J Infect Chemother xxx (2017) 1–4

Contents lists available at ScienceDirect

Journal of Infection and Chemotherapy

journal homepage: http://www.elsevier.com/locate/jic

Original Article

Individual background factors associated with vaccination for seasonal influenza in Japanese schoolchildren

Mitsuo Uchida

Center for Health, Safety and Environment Management, Shinshu University, 3-1-1 Asahi, Matsumoto, Nagano 390-8621, Japan

ARTICLE INFO

Article history:
Received 13 June 2017
Received in revised form
25 August 2017
Accepted 28 August 2017
Available online xxx

Keywords:
Influenza
Schoolchildren
Vaccine
Epidemiology
Background factor

ABSTRACT

There is little evidence about how individual background factors affect seasonal influenza vaccination of children. At the end of the 2014/2015 influenza season, a cross-sectional questionnaire survey of all elementary schoolchildren in 29 schools in Matsumoto City, Japan, was conducted to obtain information about vaccine uptake activity and individual background factors. Of the 10,524 subjects who responded, 5063 (48.1%) had been vaccinated. Grade in school, underlying disease, number of siblings, and diagnosis with and vaccination for influenza during the previous influenza season differed significantly in vaccinated and unvaccinated groups. Multivariate logistic regression showed that underlying disease and vaccination during the previous influenza season was associated with a higher rate of vaccination, whereas higher grade in school and having ≥3 siblings was associated with a lower rate of vaccination. The findings may be useful to promote a vaccination policy recommending financial support to households with many children or to encourage higher uptake of vaccination in higher grade children.

1. Introduction

Vaccination is the most important method of preventing seasonal influenza transmission among people, and both the World Health Organization (WHO) [1] and Centers of Disease Control and Prevention (CDC) [2] have recommended that people be vaccinated yearly. Influenza vaccination, especially of children, can help prevent seasonal influenza epidemics in the community [3,4]. However, seasonal influenza vaccination does not completely reduce the risk of illness, with vaccine effectiveness reported to range from 10 to 60% [5]. Thus, influenza vaccination differs from vaccination that can induce permanent immunity. Other issues associated with seasonal influenza vaccination include its cost and vaccine coverage ability, especially in children [6]. Thus, methods are needed to both enhance the effectiveness of vaccination and to increase vaccine coverage in the population.

Vaccination of adults has been associated with various individual factors. For example, in general populations vaccination coverage is associated with age and having chronic diseases [7]. In medical workers, age [8] and correct knowledge about vaccines [9] are associated with vaccination rates. Household income and number of children are also associated with attitudes toward vaccination [10]. In contrast to adults, who make their own decisions about vaccination, vaccination of children depends on decisions by their guardians and may be affected by other factors. A web-based survey showed that vaccination in children was associated with household income and recommendations by a nurse [11]; however, these results were limited because of the low sample number, possible selection bias or interpreted in only household unit. Therefore, further research is necessary to determine individual background factors associated with the vaccination of children in large, community-based populations. Clarification of these factors may help in formulating policy regarding vaccination.

The author previously conducted an observational epidemiological study to determine time dependent epidemic changes and vaccine effectiveness among schoolchildren in an entire city [12,13]. The author found that about half of these schoolchildren had been vaccinated, but the author did not determine individual factors related to vaccination. In the present study, the author further evaluated these cross-sectional epidemiological data to determine individual background factors associated with vaccination of these schoolchildren.

E-mail address: uchida01@shinshu-u.ac.jp.

http://dx.doi.org/10.1016/j.jiac.2017.08.015
1341-321X/

2. Materials and methods

2.1. Study subjects

The population and methods of our previous observational epidemiological study evaluating seasonal influenza prevalence in elementary schoolchildren during the 2014/2015 season have been described [12,13]. This study evaluated the individual background factors associated with vaccination. Briefly, a questionnaire was distributed by school nurses to all 13,217 elementary schoolchildren attending 29 public schools in Matsumoto City, Nagano, Japan, at the end of February 2015. The parents/guardians of these schoolchildren were asked to complete the questionnaires. Responses were obtained from parents/guardians of 11,390 (86.2%) of these children. After excluding questionnaires with missing data, responses from parents/guardians of 10,524 (79.6%) children were analyzed.

2.2. Ethics statement

The study was reviewed and approved by the Medical Ethics Board of Shinshu University School of Medicine (approval number 2715). Because this study was performed anonymously and questionnaires were returned voluntarily, informed consent was not obtained from study subjects.

2.3. Individual background factors and vaccine information

In this study, the answers to the questionnaire [13] were reviewed to evaluate individual factors associated with vaccination. Individual factors recorded included vaccination during the 2014/2015 influenza season (yes/no); grade of the child in school (description); sex (male/female), having underlying disease, including cardiovascular disease, pulmonary disease, kidney disease, liver disease, nerve disease, muscle disease, blood disease and diabetes (yes/no); number of siblings (description), seasonal influenza diagnosis during the previous influenza season (yes/no), and vaccination during the previous season (yes/no). Because the ages of elementary schoolchildren in Japan correspond with grades 1–6 (Must be already 6 years old at the start of their first school year, April through March. Grades thus include ages 6–7, 7–8, 8–9, 9–10, 10–11 and 11–12 years), grade was evaluated instead of age.

The study investigate uptake of vaccination during the 2014/2015 influenza season. In this year, three strains of inactivated vaccine were used for all of vaccination; A/California/7/2009(H1N1) pdm09, A/New York/39/2012(H3N2) and B/Massachusetts/2/2012 according to National Institute of Infectious Diseases of Japan [14].

2.4. Statistical analyses

Category variables were compared in the vaccinated and unvaccinated groups by Chi square tests. Univariate and multivariate logistic regression analyses were used to estimate odds ratios (ORs) and 95% confidence intervals (CIs). Multi-collinearity was evaluated by Spearman's test, which showed absence of multi-collinearity among all variables (ρ (rho) < 0.3). All statistical analyses were performed using SPSS ver 22.0 (CA, USA).

3. Results

Of the 10,524 subjects, 5063 (48.1%) had been vaccinated and 5461 (51.9%) had not. Grade in school, underlying disease, number of siblings, diagnosis with influenza during the previous season and vaccination during the previous season differed significantly in these two groups. Vaccination was more frequent in children in lower than in upper grades, in children with underlying diseases, in those with fewer siblings, in children who were not diagnosed during the previous influenza season, and in children who were vaccinated during the previous influenza season (Table 1).

Multivariate logistic regression analysis showed that grade in school, underlying disease, number of siblings and vaccination during previous season remained significant independent factors associated with vaccination during the 2014/2015 influenza season. Vaccination rate was significantly lower in children in grade 5 than in grade 1 (reference) and in those with ≥3 siblings than with 1 sibling, but was significantly higher in children with than without underlying disease and in those who were than were not vaccinated during the previous season (Table 2). Among individual factors, vaccination during the previous season showed the strongest association with vaccination during 2014/2015 (OR 48.27, 95% CI 42.89–54.31).

4. Discussion

The author assessed the epidemiological data in an observational study of all children attending public schools in Matsumoto City, Japan, during the 2014/2015 influenza season. The survey revealed the proportion of children vaccinated was low at below 50%. This low proportion might be associated with household economic factors [11]. To explore associations between vaccine uptake and background factors at an individual level, a further study was planned. Finally, the author found that vaccination during that season was associated with grade in school, having underlying disease, number of siblings and vaccination during the previous season. The strength of this study was its being a complete survey of one Japanese city, enabling large samples to be analyzed. By assessing all schoolchildren, the author believes that sampling bias was reduced as much as possible.

ORs of vaccination tended to decrease in higher grade children. Relative to children in first grade, the lowest OR was

Table 1
Characteristics of background factors in schoolchildren vaccinated and unvaccinated for seasonal influenza.

Factors	Vaccinated (%)	Unvaccinated (%)	*P*-value#
	5063 (48.1)	5461 (51.9)	
Sex			0.80
Male	2578 (48.0)	2794 (52.0)	
Female	2485 (48.2)	2667 (51.8)	
Grade			<0.01
1	995 (54.0)	849 (46.0)	
2	910 (50.7)	885 (49.3)	
3	866 (49.3)	890 (50.7)	
4	818 (47.2)	916 (52.8)	
5	742 (43.9)	950 (56.1)	
6	732 (43.0)	971 (57.0)	
Underlying diseases			<0.01
Yes	687 (61.6)	429 (38.4)	
No	4376 (46.5)	5032 (53.5)	
Siblings			<0.01
1	811 (51.2)	773 (48.8)	
2	2915 (51.4)	2758 (48.6)	
3	1193 (42.7)	1604 (57.3)	
≥4	144 (30.6)	326 (69.4)	
Diagnosed in previous season			0.049
Yes	1569 (46.7)	1790 (53.3)	
No	3494 (48.8)	3671 (51.2)	
Vaccination in previous season			<0.01
Yes	4549 (84.6)	825 (15.4)	
No	514 (10.0)	4636 (90.0)	

#Chi-square test.

Please cite this article in press as: Uchida M, Individual background factors associated with vaccination for seasonal influenza in Japanese schoolchildren, J Infect Chemother (2017), http://dx.doi.org/10.1016/j.jiac.2017.08.015

Table 2
Association between vaccination and individual background factors of schoolchildren.

Factors	Univariate logistic model			Multivariate logistic model		
	Odds ratio	95%CI low	95%CI high	Odds ratio	95%CI low	95%CI high
Sex						
Male	Ref			Ref		
Female	0.99	0.92	1.07	0.97	0.86	1.09
Grade						
1	Ref			Ref		
2	0.88†	0.77	1.00	0.97	0.80	1.18
3	0.83‡	0.73	0.95	1.02	0.84	1.24
4	0.76‡	0.67	0.87	0.89	0.73	1.08
5	0.67‡	0.58	0.76	0.81†	0.66	0.99
6	0.64‡	0.56	0.73	0.86	0.70	1.05
Underlying diseases						
No	Ref			Ref		
Yes	1.84‡	1.62	2.09	1.43‡	1.18	1.72
Siblings						
1	Ref			Ref		
2	1.01	0.90	1.13	1.00	0.84	1.18
3	0.71‡	0.63	0.80	0.76‡	0.63	0.92
≥4	0.42‡	0.34	0.52	0.67‡	0.48	0.92
Diagnosed in previous season						
No	Ref			Ref		
Yes	0.92†	0.85	1.00	0.90	0.79	1.02
Vaccination in previous season						
No	Ref			Ref		
Yes	49.73‡	44.22	55.93	48.27‡	42.89	54.31

†$P < 0.05$, ‡$P < 0.01$.

observed in fifth grade children. The national influenza statistics report from the Ministry of Health, Labour and Welfare of Japan has reported that the yearly medical examination rates for influenza are higher in children aged 5–9 years (including children in grades 1–3) than in children aged 10–14 years (including children in grades 4–6) [15]. That report suggested that the numbers of symptomatic schoolchildren and those going to a clinic or hospital decreased with increasing grade. An age factor may affect attitude toward vaccination and explain the difference in vaccination rate between higher grade and lower grade schoolchildren.

The OR for vaccination was higher in subjects with than without underlying disease. Government policy mandated that subjects with a higher risk of influenza infection had a priority of vaccination during the 2009 influenza A (H1N1) pandemic [16]. Vaccination rates during the 2009/2010 season were higher in adults with than without underlying disease in Japan [17]. Vaccination rates have also been shown higher in high risk group adults [7]. Thus, higher influenza vaccination rates in adult populations with some chronic diseases may be a general phenomenon. The author could confirm similar results that children at higher risk of influenza infection had a higher OR of vaccination during the 2014/2015 season.

The author also found that schoolchildren with three or more siblings had a significantly lower OR for vaccination. An individual vaccination in Japan costs around ¥ 3000 ($ 27) [18], increasing the costs for households with many children. Higher income level has been associated with higher vaccination rates [10,11], suggesting that the cost of vaccination is associated with the rate of vaccination. Because our survey did not include questions about household income level, the author could not determine the relationship between vaccination rate and household income. However, these findings suggest that vaccination policy should consider costs of vaccination [19]. Official cost support for households with many children may increase vaccination rates.

A web-based survey in Japan reported that habitual vaccination is strongly predictive of individual vaccinations [10,11]. Our community-based observational study also showed a similar tendency, that yearly vaccination for influenza was associated with vaccination during the 2014/2015 influenza season. On the other hand, diagnosed in the previous year was not associated with vaccination in the current year. This disparity may indicate that guardians who practice habitual vaccination probably believe vaccine is effective [7] regardless of whether or not their children were diagnosed with influenza in the previous year. In other words, habitual vaccination behavior may be a stronger decision factor, when considering vaccination, than past influenza diagnosis. Specifically targeting subjects with no habit of vaccination may therefore increase vaccine coverage in a population. In addition, the amounts of vaccine prepared or stored should be based on use during the previous year, to avoid insufficiency or overstock during the next year.

This study had several limitations. First, as noted above, the income level of households was not included in the questionnaire although this factor may be important in interpreting the decision to vaccinate children. Second, recall bias could not be ruled out fully because of the nature of the questionnaire. However, because this questionnaire addressed recent experiences, possible bias may have been relatively controlled. Third, the results of this study may not be generalizable to countries in which habits and customs differ from those in Japan. School and vaccination systems may have especially affected the result of this study.

5. Conclusions

The association between individual background factors and vaccination during the 2014/2015 influenza season was evaluated among all elementary schoolchildren in Matsumoto City, Japan using an observational epidemiological study method. Vaccination rates were associated with grade in school, the presence of underlying disease, number of siblings and vaccination during the previous influenza. These findings provide further evidence that vaccination of schoolchildren was associated with their individual background factors. The findings may be useful to promote a vaccination policy recommending financial support to households with many children or to encourage higher uptake of vaccination in

Please cite this article in press as: Uchida M, Individual background factors associated with vaccination for seasonal influenza in Japanese schoolchildren, J Infect Chemother (2017), http://dx.doi.org/10.1016/j.jiac.2017.08.015

higher grade children, and the policy may increase vaccination uptake.

Authorship statement

The author meets the ICMJE authorship criteria.

Conflicts of interest

None.

Acknowledgments

The author thanks Dr. Shigeyuki Kawa, Dr. Minoru Kaneko, Tomoko Fujimura, Hiroko Hayashi, Naomi Yuzawa, Kiyomi Tanaka, Yoko Watanabe, Kazuki Nagai, Kyoko Inuura, and Yoshinobu Shinkai of the Center for Health, Safety and Environmental Management for their assistance in the collection and analysis of data. This work was supported by JSPS KAKENHI [Grant Number JP26860413, JP16K09052].

References

[1] WHO. Influenza (seasonal). 2014. http://www.who.int/mediacentre/factsheets/fs211/en/. [Accessed 1 April 2017].
[2] CDC. Advisory committee on immunization practices (ACIP). 2016. http://www.cdc.gov/vaccines/acip/. [Accessed 1 April 2017].
[3] Reichert TA, Sugaya N, Fedson DS, Glezen WP, Simonsen L, Tashiro M. The Japanese experience with vaccinating schoolchildren against influenza. N Engl J Med 2001;344:889–96.
[4] Loeb M, Russell ML, Moss L, Fonseca K, Fox J, Earn DJ, et al. Effect of influenza vaccination of children on infection rates in hutterite communities: a randomized trial. JAMA 2010;303:943–50.
[5] CDC. Vaccine effectiveness – how well does the flu vaccine work?. 2016. http://www.cdc.gov/flu/about/qa/vaccineeffect.htm. [Accessed 1 April 2017].
[6] Ahout I, Ferwerda G, de Groot R. Influenza vaccination in kids, are you kidding me? J Infect 2014;68(Suppl. 1):S100–7.
[7] Ciblak MA, Grip P. Influenza vaccination in Turkey: prevalence of risk groups, current vaccination status, factors influencing vaccine uptake and steps taken to increase vaccination rate. Vaccine 2013;31:518–23.
[8] Alhammadi A, Khalifa M, Abdulrahman H, Almuslemani E, Alhothi A, Janahi M. Attitudes and perceptions among the pediatric health care providers toward influenza vaccination in Qatar: a cross-sectional study. Vaccine 2015;33:3821–8.
[9] Costantino C, Amodio E, Calamusa G, Vitale F, Mazzucco W. Could university training and a proactive attitude of coworkers be associated with influenza vaccination compliance? A multicentre survey among Italian medical residents. BMC Med Educ 2016;16:38.
[10] Wada K, Smith DR. Influenza vaccination uptake among the working age population of Japan: results from a national cross-sectional survey. PLoS One 2013;8, e59272.
[11] Shono A, Kondo M. Factors associated with seasonal influenza vaccine uptake among children in Japan. BMC Infect Dis 2015;15:72.
[12] Uchida M, Kaneko M, Hidaka Y, Yamamoto H, Honda T, Takeuchi S, et al. Prospective epidemiological evaluation of seasonal influenza in all elementary schoolchildren in Matsumoto City, Japan, in 2014/2015. Jpn J Infect Dis 2017;70:333–9.
[13] Uchida M, Kaneko M, Hidaka Y, Yamamoto H, Honda T, Takeuchi S, et al. Effectiveness of vaccination and wearing masks on seasonal influenza in Matsumoto City, Japan, in the 2014/2015 season: an observational study among all elementary schoolchildren. Prev Med Rep 2017;5:86–91.
[14] National Institute of Infectious Diseases of Japan. A report of seasonal influenza in 2014/15. 2015. http://www.nih.go.jp/niid/images/idsc/disease/influ/fludoco1415.pdf. [Accessed 1 April 2017].
[15] Ministry of Health Labour and Welfare. An official report of seasonal influenza. 2015. http://www.mhlw.go.jp/bunya/kenkou/kekkaku-kansenshou01/dl/fludoco1415.pdf. [Accessed 1 April 2017].
[16] Ministry of Health Labour and Welfare. Vaccination for having basement diseases. 2009. http://www.mhlw.go.jp/kinkyu/kenkou/influenza/dl/infu091028-02.pdf. [Accessed 1 April 2017].
[17] Yi S, Nonaka D, Nomoto M, Kobayashi J, Mizoue T. Predictors of the uptake of A (H1N1) influenza vaccine: findings from a population-based longitudinal study in Tokyo. PLoS One 2011;6, e18893.
[18] QLife. A survey of seasonal influenza vaccination cost. 2016. https://www.qlife.jp/square/hospital/story875.html. [Accessed 1 April 2017].
[19] Armstrong K, Berlin M, Schwartz JS, Propert K, Ubel PA. Barriers to influenza immunization in a low-income urban population. Am J Prev Med 2001;20:21–5.

Please cite this article in press as: Uchida M, Individual background factors associated with vaccination for seasonal influenza in Japanese schoolchildren, J Infect Chemother (2017), http://dx.doi.org/10.1016/j.jiac.2017.08.015