

Influencing Factors for Influenza Vaccination among South Korean Adolescents with Asthma Based on a Nationwide Cross-Sectional Study

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Keywords

Adolescent · Asthma · Influenza · Korean Youth Risk Behavior Web-Based Survey · Vaccination

Abstract

Background: Influenza viral infection is a major public health problem with significant morbidity and mortality. Asthma is a risk factor for developing serious complications related to influenza infection. **Objective:** We explored factors associated with influenza vaccination coverage among adolescents with asthma. **Methods:** Data were obtained from 62,276 participants in the 13th Korean Youth Risk Behavior Web-Based Survey (KYRBS) conducted in 2017. KYRBS data were obtained from a stratified, multistage, clustered sample. We used multiple logistic regression analyses to identify variables potentially related to influenza vaccination in adolescents with asthma. **Results:** The proportion of asthma was 8.8%, and the influenza vaccination rate overall was 37.9%. It was 41.8% in the asthma group and 37.5% in the nonasthma group ($p < 0.001$). After regression, male sex (odds ratio (OR) = 1.45; 95% CI 1.35–1.55), a high socioeconomic status (OR = 1.12; 95% CI 1.05–1.19), residence at an orphanage (OR = 1.93; 95% CI 1.38–2.29), regular breakfast consumption (OR = 1.09; 95% CI 1.02–1.17), and subjective good health (OR = 2.39; 95% CI 1.69–3.39) were associated with increased

influenza vaccination, whereas current smoking (OR = 0.87; 95% CI 0.67–0.96) and a depressive mood (OR = 0.77; 95% CI 0.64–0.95) were inversely associated in adolescents with asthma. **Conclusion:** It is important to improve influenza vaccination in adolescents with asthma, especially females, those with a low socioeconomic status, independent residents, breakfast skippers, current smokers, and those who consider themselves unhealthy and have depressive moods.

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Introduction

Influenza is a communicable disease that occurs on an annual basis due to its viral characteristics, including constant changes to the influenza virus genome [1]. Although influenza is a vaccine-preventable infection, and an annually updated vaccination is provided, influenza viral infection is a major public health problem with significant morbidity and mortality [1, 2]. Most of the mortality related to influenza occurs in high-risk populations and those with preexisting comorbidities and chronic diseases.

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es [1, 2]. According to the World Health Organization (WHO), influenza epidemics cause approximately 1 million influenza-associated hospitalizations among children younger than 5 years annually, result in 250,000–650,000 deaths among all age groups, and induce 3–5 million cases of severe illness per year, with the majority occurring in high-risk populations and low- and middle-income countries [2–5]. Among several high-risk groups, asthma is a considerable risk factor for the development of serious complications related to influenza infection (i.e., pneumonia and acute respiratory failure) [6, 7]. Considering that the overall prevalence of asthma in all children younger than 18 years in Korea from 2010 to 2014 was 14.3% [8], influenza outbreak in these groups can cause significant problems not only for personal but also for public health. Influenza infection makes children with asthma more susceptible to bronchoconstriction, precipitates acute exacerbation of bronchial obstruction, induces exacerbations of asthma, and further increases bronchial responsiveness and deleteriously affects lung function [9]. Bronchial obstruction then rapidly deteriorates, especially during the first 2 days of illness, and may require at least 7 days for recovery [9].

The influenza vaccine is considered safe for administration to persons with asthma, and vaccination has been recommended since 1964 in the USA [10]. The effectiveness of vaccination in preventing influenza is 70–90%, and vaccination reduces morbidity in patients with asthma when the strains included in the vaccine match the strains in circulation [3, 10]. Therefore, influenza vaccination is widely and strongly recommended in high-risk individuals [2, 3, 11]. In South Korea (Republic of Korea), influenza vaccination has been made free of charge for individuals from 6 months to 12 years of age and adults over 65 years of age since October 12, 2018, by government financial support; however, the actual vaccination rate among children was lower than that for adults during that free vaccination period (60.6 vs. 80.6%) [12]. Influenza vaccination is also recommended for adolescents, but financial support is not yet offered to encourage vaccination uptake in Korea. We presume that adolescents have considerably lower influenza vaccination rates than those getting free vaccination, and this has led to significant public health concerns. Although several studies have analyzed factors associated with influenza vaccination among adults with asthma [1, 13, 14], there have been few reports of vaccination rates and associated factors among adolescents with asthma [15, 16]. We hypothesized that adolescents with asthma are more likely to get influenza vaccination than adolescents without asthma

for the purpose of controlling their disease and preventing complications due to influenza infection. It is important to determine the influencing factors for vaccination to increase the overall coverage of influenza vaccination among adolescents with asthma, who are included in groups at a high risk of developing influenza-related complications. This study had 3 aims. First, we investigated influenza vaccination rates, clinical characteristics, dietary and problem behaviors, and the mental health status of adolescents using a large volume of national survey data. Second, we compared these in adolescents with and without asthma, especially regarding influenza vaccination. Third, we identified the influencing factors associated with the influenza vaccination coverage in adolescents with asthma, which was our main purpose. Our results can be used to reveal the influenza vaccination rate in adolescents with asthma in Korea and to determine high-risk groups that should be targeted for increased vaccination uptake.

Materials and Methods

Study Design and Groups

The Korean Youth Risk Behavior Web-Based Survey (KYRBS) was initiated by the Korean Ministry of Education, the Ministry of Health and Welfare, and the Korean Centers for Disease Control and Prevention (KCDC) in 2005. The purpose of the KYRBS is to assess annually numerous health-risk behaviors among youths in Korea, and it comprises 15 sections (i.e., socioeconomic status [SES], diet, physical activity, obesity and weight control, mental health, oral health, personal hygiene, injuries and safety awareness, violence, drinking, smoking, sexual behavior, drug use, atopy and asthma, and internet addiction). The 13th KYRBS is a cross-sectional, 123-question online survey conducted in a nationally representative sample of Korean adolescents aged 13–18 years from April to August 2017. A complex sample design, which included multistage sampling, stratification, and clustering, was used to obtain a nationally representative sample; the participants are stratified into multistage clustered samples in 129 population strata derived from 43 area clusters (metropolitan areas, medium or small cities, or rural areas) representing about 3,000,000 middle and high school students. Subsequently, the number of sample schools in each region was determined according to the composition of the target population. For the analysis herein, allocated target schools were systematically selected as 800 samples (400 middle schools and 400 high schools). Then, in each selected school, sample classes at each grade level were also selected randomly using stratified cluster extraction with systematic sampling. All of the participants had provided written informed consent (both directly and from their parents or legal guardians) for approval for getting access to the survey. Students participated in the KYRBS voluntarily and completed the self-reported web-based survey at a school computer laboratory under the principle of anonymity to keep privacy information out. After the process was sufficiently explained by teachers, completion of the survey required 45–50 min, as deter-

Table 1. General characteristics, dietary habits, and oral health behavior of the study subjects

	Asthma		<i>p</i> value		Asthma		<i>p</i> value
	no (<i>n</i> = 56,854)	yes (<i>n</i> = 5,422)			no (<i>n</i> = 56,854)	yes (<i>n</i> = 5,422)	
Sex			<0.001	Subjective health			<0.001
Female	28,290 (48.48)	2,362 (41.99)		Very healthy	16,235 (28.24)	1,159 (21.52)	
Male	28,564 (51.52)	3,060 (58.01)		A little healthy	25,255 (44.39)	2,264 (41.86)	
Grade			0.003	Average	12,009 (21.29)	1,408 (25.83)	
Middle school				A little unhealthy	3,124 (5.65)	537 (9.82)	
1st grade	9,396 (14.97)	793 (13.35)		Very unhealthy	231 (0.43)	54 (0.96)	
2nd grade	9,429 (15.30)	948 (16.18)		Subjective happiness			<0.001
3rd grade	9,386 (14.97)	933 (16.07)		Very happy	17,076 (29.34)	1,497 (27.10)	
High school				A little happy	21,556 (38.07)	2,008 (36.95)	
1st grade	9,240 (17.07)	925 (17.59)		Average	13,981 (25.03)	1,328 (25.19)	
2nd grade	9,840 (18.94)	960 (19.50)		A little unhappy	3,577 (6.34)	464 (8.44)	
3rd grade	9,563 (18.75)	863 (17.31)		Very unhappy	664 (1.22)	125 (2.33)	
Grade			0.674	Perceived stress			<0.001
Middle school	28,211 (45.23)	2,674 (45.60)		Very much	5,755 (9.98)	753 (13.60)	
High school	28,643 (54.77)	2,748 (54.40)		Much	15,211 (26.72)	1,540 (28.56)	
Subjective economic status			<0.001	A little	24,103 (42.86)	2,168 (39.85)	
High	22,585 (40.24)	2,217 (41.82)		Not much	9,469 (16.44)	760 (14.15)	
Middle	26,237 (45.85)	2,345 (42.69)		Not at all	2,316 (4.00)	201 (3.84)	
Low	8,032 (13.91)	860 (15.49)		Sleep satisfaction			<0.001
Academic achievement			0.453	Plenty	4,678 (7.90)	445 (7.85)	
High	22,333 (39.09)	2,191 (40.03)		Enough	10,143 (17.35)	882 (16.03)	
Middle	16,279 (28.73)	1,531 (28.48)		A little	18,418 (32.43)	1,634 (30.19)	
Low	18,242 (32.18)	1,700 (31.48)		Not enough	15,891 (28.33)	1,535 (28.61)	
Residence type			<0.001	Not enough at all	7,724 (13.99)	926 (17.33)	
With parents	54,051 (95.46)	5,111 (95.11)		Depression			<0.001
With relatives	440 (0.76)	56 (0.85)		No	42,876 (75.36)	3,788 (70.14)	
Dormitory	2,101 (3.37)	200 (3.11)		Yes	13,978 (24.64)	1,634 (29.86)	
Orphanage	262 (0.41)	55 (0.93)		Suicidal ideation			<0.001
Breakfast consumption			0.001	No	50,130 (88.23)	4,562 (84.48)	
<2 times/week	13,424 (23.58)	1,382 (25.73)		Yes	6,724 (11.77)	860 (15.52)	
≥2 times/week	43,430 (76.42)	4,040 (74.27)		Suicidal attempts			<0.001
Current drinking			0.012	No	55,438 (97.54)	5,204 (96.12)	
No	48,169 (84.07)	4,510 (82.52)		Yes	1,416 (2.46)	218 (3.88)	
Yes	8,685 (15.93)	912 (17.48)		Influenza vaccination			<0.001
Current smoking			<0.001	No	34,934 (62.53)	3,101 (58.21)	
No	53,519 (93.77)	4,988 (91.94)		Yes	21,918 (37.47)	2,321 (41.79)	
Yes	3,335 (6.23)	434 (8.06)					

Values are presented as numbers (%). Demographic characteristics were calculated by descriptive statistics such as weighted percentages.

mined by assessing the website using students' randomly assigned identification numbers. In the present study, we used documents publicly available from the 13th KYRBS published in 2018. Survey participation excluded age-eligible respondents with absenteeism (absence without permission), those with special educational needs (e.g., development disabilities), and those with dyslexia. The reasons for nonparticipation were not available, but among the 64,991 targeted participants, a total of 62,276 students at 799

schools were included in the analysis, and participants could not skip to the next question without providing a proper answer because the online system did not accept a nonresponse.

Evaluation Indices

Allergic Diseases

The diagnosis of asthma was evaluated based on an answer of "yes" to the following question: "Have you ever been diagnosed with

asthma by a doctor at any point in your life or within recent 12 months?" The severity of the disease, current symptoms, the presence of management, and the treatment modality were not assessed.

Socioeconomic and Demographic Characteristics

We evaluated information on the following socioeconomic characteristics: age, sex, school grade (middle, high), residential type, family structure, SES, and academic achievements. The type of residence was assessed as living with family, with relatives, independently such as in a dormitory, or in an orphanage. SES and academic achievement were assessed by the following question: "During the past 12 months, how would you rate your family's SES and your academic performance?" Responses to questions about SES and academic achievement were divided into the following 5 categories: high, middle-high, middle, middle-low, and low. However, we categorized it as high (high or middle-high), middle (middle), or low (middle-low or low).

Dietary Behaviors and Smoking and Drinking Statuses

The frequency of breakfast consumption was assessed with the question: "During the past 7 days, how many days did you eat breakfast?" Those who indicated that they ate breakfast fewer than 2 days per week were defined as "breakfast skippers." Smoking status was assessed by the question: "Have you ever smoked cigarettes, even once?" If the answer was "yes," then the follow-up question was: "How many days did you smoke even one cigarette during the last month before survey?" Those who responded "more than one day" were defined as current smokers. Alcohol consumption status was determined by the question: "Have you ever consumed alcohol, even once?" If the answer were "yes" the following question was asked: "How many days did you drink at least one shot glass of alcohol during the last month before the survey?" Those who responded "more than one day" were classified as current drinkers.

Emotional States

Subjective health was assessed with the question: "What do you think about your health state?" and the answers were scored on a 5-point scale (1, very healthy; 2, healthy; 3, average; 4, a little unhealthy; and 5, very unhealthy). Perceived happiness was assessed with the question: "How do you rate your happiness?" and the answers were scored on a 5-point scale (1, very happy; 2, a little happy; 3, average; 4, a little unhappy; and 5, very unhappy). The degree of sleep satisfaction was assessed by the question: "Did you feel refreshed after sleeping during the last week?" The 5-point scale comprised the following 5 categories: well enough, enough, so-so, not enough, and never enough. Perceived stress status was assessed with the question: "How often do you feel stress?" using a 5-point scale (1, very much; 2, much; 3, a little; 4, not much; and 5, not at all). The Center for Epidemiologic Studies Depression Scale (CES-D) is most commonly used to screen for or assess levels of depression [17]. Due to the study design, however, experience with a depressive mood was defined as a participant reporting feelings of sadness or desperation to any degree that caused cessation of their usual activities almost every day for 2 weeks or longer within the most recent 12 months preceding the survey.

Statistical Analysis

We conducted all statistical analyses using complex sample procedures in the Statistical Package for the Social Sciences (SPSS)

software program (version 21.0; SPSS Inc., Chicago, IL, USA) and survey data were weighed for statistical representation of the general population based on the sample design. The χ^2 test for categorical variables and an independent t test for continuous variables were used where appropriate to compare general characteristics between subjects with asthma and without asthma. Following the selection of significant covariates, we performed logistic regression analysis to identify the associated influencing factors for influenza vaccination coverage in adolescents with asthma. Odds ratio (OR), adjusted OR, and 95% CI were obtained. For all analyses, $p < 0.05$ was considered statistically significant.

Results

Clinical Characteristics, Dietary Behaviors and Emotional State in the Asthma and Nonasthma Groups

Table 1 shows the general characteristics of the study participants. Among the 62,276 participants, the proportion of asthma cases was 8.8%, and the influenza vaccination rate of overall was 37.9%. The difference in vaccination rates between asthmatics and nonasthmatics was relatively small (41.8 vs. 37.5%); however, this difference was statistically significance ($p < 0.001$). Table 1 also presents the clinical differences between subjects with asthma and without asthma. Compared to participants without asthma, among those with asthma there was a higher proportions of those who skipped breakfast and currently drank and smoked. All mental health variables were statistically significant. Among subjects with asthma there was a higher proportion of subjects who perceived themselves as unhealthier and unhappier, felt more stress, were unsatisfied with sleep, and had more frequent depressive mood than subjects without asthma.

General Characteristics, Dietary Habits, and Mental Health States of Asthma and Nonasthma Groups According to Vaccination

Among both asthma and nonasthma subjects, the influenza vaccination coverage was higher in those of middle school age, those with a higher SES and academic achievement, and those who did not drink alcohol, currently smoked, perceived themselves as healthy and happy, and had sleep satisfaction (Table 2).

Comparisons between the Asthma and Nonasthma Groups According to Influenza Vaccination

In the vaccinated groups, among the subjects with asthma there was a higher proportion of males, subjects in the 2nd grade of middle school, those who lived in an

Table 2. General characteristics, dietary habits, and oral health behavior of the asthma and nonasthma groups according to vaccination

	Asthma					
	no (<i>n</i> = 56,854)			yes (<i>n</i> = 5,422)		
	inoculation			inoculation		
	no (<i>n</i> = 34,934)	yes (<i>n</i> = 21,918)	<i>p</i> value	no (<i>n</i> = 3,101)	yes (<i>n</i> = 2,321)	<i>p</i> value
Sex			0.027			0.082
Female	17,159 (47.72)	11,130 (49.73)		1,332 (40.75)	1,030 (43.71)	
Male	17,775 (52.28)	10,788 (50.27)		1,769 (59.25)	1,291 (56.29)	
Grade			<0.001			<0.001
Middle school						
1st grade	3,785 (9.69)	5,610 (23.77)		283 (8.29)	510 (20.40)	
2nd grade	4,420 (11.39)	5,008 (21.81)		369 (11.45)	552 (22.76)	
3rd grade	5,826 (14.86)	3,560 (15.14)		543 (16.01)	390 (16.16)	
High school						
1st grade	6,307 (18.75)	2,933 (14.28)		575 (19.12)	350 (15.47)	
2nd grade	7,312 (22.52)	2,528 (12.98)		663 (23.04)	297 (14.55)	
3rd grade	7,284 (22.78)	2,279 (12.02)		641 (22.09)	222 (10.65)	
Grade			<0.001			<0.001
Middle school	14,031 (35.95)	14,178 (60.72)		1,222 (35.75)	1,452 (59.32)	
High school	20,903 (64.05)	7,740 (39.28)		1,879 (64.25)	869 (40.68)	
Subjective economic status			<0.001			<0.001
High	12,519 (36.29)	10,064 (46.81)		1,141 (37.94)	1,076 (47.22)	
Middle	16,698 (47.57)	9,539 (42.98)		1,374 (43.33)	971 (41.81)	
Low	5,717 (16.13)	2,315 (10.21)		586 (18.73)	274 (10.97)	
Academic achievement			<0.001			<0.001
High	12,932 (36.69)	9,400 (43.08)		1,170 (37.24)	1,021 (43.93)	
Middle	10,040 (28.89)	6,238 (28.46)		875 (28.40)	656 (28.61)	
Low	11,962 (34.41)	6,280 (28.45)		1,056 (34.37)	644 (27.47)	
Residence type			<0.001			0.239
With parents	33,091 (95.12)	20,958 (96.01)		2,908 (94.73)	2,203 (95.64)	
With relatives	287 (0.80)	153 (0.69)		34 (0.87)	22 (0.82)	
Dormitory	1,415 (3.69)	686 (2.85)		129 (3.52)	71 (2.54)	
Orphanage	141 (0.39)	121 (0.45)		30 (0.88)	25 (0.99)	
Breakfast consumption			<0.001			0.140
<2 times/week	8,764 (25.13)	4,660 (21.00)		826 (26.56)	556 (24.59)	
≥2 times/week	26,170 (74.87)	17,258 (79.00)		2,275 (73.44)	1,765 (75.41)	
Current drinking			<0.001			0.019
No	28,985 (82.30)	19,182 (87.02)		2,533 (81.34)	1,977 (84.16)	
Yes	5,949 (17.70)	2,736 (12.98)		568 (18.66)	344 (15.84)	
Current smoking			<0.001			0.009
No	32,636 (93.10)	20,881 (94.87)		2,824 (91.07)	2,164 (93.15)	
Yes	2,298 (6.90)	1,037 (5.13)		277 (8.93)	157 (6.85)	
Subjective health			<0.001			0.043
Very healthy	9,536 (27.10)	6,698 (30.14)		622 (20.73)	537 (22.61)	
A little healthy	15,366 (43.99)	9,888 (45.06)		1,298 (41.86)	966 (41.88)	
Average	7,736 (22.22)	4,273 (19.73)		807 (25.52)	601 (26.27)	
A little unhealthy	2,139 (6.23)	985 (4.69)		342 (10.93)	195 (8.28)	
Very unhealthy	157 (0.46)	74 (0.37)		32 (0.97)	22 (0.96)	
Subjective happiness			<0.001			0.011
Very happy	9,522 (26.72)	7,553 (33.70)		789 (25.28)	708 (29.62)	
A little happy	13,402 (38.47)	8,153 (37.41)		1,161 (37.16)	847 (36.64)	
Average	9,121 (26.48)	4,860 (22.62)		791 (26.28)	537 (23.68)	
A little unhappy	2,432 (6.98)	1,145 (5.26)		284 (8.87)	180 (7.83)	
Very unhappy	457 (1.34)	207 (1.01)		76 (2.40)	49 (2.23)	

Table 2 (continued)

	Asthma					
	no (<i>n</i> = 56,854)			yes (<i>n</i> = 5,422)		
	inoculation			inoculation		
	no (<i>n</i> = 34,934)	yes (<i>n</i> = 21,918)	<i>p</i> value	no (<i>n</i> = 3,101)	yes (<i>n</i> = 2,321)	<i>p</i> value
Perceived stress			<0.001			0.866
Very much	3,735 (10.51)	2,020 (9.11)		438 (13.67)	315 (13.50)	
Much	9,582 (27.26)	5,629 (25.84)		867 (27.97)	673 (29.39)	
A little	14,725 (42.80)	9,377 (42.96)		1,250 (40.16)	918 (39.40)	
Not much	5,575 (15.72)	3,893 (17.63)		430 (14.23)	330 (14.04)	
Not at all	1,317 (3.72)	999 (4.46)		116 (3.97)	85 (3.66)	
Sleep satisfaction			<0.001			<0.001
Plenty	2,567 (7.06)	2,111 (9.30)		228 (7.18)	217 (8.77)	
Enough	5,799 (16.20)	4,344 (19.27)		467 (14.64)	415 (17.96)	
A little	11,129 (31.85)	7,287 (33.39)		928 (30.12)	706 (30.30)	
Not enough	10,231 (29.66)	5,660 (26.13)		882 (28.75)	653 (28.41)	
Not enough at all	5,208 (15.24)	2,516 (11.91)		596 (19.31)	330 (14.56)	
Depression			0.727			0.041
No	26,342 (75.41)	16,532 (75.27)		2,196 (71.29)	1,592 (68.55)	
Yes	8,592 (24.59)	5,386 (24.73)		905 (28.71)	729 (31.45)	
Suicidal ideation			0.631			0.239
No	30,790 (88.29)	19,338 (88.14)		2,623 (85.00)	1,939 (83.76)	
Yes	4,144 (11.71)	2,580 (11.86)		478 (15.00)	382 (16.24)	
Suicidal attempts			0.758			0.272
No	34,075 (97.56)	21,361 (97.51)		2,984 (96.38)	2,220 (95.76)	
Yes	859 (2.44)	557 (2.49)		117 (3.62)	101 (4.24)	

Values are presented as numbers (%). Survey data were weighed for statistical representation of the general population based on the sample design. A χ^2 test was applied to determine statistical differences between categorical data and an independent *t* test was used for continuous variables.

orphanage, skipped breakfast, and currently smoked and drank, those with poor self-rated health and happiness and felt much stress, and those who had sleep dissatisfaction and depressive moods than among the subjects without asthma (Table 3). Among those with a higher educational grades, except those in the 2nd grade of middle school, in particular, there were lower vaccination rates.

Influencing Factors for Influenza Vaccination of Subjects with Asthma

Table 4 shows the results of univariate and multiple logistic regression analyses for influencing factors for influenza vaccination among the participants with asthma. Being male (adjusted OR = 1.45; 95% CI 1.35–1.55), having a high SES (adjusted OR = 1.12; 95% CI 1.05–1.19), residence at orphanage (adjusted OR = 1.93; 95% CI 1.38–2.29), regular breakfast consumption (adjusted OR = 1.09; 95% CI 1.02–1.17), and subjective good health (adjusted OR = 2.39;

95% CI 1.69–3.39) were positively associated with influenza vaccination, while current smoking (adjusted OR = 0.87; 95% CI 0.67–0.96) and depressive mood (adjusted OR = 0.77; 95% CI 0.64–0.95) were inversely associated.

Discussion

The current study is unique in that its findings comprise population-based data on influenza vaccination status and influencing factors related to vaccination among adolescents with asthma in Korea. Our analysis determined that, in line with our hypothesis, adolescents with asthma were more likely to get influenza vaccination and more engaged in negative dietary and problem behaviors and negative mental health states than adolescents without asthma. We also demonstrated that males, people with a high SES, orphanage residents, those who eat

Table 3. Comparisons between the asthma and nonasthma groups among the influenza vaccination groups

	Asthma		<i>p</i> value		Asthma		<i>p</i> value
	no (<i>n</i> = 21,918)	yes (<i>n</i> = 2,321)			no (<i>n</i> = 21,918)	yes (<i>n</i> = 2,321)	
Sex			<0.001	Subjective health			<0.001
Female	11,130 (49.73)	1,030 (43.71)		Very healthy	6,698 (30.14)	537 (22.61)	
Male	10,788 (50.27)	1,291 (56.29)		A little healthy	9,888 (45.06)	966 (41.88)	
Grade			0.003	Average	4,273 (19.73)	601 (26.27)	
Middle school				A little unhealthy	985 (4.69)	195 (8.28)	
1st grade	5,610 (23.77)	510 (20.40)		Very unhealthy	74 (0.37)	22 (0.96)	
2nd grade	5,008 (21.81)	552 (22.76)		Subjective happiness			<0.001
3rd grade	3,560 (15.14)	390 (16.16)		Very happy	7,553 (33.70)	708 (29.62)	
High school				A little happy	8,153 (37.41)	847 (36.64)	
1st grade	2,933 (14.28)	350 (15.47)		Average	4,860 (22.62)	537 (23.68)	
2nd grade	2,528 (12.98)	297 (14.55)		A little unhappy	1,145 (5.26)	180 (7.83)	
3rd grade	2,279 (12.02)	222 (10.65)		Very unhappy	207 (1.01)	49 (2.23)	
Grade			0.267	Perceived stress			<0.001
Middle school	14,178 (60.72)	1,452 (59.32)		Very much	2,020 (9.11)	315 (13.50)	
High school	7,740 (39.28)	869 (40.68)		Much	5,629 (25.84)	673 (29.39)	
Subjective economic status			0.409	A little	9,377 (42.96)	918 (39.40)	
High	10,064 (46.81)	1,076 (47.22)		Not much	3,893 (17.63)	330 (14.04)	
Middle	9,539 (42.98)	971 (41.81)		Not at all	999 (4.46)	85 (3.66)	
Low	2,315 (10.21)	274 (10.97)		Sleep satisfaction			<0.001
Academic achievement			0.624	Plenty	2,111 (9.30)	217 (8.77)	
High	9,400 (43.08)	1,021 (43.93)		Enough	4,344 (19.27)	415 (17.96)	
Middle	6,238 (28.46)	656 (28.61)		A little	7,287 (33.39)	706 (30.30)	
Low	6,280 (28.45)	644 (27.47)		Not enough	5,660 (26.13)	653 (28.41)	
Residence type			0.004	Not enough at all	2,516 (11.91)	330 (14.56)	
With parents	20,958 (96.01)	2,203 (95.64)		Depression			<0.001
With relatives	153 (0.69)	22 (0.82)		No	16,532 (75.27)	1,592 (68.55)	
Dormitory	686 (2.85)	71 (2.54)		Yes	5,386 (24.73)	729 (31.45)	
Orphanage	121 (0.45)	25 (0.99)		Suicidal ideation			<0.001
Breakfast consumption			<0.001	No	19,338 (88.14)	1,939 (83.76)	
<2 times/week	4,660 (21.00)	556 (24.59)		Yes	2,580 (11.86)	382 (16.24)	
≥2 times/week	17,258 (79.00)	1,765 (75.41)		Suicidal attempts			<0.001
Current drinking			0.001	No	21,361 (97.51)	2,220 (95.76)	
No	19,182 (87.02)	1,977 (84.16)		Yes	557 (2.49)	101 (4.24)	
Yes	2,736 (12.98)	344 (15.84)		Values are presented as numbers (%). Survey data were weighed for statistical representation of the general population based on the sample design. A χ^2 -test was applied to determine statistical differences between categorical data and an independent <i>t</i> test was used for continuous variables.			
Current smoking			0.001				
No	20,881 (94.87)	2,164 (93.15)					
Yes	1,037 (5.13)	157 (6.85)					

breakfast regularly, and those with subjective good health were strongly associated with influenza vaccination coverage, while those with current smoking and depressive mood were inversely influencing factors for vaccination among adolescents with asthma. Therefore, we suggested that an influenza vaccination program be emphasized for females, those with a low SES and independent residences, breakfast skippers, those with a poor self-perceived

health status, current smokers, and those with depressive moods to increase vaccination rates among asthmatic adolescents.

Most persons who are infected with influenza recover fully without serious complications or sequelae. However, those with asthma face a high risk of complications from influenza [6, 7]. The 2009 H1N1 pandemic heightened awareness of the serious potential complications of

Table 4. Factors influencing influenza vaccination in adolescents with asthma

	Asthma			
	crude		adjusted	
	OR (95% CI)	<i>p</i> value	OR (95% CI)	<i>p</i> value
Sex				
Female	Reference		Reference	
Male	1.30 (1.22–1.39)	<0.001	1.45 (1.35–1.56)	<0.001
Grade				
Middle school				
1st grade	Reference		Reference	
2nd grade	1.19 (1.07–1.31)	0.001	1.15 (1.04–1.28)	0.008
3rd grade	1.20 (1.08–1.34)	0.001	1.20 (1.07–1.34)	0.002
High school				
1st grade	1.16 (1.03–1.30)	0.013	1.15 (1.02–1.29)	0.023
2nd grade	1.16 (1.03–1.29)	0.010	1.11 (0.99–1.24)	0.078
3rd grade	1.04 (0.92–1.16)	0.551	0.98 (0.87–1.10)	0.738
Grade				
Middle school	1.01 (0.95–1.09)	0.674		
High school	Reference			
Subjective economic status				
High	1.12 (1.05–1.19)	0.001	1.12 (1.04–1.19)	0.001
Middle	Reference		Reference	
Low	1.20 (1.09–1.31)	<0.001	1.07 (0.97–1.18)	0.171
Academic achievement				
High	1.05 (0.97–1.13)	0.217		
Middle	1.01 (0.94–1.10)	0.714		
Low	Reference			
Residential type				
With parents	Reference		Reference	
With relatives	1.12 (0.84–1.50)	0.427	0.99 (0.74–1.34)	0.986
Live at dormitory	0.92 (0.78–1.10)	0.368	0.91 (0.77–1.08)	0.278
Live at orphanage	2.26 (1.60–3.20)	<0.001	1.91 (1.37–2.67)	<0.001
Breakfast consumption				
<2 times/week	1.12 (1.05–1.20)	0.001	1.09 (1.02–1.17)	0.012
≥2 times/week	Reference		Reference	
Current drinking				
No	Reference		Reference	
Yes	1.89 (1.79–1.99)	<0.001	0.94 (0.85–1.05)	0.265
Current smoking				
No	Reference		Reference	
Yes	1.32 (1.16–1.49)	<0.001	1.06 (0.92–1.22)	0.398
Subjective health				
Very healthy	Reference		Reference	
A little healthy	1.24 (1.14–1.35)	<0.001	1.35 (1.24–1.48)	<0.001
Average	1.59 (1.45–1.75)	<0.001	1.76 (1.58–1.95)	<0.001
A little unhealthy	2.28 (2.01–2.59)	<0.001	2.35 (2.04–2.72)	<0.001
Very unhealthy	2.98 (2.15–4.13)	<0.001	2.39 (1.68–3.38)	<0.001
Subjective happiness				
Very happy	Reference		Reference	
A little happy	1.05 (0.97–1.13)	0.206	0.94 (0.87–1.03)	0.176
Average	1.09 (0.99–1.19)	0.051	0.85 (0.77–0.94)	0.002
A little unhappy	1.44 (1.28–1.62)	<0.001	0.88 (0.77–1.02)	0.092
Very unhappy	2.07 (1.69–2.54)	<0.001	0.98 (0.76–1.27)	0.897

Table 4 (continued)

	Asthma			
	crude		adjusted	
	OR (95% CI)	<i>p</i> value	OR (95% CI)	<i>p</i> value
Perceived stress				
Very much	1.42 (1.19–1.69)	<0.001	1.12 (0.92–1.37)	0.252
Much	1.11 (0.95–1.30)	0.185	1.06 (0.89–1.25)	0.536
A little	0.97 (0.83–1.13)	0.684	0.98 (0.83–1.16)	0.834
Not much	0.90 (0.76–1.06)	0.202	0.93 (0.78–1.10)	0.382
Not at all	Reference		Reference	
Sleep satisfaction				
Plenty	Reference		Reference	
Enough	0.93 (0.81–1.06)	0.291	0.93 (0.81–1.07)	0.330
A little	0.94 (0.83–1.06)	0.295	0.92 (0.81–1.05)	0.205
Not enough	1.02 (0.90–1.15)	0.799	0.97 (0.85–1.11)	0.680
Not enough at all	1.25 (1.09–1.43)	0.002	1.08 (0.93–1.25)	0.315
Depression				
No	Reference		Reference	
Yes	1.30 (1.22–1.39)	<0.001	1.12 (1.04–1.21)	0.003
Suicidal ideation				
No	Reference		Reference	
Yes	1.38 (1.27–1.50)	<0.001	1.06 (0.95–1.18)	0.312
Suicidal attempts				
No	Reference		Reference	
Yes	1.60 (1.36–1.88)	<0.001	1.16 (0.96–1.39)	0.123
Influenza vaccination				
No	0.83 (0.78–0.89)	<0.001	0.81 (0.76–0.87)	<0.001
Yes	Reference		Reference	

Following the selection of significant covariates, univariate and multivariate logistic regression analyses were performed to identify the factors influencing influenza vaccination in adolescents with asthma. OR, adjusted OR, and 95% CI were obtained.

influenza [7]. Therefore, routine annual influenza vaccination for all persons aged ≥ 6 months who do not have contraindications has been recommended and emphasized by the CDC and the Advisory Committee on Immunization Practices (ACIP) of the CDC [15, 18]. It is particularly important to increase influenza vaccination rates for persons at increased risk for severe illness and complications from influenza such as asthma because immunization is the most effective way to prevent influenza and its complications [10, 13]. Positive predictors of vaccination among adults with chronic diseases include a high awareness of the potential severity of influenza and of the importance and safety of vaccination, those who have experienced influenza previously, and those under a recommendation by a healthcare provider [1]. In children, the positive factor that most often motivates parents to vaccinate their children is promotion

by the government or mass media [19]. However, negative predictors include safety concerns about influenza vaccinations and distrust of the vaccine's effectiveness [19]. Our study revealed several influencing factors for influenza vaccination among adolescents with asthma. Based on independent variables, our analysis showed that male respondents were more likely to get influenza vaccination, and this was also evident in our multivariate analysis. Although sex as an influencing factor in influenza vaccination among adults has been inconsistently evident [1, 20, 21], unlike in our study, several studies have shown higher vaccination rates in females than in males [22, 23]. In general, because females tend to have a healthier lifestyle and be more interested in health information, are more likely to follow preventive health care recommendations, and use health care services more often than males do, acceptance for the influ-

enza vaccination is likely to be higher among females [24, 25]. However, in our study, the proportion of males among the total subjects and the asthma groups was higher than that of females, so this uneven distribution in sex may have influenced our results. Further studies are needed to elucidate associations between sex and influenza vaccination coverage.

The association between SES and influenza vaccination has been also inconclusive. One report stated that children with a lower household income were more likely to get influenza vaccinations than those with a higher income [16], and others reported that influenza vaccination rates were lower among adults with lower household incomes than those with higher incomes [13]. In our study, a higher SES was associated with higher vaccination rates among adolescents with asthma. This may be explained by the fact that parents with a high SES are more likely to access medical care for improving their offspring's health states, especially with no governmental financial support for influenza vaccinations. These wealth disparities may effect negative burdens on society in the preventive medical care level. Therefore, public health promotion programs should implement influenza vaccination policies for adolescents with a low SES among asthmatics [13].

When the vaccine supply is limited, vaccination efforts should focus on persons at a higher risk for medical complications attributable to severe influenza, such as residents of nursing homes and other long-term care facilities [10]. In our study, we found that, among adolescents with asthma, the vaccinated groups had a higher proportion of living at orphanages than did the nonvaccinated groups. This means that vaccination programs performed successfully for youths living in groups. Thus, it is clear that expressions of public concern are needed for adolescents who live independently in dormitories or lodges. To the best of our knowledge, there has been no study of the direct relationship between breakfast consumption and influenza vaccination rates. However, considering the results of many studies that skipping breakfast is significantly associated with poor health lifestyles, it was not surprising that, among asthma adolescents, the vaccinated group had a higher proportion of regular breakfast eaters than did the nonvaccinated group. Regarding the subjective health state, previous studies have revealed that the most common reason for nonvaccination is the judgment of being healthy enough not to need vaccination, and a poor subjective health status has been associated with a higher vaccination rate [21, 26]. However, the results of our study differed from those of previous studies. This finding may be explained in that individuals who self-re-

port their health as "good" may have healthier lifestyles, including getting timely vaccinations, and we assumed that this might increase their opportunities to be vaccinated for influenza. Routine checkups in the previous year are well-known associated factors for an increased likelihood of influenza vaccination in adults with asthma [27]. Depression is associated with changes in individuals' health status, and this influences health-related behaviors by lowering mood, reducing energy, and decreasing activity [28, 29]. Thus, depressive mood was inversely correlated with influenza vaccination among adolescents with asthma in our study. Screening for depressive mood should be emphasized for increasing influenza vaccination coverage among adolescents with asthma.

Our study also found that the vaccination rates among asthma adolescents declined after the 2nd grade of middle school. Determination of vaccination for young children is mainly decided by parents. However, for adolescents, especially those in a highly competitive academic environment such as Korea, determination of vaccination may differ according to whether there is time to go to the clinic. This may explain that the lowest vaccination group was the 3rd grade of high school students, who should have intensive preparation for college entrance exams or their own major life decisions (such as choosing a career path).

This study has several strengths that improved on the findings of previous reports. To the best of our knowledge, factors associated with influenza vaccination in adolescents with asthma have not been explored based on a large population data set, as our study conducted. This was a nationwide, government-directed survey with a high response rate comprising a large number of participants. An equal proportion of middle school and high school students (400 schools each) with a socioeconomically diverse sample was represented, and all of the analyses in this study were based on sample weights and adjusted for the complex sample design of the survey. These parameters allow for the generalization of results. However, this study has some limitations. First, this study was cross-sectional in design, so we could not establish causal relationships between influencing factors and influenza vaccination in adolescents with asthma. Well-controlled prospective studies are necessary to confirm the results of the present study. Second, the survey explored only whether participants were vaccinated during the past year and did not identify the reasons why they were not vaccinated. Third, the diagnosis of asthma in this study was evaluated by asking whether the participants had ever been diagnosed with asthma, regardless of their current symptoms and asthma severity, which may have led to the misclassification of

asthma. Fourth, although this study was based on a national survey, because the survey did not include adolescents who had dropped out of school or faced expulsion, the results may differ when they are included. Another limitation of this study was the self-reported nature of the data. Specifically, in this kind of format, despite the anonymity of the task, adolescents may believe that their answers would be linked to private and confidential information, and this may result in erroneous reporting, a substantial decreased credibility of responses, and recall bias.

Conclusions

Although Korean adolescents with asthma have higher rates of influenza vaccination than subjects without asthma, more concerted efforts are needed to improve influenza vaccination for prevention of serious complications of influenza in the sense that they are at a high risk. Emphasizing awareness of influenza and the need for vaccination through public campaigns and mass media will be one of the cornerstones for implementing a successful vaccination program. Health care providers should be ready to give precise information about influenza vaccination and actively encourage people to be vaccinated against influenza, especially for females, those with a low SES, independent residents, breakfast skippers, those who consider themselves unhealthy, current smokers, and those with depressive moods among adolescents with asthma. If the vaccination rate in these groups is increased, the influenza prevalence rate and its related complications could be reduced in high-risk groups, enhancing public health.

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Statement of Ethics

The Institutional Review Board of the KCDC approved this online statistical research. We used publicly available documents for academic purposes. The study protocol was reviewed and approved by the Institutional Review Board of the Samsung Changwon Hospital (IRB No. 2019-09-003), which waived the requirement for informed consent.

Disclosure Statement

The authors declare that they have no conflict of interests.

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Author Contributions

Y.K. and S.H.K. designed this study. Y.K. and M.H.C. equally contributed to this study as first authors in the data collection and the writing and critical revision of this paper. J.S.L. and J.H.L. contributed in the interpretation of the results and reviewed the related articles. S.H.J. also contributed in data collection and data analysis. S.H.K. supervised this study, conceptualized much of this study, designed the measures analyzed, reviewed and revised the initial version of this paper, and approved the final version.

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