2006. Baseline survey for them was conducted in October or November 2006, and 542 (54.2%) subjects responded with an informed consent. We excluded one person because he passed away before the follow-up survey. Thus, we analyzed 541 subjects. We followed-up the participants concerning acute febrile illnesses, hospitalizations, and so on every prior month from December 2006 to April 2007 though telephone interviews. The Chi-square test and Mann-Whitney U-test were used to compare vaccinated group to non-vaccinated group, and Cox's hazard model was conducted to control for potential confounding factors.

Results: After adjusting for confounders, the vaccination decreased acute fevers higher than or equal to 37.5˚C (Hazard ratio (HR) =0.42, 95% confidence interval (CI)=(0.20, 0.90)) from December 2006 to March 2007, but was not associated with the risk of ILI (HR=1.25, 95%CI=(0.29, 5.37)).

Conclusion: An influenza vaccination may decrease an acute fever during an influenza epidemic season in community-dwelling elderly.

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Key words: Influenza vaccine, Effectiveness, Influenza-like illness, Community-dwelling elderly

1　INTRODUCTION

According to the Advisory Committee on Immunization Practices (ACIP) in the United States, inactivated influenza vaccination is 30-70% effective in preventing hospitalization for pneumonia and influenza among elderly persons not living in nursing homes or chronic-care facilities. Annual vaccinations are recommended for those groups, as well as the residents of nursing homes and for those groups with high-risk medical conditions[1]. The Japanese Ministry of Health, Labour and Welfare recommended a vaccination including the assistance though public funds, for a senior citizens older than 65 years old from 2001, because they recognized the elderly to be a high-risk group for influenza.

Most observational studies about the effectiveness of influenza vaccines in community-dwelling elderly have been investigated by linkage to large scale databases[2-10]. Because existing administrative databases cannot be used to evaluate the effectiveness of influenza vaccination in Japan, another approach to evaluate the effectiveness of an influenza vaccination is needed[11]. All subjects should be followed equally thorough the influenza season to examine the effects of the influenza vaccination for

influenza-like illness (ILI) and high fever, as such studies have so far mostly been limited to elderly residents in nursing homes[12,13]. In general, little is known about the vaccine effectiveness for ILI in community-dwelling elderly[14]. In the previous cohort study in Saga, Japan[15], influenza vaccination decreased ILI significantly (OR=0.38; 95%CI=(0.17,0.85)) after adjusting for confounders. This present study was a population-based cohort study, conducted during the 06/07 season to examine the effectiveness of an influenza vaccine among community-dwelling elderly in Sapporo, Japan.

2 SUBJECTS AND METHODS

We selected 1,000 elderly citizens ranging from 65 to 74 years old randomly from a population registry of Sapporo City in September 2006. We sent them a letter with an explanation of the study and requesting for their participation. The eligibility criteria to participate in study were as follows; not being hospitalized, not being institutionalized, and having access to contact by telephone at least once a month. As a baseline survey in October or November 2006, we asked them to answer the self-administered questionnaire about baseline characteristics that might act as potential confounders including: a history of influenza vaccinations (this season(06/07), pre-season(05/06), and the season before last(04/05)), a diagnosis of influenza (this season(06/07), pre-season(05/06), and the season before last(04/05)), health condition by self report, health status (underlying disease etc), history of ILI, vaccination, smoking habits, exercise habits, going out to crowded areas, history of hospitalizations for pneumonia, day care or day service or short stay use, hand washing and gargling habits, and family constitution. Among the 1,000 elderly citizens, 542 (54.2%) subjects responded with a written informed consent. We excluded one person because he passed away before the follow-up survey. Thus, we followed-up and analyzed 541 subjects.

The survey period was defined as from 1 November 2006 to 31 March 2007. We performed a follow-up survey by telephone in December 2006, and in January, February, March, and April 2007 (five times in total). Every month, we interviewed the elderly regarding ILI, acute febrile illnesses, hospitalizations, and death during the previous month by telephone. When an event occurred, we asked the elderly when the event did happen. ILI was defined that community-dwelling elderly have received a diagnosis at a hospital during the epidemic period in this study.

This study was approved by the Ethical Boards of Sapporo Medical University.

3 ANALYSIS

Statistical analyses were performed using the Statistical Package for Social Science (SPSS). The Chi-square test and Mann-Whitney U-test were used to compare vaccinated group and non-vaccinated group. Cox's hazard model was conducted to control for any confounding factors. The HR and their 95%CI were calculated for each factor based on the Cox's hazard model coefficient and standard error. For each of the estimations, the HR was adjusted for gender, age, and underlying disease (one or more of the following criteria; high blood pressure, a cardiovascular disease, a respiratory system disease, diabetes, a cerebrovascular disease). A level of 0.05 was used as the critical level of significance.

4 RESULTS

A total of 541 community-dwelling elderly were followed during the 06/07 influenza season. Participants included 306 (56.6%) males with a mean age (± standard deviation; SD) of 69.5 ±2.9 years. The rate of vaccination was 56.7%. Table 1 shows a comparison of the baseline variables between the vaccinated group and the non-vaccinated group. The vaccinated group was more likely to be female ($p=0.01$), older ($p<0.01$), to have underlying disease ($p<0.01$), to have never been a smoker ($p=0.01$), to have family medicine ($p<0.01$), and to gargle after returning home ($p<0.01$) than the non- vaccinated group.

Table 2 shows the ILI affection, and the vaccination situation in 2005/2006 (05/06) seasons. The vaccinated group in the 05/06 season was less likely to have an ILI in the 05/06 season ($p<0.01$), and more likely to vaccinate in the 06/07 season ($p<0.01$) than the non-vaccinated group in 05/06.

Table 3 illustrates the ILI affection and the vaccination situation in the 04/05 seasons. The vaccinated group in the 04/05 season was less likely to have an ILI in the 04/05 season ($p=0.04$), and more likely to vaccinate in the 06/07 season ($p<0.01$) than their counterparts.

The effect of the vaccine for each event is shown in Table 4. When the patients vaccinated, the risk of fever higher than or equal to 37.5˚C for the latter was reduced compared with their counterparts (crude: HR=0.47, 95%CI=(0.23, 0.97); adjusted: HR=0.42, 95%CI=(0.20, 0.90)). We compared the groups with and without underlying diseases, and the factor of having an

Table 1 Baseline characteristic

	The vaccinated group (n=307)	The non-vaccinated group (n=234)	p-value[$]
Gender (Male)	159 (51.8%)	147 (62.8%)	0.01
Age (years old)	70.0±2.8	68.8±2.9	<0.01
Having underlying disease (yes)*	189 (61.6%)	107 (45.7%)	<0.01
Health condition (good, normal)	281 (91.5%)	218 (93.2%)	0.52
Smoking habits (yes)	39 (12.7%)	50 (21.4%)	0.01
Regular exercise (More than once a week)	195 (63.5%)	146 (62.4%)	0.79
Having family medicine (yes)	259 (84.4%)	154 (65.8%)	<0.01
Going out to crowd areas (more than once a week)	253 (82.4%)	186 (79.5%)	0.44
Number of family members living together	2.7±1.4	2.6±1.1	0.31
Living together with a kindergarten, nursery, or primary schoolchild (yes)	23 (7.5%)	11 (4.7%)	0.21
Washes hands after returning home (yes)	279 (90.9%)	209 (89.3%)	0.57
Gargles after returning home (yes)	256 (83.4%)	169 (72.2%)	<0.01
Using a day-care or day-service (More than once a week)	7 (2.3%)	3 (1.3%)	0.53
Using a short stay service (yes)	1 (0.3%)	2 (0.9%)	0.58

number (%), means ± SD

underlying disease *: one or more of the following criteria: high blood pressure, a cardiovascular disease, a respiratory system disease, diabetes, a cerebrovascular disease

p-value[$]: Fisher's exact test, Mann-Whitney's U test.

Table 2 Influenza-like illness (ILI) affection in the 05/06 seasons, and the vaccination situation in the 06/07 seasons; comparing the vaccinated group and non-vaccinated group in the 05/06 season

	The vaccinated group in the 05/06 season (n=282)	The non-vaccinated group in the 05/06 season (n=259)	p-value[$]
ILI in the 05/06 season	3 (1.1%)	13 (5.0%)	<0.01
Vaccination in the 06/07season	263 (93.3%)	44 (17.0%)	<0.01

number (%)

p-value[$]: Fisher's exact test

Table 3 Influenza-like illness (ILI) affection in the 04/05 seasons, and the vaccination situation in the 06/07 seasons; compared vaccinated group and non-vaccinated group in the 04/05 season

	The vaccinated group in the 04/05 season (n=231)	The non-vaccinated group in the 04/05 season (n=310)	p-value[$]
ILI in the 04/05 season	4 (1.7%)	16 (5.2%)	0.04
Vaccinated in the 06/07season	208 (90.0%)	99 (31.9%)	<0.01

number (%)

p-value[$]: Fisher's exact test

underlying disease was not significant, although we did not show the data in the table.

Table 5 demonstrates the baseline characteristic in fevers higher than or equal to 37.5˚C. The group that had a fever higher than or equal to 37.5˚C were more likely to live together with a daughter (p=0.01), or kindergarten, nursery, or primary schoolchild (p=0.04) than the group that didn't have a fever higher than or equal to 37.5˚C. Also, the group that had a fever higher than or equal to 37.5˚C were less likely to vaccinate in 05/06 (p=0.03) than their counterparts.

Table 4 Effect of the vaccine for each event

	The vaccinated group (n=307)	The non-vaccinated group (n=234)	Hazard ratio* (95%CI[#])	Hazard ratio** (95%CI[#])
Fever (≧37.0˚C)	27 (8.8%)	27 (11.5%)	0.75 (0.44, 1.28)	0.74 (0.42, 1.29)
(≧37.5˚C)	12 (3.9%)	19 (8.1%)	0.47 (0.23, 0.97)	0.42 (0.20, 0.90)
(≧38.0˚C)	10 (3.3%)	14 (6.0%)	0.54 (0.24, 1.21)	0.48 (0.21, 1.12)
ILI	4 (1.3%)	4 (1.7%)	0.75 (0.19, 3.01)	1.25 (0.29, 5.37)
Pneumonia	2 (0.7%)	0 (0%)	- †	- †
Hospitalization for influenza	2 (0.7%)	0 (0%)	- †	- †

number (%)

p-value[$]: Fisher's exact test

CI[#]: confidence interval

The vaccinated group vs. the non-vaccinated group

Hazard ratio*: crude

Hazard ratio**: adjusted for sex, age, and underlying disease (one or more of the following criteria; high blood pressure, a cardiovascular diease, a respiratory system disease, diabetes, a cerebrovascular disease).

† : Could not be calculated.

Table 5 Baseline characteristic in fever higher than or equal to 37.5˚C

	More higher than or equal to 37.5˚C		p-value[$]
	Not having (n=510)	Not having (n=510)	
Gender (Male)	15 (48.4%)	291 (57.1%)	0.36
Age (years old)	69.2±3.1	69.5±2.9	0.58
Having underlying disease* (yes)	18 (58.1%)	278 (54.5%)	0.85
Health condition (good, normal)	27 (87.1%)	472 (92.5%)	0.29
Smoking habits (yes)	3 (9.7%)	86 (16.9%)	0.45
Regular exercise (More than once a week)	17 (54.8%)	324 (63.5%)	0.34
Going out to crowded areas (more than once a week)	25 (80.6%)	414 (81.2%)	1.00
Number of family members living together	3.1±1.9	2.6±1.2	0.14
Living together with a daughter (including the justice) (yes)	13 (41.9%)	109 (21.4%)	0.01
Living together with a kindergarten, nursery, or primary schoolchild (yes)	5 (16.1%)	29 (5.7%)	0.04
Washes hands after returning home (yes)	29 (93.5%)	459 (90.0%)	0.76
Gargles after returning home (yes)	22 (71.0%)	403 (79.0%)	0.27
Using a day-care or day-service (More than once a week)	0 (0%)	10 (2.0%)	- **
Using a short stay service (yes)	0 (0%)	3 (0.6%)	- **
Vaccinated in the 05/06 (yes)	10 (32.3%)	272 (53.3%)	0.03
Vaccinated in the 04/05 (yes)	10 (32.3%)	221 (43.3%)	0.27

number (%), means ± SD

underlying disease *: one or more of the following criteria: high blood pressure, a cardiovascular disease, a respiratory system disease, diabetes, a cerebrovascular disease

p-value[$]: Fisher's exact test, Mann-Whitney's U test.

**: Could not be calculated.

5 DISCUSSION

In the baseline characteristics, the vaccinated group was more likely to never have been a smoker, and gargle after returning home. There is possibility that the vaccinated group had a healthier consciousness than their counterparts, and there may have also been selection bias. The vaccinated group may have taken the recommendation of the vaccination more than the non-vaccinated group, because the vaccinated group was more likely to have an underling disease and family medicine.

In the present study, the vaccinated group in the 05/06 season was less likely to have an ILI in the 05/06 season (the vaccinated vs. the non-vaccinated: 1.1% vs. 5.0%) and the vaccinated group in the 04/05 season was less likely to have an ILI in the 04/05 season (the

vaccinated vs. the non-vaccinated: 1.7% vs. 5.2%) than their counterparts. Hara et al[16] reported vaccinated group were less likely to have ILI than non-vaccinated group. The result of the present study supported the result of the study[16], though year in an influenza season, the type of endemic influenza viruses, and area in Japan were different. However, there is a possibility of misclassification[11] or selection bias, because the vaccinated group may be likely to attend a hospital after they become sick. This study of effectiveness of an influenza vaccine in persons aged 65 years or over living in a community was limited[17-19], especially in the effectiveness for ILI[14, 20].

The vaccinated group in the 05/06 season was more likely to vaccinate in the 06/07 season than the non-vaccinated group in the 05/06 (the vaccinated vs. the non-vaccinated: 93.3% vs. 17.0%), and the vaccinated group in the 04/05 season was more likely to vaccinate in the 06/07 season (the vaccinated vs. the non-vaccinated: 90.0% vs. 31.9%) than their counterparts. If the community-dwelling elderly were vaccinated once, the elderly may be vaccinated again the next year. Therefore, it would be important for the Japanese Government to intervene to find ways to vaccinate for the elderly.

In this present cohort study among community-dwelling elderly, influenza vaccination reduced the risk of a fever higher than or equal to 37.5˚C during the epidemic period. The result of the present study supported the result of the previous cohort study in Saga[15]. Critical point of high fever of this study (37.5˚C) was different from that of the previous study in Saga (38.5˚C)[16]. Because there are no other reports, to our knowledge, regarding effectiveness of influenza vaccine reducing risk of acute febrile illness, future study is necessary to identify the critical point of high fever for vaccine effectiveness. In a follow-up survey over the telephone, it was difficult to perform an influenza judgment in the present study because the survey asked a self-report, however it is correct for judging the fever. A high fever from influenza is an important health hazard in elderly in a community.

Comparison between a high-risk condition group and a low-risk condition group are important in a general influenza study[21], and it was not significant in the present study. Although we compared risk of having ILI between a high-risk group and a low-risk group, it was not significantly different. No difference between them might occur from small sample size, relatively low response rate (54%), or low prevalence of pneumonia during this influenza seasons in Japan compared with a report in Europe[22] . Such variables do not capture the important difference in health status between vaccinated and unvaccinated individuals, and the adjustment for these variables alone does not remove the confounding factors. In our future study, we will control for confounding with detailed medical record information.

In the present study, the group that had a fever higher than or equal to 37.5˚C was more likely to live together a daughter (p=0.01), or a kindergarten or nursery or a primary schoolchild (p=0.04) than the group that didn't have a fever higher than or equal to 37.5˚C. There is possibility that a child brought the influenza virus into the house. ACIP[1] has recommended that health-care workers take vaccination against seasonal influenza. It is thought that prevention in the whole family is important.

Certain limitations in the present study should be disclosed. First, the present study may have had a selection bias because the response rate was 54.2%. Second, the number of subjects was insufficient. Third, there was the possibility of misclassifications in the present study because the judgment of influenza was taken via a self-report, although we confined it to physician's diagnosed ILI.

In conclusion, a population based cohort study was conducted during the 06/07 influenza season to examine the effectiveness of an influenza vaccine among 541 community-dwelling elderly, ranging from 65 to 74 years. After adjusting for confounders, the vaccination decreased acute fevers higher than or equal to 37.5˚C (HR =0.42, 95% CI=(0.20, 0.90)) during the epidemic period. Therefore influenza vaccinations may be decreased acute fevers during influenza epidemic periods in community-dwelling elderly.

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2006-07 シーズンでの地域居住高齢者における急性発熱疾患に対するインフルエンザワクチンの効果：日本におけるコホート研究

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背景：毎年のワクチン接種は，療養所などの入所者と同様に，医学的高リスク集団に対し推奨されている．しかしながら，地域居住高齢者におけるインフルエンザワクチン効果についてはほとんど分かっていない．

方法：地域居住高齢者におけるインフルエンザワクチン効果を調べることを目的とし，2006-2007 年（06/07）のインフルエンザ流行期にコホート研究を行った．2006 年 9 月に札幌市住民基本台帳から 65 ～ 74 才の地域居住高齢者 1,000 人を無作為に選出した．ベースライン調査は 2006 年 10 月，11 月に行われ，542 人（54.2%）が研究参加に同意をした．追跡開始前に 1 人死亡したため除外し，541 人を解析対象者とした．2006 年 12 月から 2007 年 4 月まで毎月（計 5 回）電話による追跡調査を行い，発熱，入院などの発生について尋ねた．カイ二乗検定，Mann-Whitney の U 検定でワクチン接種群と非接種群の比較を行い，Cox の比例ハザードモデルを用い交絡要因を調節した Hazard Ratio（HR）を算出した．

結果：補正後，ワクチン接種群は非接種群に比べて 2006 年 12 月から 2007 年 4 月までの間の 37.5 度以上の発熱（HR = 0.42，95%信頼区間 =（0.29，5.37））においてリスクが低下した．しかしながら，インフルエンザ様疾患とは関係が無かった（HR = 1.25，95% CI =（0.29，5.37））．

まとめ：インフルエンザワクチン接種は，地域居住高齢者に対しインフルエンザ流行期の発熱を減少させることが示唆された．