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Factors influencing on influenza vaccination and its trends of coverage in patients with diabetes in Korea: A population-based cross-sectional study

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ABSTRACT

Background: Influenza infection is a contagious disease and annual influenza vaccination is recommended to the patients with chronic diseases. Although diabetes is an indication for influenza vaccination, the global rate of influenza vaccination is insufficient. Therefore, our study aimed to elucidate influenza vaccination statuses among patients with diabetes and the related factors in Korea.
Methods: A total of 32,268 subjects (4,540 with and 27,728 without diabetes) from the Korea National Health and Nutrition Examination Survey III–VI (2005–2015) were included. Socioeconomic factors and health-related factors were analyses for the relation of influenza vaccination by Student's *t*-test, the chi-squared test and a multivariate logistic regression analysis.
Results: The influenza vaccination coverage rates were 50.0% in the diabetes mellitus (DM) group and 38.2% in the non-DM group. The trends in influenza vaccination rates during KNHANES III–VI were not significant in each group (P trend = 0.24 in the DM group, 0.30 in the non-DM group). Socioeconomic (older age, female sex, higher family income, and medical aid insurance) and health-related factors (lack of risky alcohol consumption, obesity, and recent health check-ups) were associated with influenza vaccination among patients with DM.
Conclusions: The rate of influenza vaccination among patients with diabetes is insufficient in Korea. More efforts are needed to increase the influenza vaccination rates among vulnerable at-risk populations.

1. Introduction

Influenza infection is a contagious disease that has caused serious public health issues worldwide [1]. Infection with the influenza virus often causes mild to severe complications, particularly in high-risk populations [2]. According to the World Health Organization, the global burden of influenza includes 3–5 million cases of severe illness and 250,000–500,000 deaths [2]. Annual influenza vaccination is considered the most effective preventive measure against infection and is recommended for elderly people, those with chronic diseases, cancer patients, immunosuppressed patients, health care workers, pregnant women, and children [2,3]. In Korea, the Ministry of Health and Welfare reported that the coverage rate of influenza vaccination has increased from 26.3% in 2009 to 31.7% in 2012 due to improvements in public awareness through national campaigns and by strengthening preventive activities by the government [4]. Another survey from Korea indicated that influenza vaccination coverage was 34.3% in the general population and 61.3% in high risk groups in 2007 [5]. In particular, the rate of elderly and children from 6 months to <12 months of age sharply increased up to 82.3% and 87.6% after a cost-free influenza vaccination program provided by the Korean government since 2015 and 2016, respectively [6,7].

Globally, diabetes mellitus (DM) is another disease with major ramifications for public health. Currently, the prevalence of diabetes in Korea has increased to 13.7% [8]. The consideration of diabetes as an indication for influenza vaccination is supported by

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evidence indicating the efficacy and cost-effectiveness of this measure for decreasing hospital admissions and mortality [9–11]. Still, the global rate of influenza vaccination is insufficient. Moreover, the following vaccination rates have been reported among diabetes patients: 61.6% in the USA, 65.7% in Spain, 53.7% in France, 27–63.3% in Turkey, 54.5% in Hong Kong, and 31–35% in Taiwan [12–17]. In Korea, only 57.2% of patients admitted to hospitals for chronic diseases and 75.8% of elderly people were vaccinated against influenza [18,19]. However, the current influenza vaccination status among Korean patients with diabetes has not been evaluated. Therefore, our study aimed to elucidate differences in influenza vaccination statuses between patients with and without diabetes and the related factors, using data collected nationwide from 2005 to 2015.

2. Methods

2.1. Study participants

The Korea National Health and Nutrition Examination Survey (KNHANES) is a cross-sectional, nationally representative survey conducted by the Korean Ministry of Health and Welfare. To date, this survey has been performed in 6 phases: KNHANES phases I (1998), II (2001), III (2005), IV (2007–2009), V (2010–2012), and VI (2013–2015) [20]. Data from 2005 to 2015 (KNHANES III, IV, V, VI) were included in this study. The KNHANES comprises a Health Interview Survey, a Health Behavior Survey, a Health Examination Survey, and a Nutrition Survey. Households were defined as sampling units and stratified, and data were collected from household registries using a multistage, probability-based sampling design based on sex, age, and geographic area. After completing this survey, participants provided written informed consent for the use of their data in further analyses and were given the right to refuse to participate in accordance with the National Health Enhancement Act.

From among the 107,498 subjects who participated in the KNHANES III–VI (2005–2015), we excluded subjects younger than 40 years and those who did not provide information about influenza vaccination and/or diabetes prevalence (n = 75,230). Subsequently, a total of 32,268 subjects (4540 with and 27,728 without diabetes) were included in the final analysis. The institutional review board of the Korea Centers for Disease Control and Prevention approved the study protocol, and all participants signed informed consent forms.

2.2. Questionnaire and anthropometric measurements

For the Health Interview Survey, a self-administered questionnaire was used to gather information about socioeconomic factors (age, sex, marital status, employment status, education level, family monthly income, residential area, and medical insurance status) and health-related factors (smoking status, alcohol consumption, physical activity, self-rated health status, other disease, influenza vaccination, and health check-up participation). The employment status was classified as "yes" or "No". The marital status was classified as "married", "single," or "divorced/separated/widowed". The education level was classified as "college or higher", "high school", "middle school", or "elementary school or lower." The household income was categorized into "low," "low middle", "middle high", and "high" quartiles. The residential area was classified as "urban" or "rural". The medical insurance status was classified as "National health insurance" and "Medicaid/none". Patients' self-rated health status was further divided into "excellent/good", "fair", and "poor/very poor" groups. Participants provided "yes" or "no" responses to questions regarding health check-ups, such as "Have you undergone a health check-up within the last 2 years?". Other diseases included angina, myocardial infarction, asthma, obstructive lung disease, restrictive lung disease, cancer (e.g., stomach, liver, colon, breast, cervix, lung, and thyroid), liver cirrhosis, and renal disease.

Smokers were classified as current, former, or non-smokers. Risky alcohol consumption was defined as ingesting more than 5 alcoholic beverages during a single occasion. Regular exercise was defined as routine walking at least five times per week for at least 30 min at a time or engaging in regular moderate (at least five times per week for at least 30 min at a time) or strenuous (at least three times per week for at least 20 min at a time) exercise, as defined by the American College of Sports Medicine Guidelines during the survey period [21]. Physical examinations were performed by trained medical staff according to standardized procedures. The body weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively, while subjects wore light indoor clothing without shoes. The body mass index (BMI) was calculated as the ratio of weight in kilograms to height in meters squared (kg/m^2).

2.3. Blood collection and biochemical analyses

For clinical chemistry assays, serum was obtained from each participant via separation from peripheral venous blood collected after a minimum fasting period of 8 h. Fasting glucose and hemoglobin (Hb) A1C levels were measured by high performance liquid chromatography on a Tosoh G8 device (Tosoh Corporation, Tokyo, Japan).

2.4. Diabetes mellitus definition and influenza vaccination status

DM was defined as a serum fasting blood glucose level $\geq$126 mg/dL, the use of medication (oral drug, insulin) for DM by self-reporting, and/or an HbA1C value $\geq$6.5% [22]. The influenza vaccination status was assessed using the question "have you received an influenza vaccination within the past 1 year?", to which the participant answered "yes" or "No". The Korean government provides free influenza vaccinations to elderly people ($\geq$65 years) and infants 6–12 months of age. Moreover, although the indications differ slightly among self-governing areas, public health centers usually provide free influenza vaccines to disabled individuals, those with medical aid insurance, and men of national merit including national veteran honorees.

2.5. Data analysis

All sampling and weight variables used in the present study were stratified, and all statistical analyses used the SAS survey procedure to ensure appropriate estimates and standard errors. In addition, all statistical procedures used survey sample weights to produce unbiased estimates for the descriptive and analytical data analyses. Descriptive statistical methods were used to describe the basic characteristics of the study population, and numbers and percentages were reported for each variable. All clinical characteristics were compared among the participants, and Student's *t*-test and the chi-squared test were used for continuous and categorical variables, respectively. A multivariate logistic regression analysis was also used to assess the data by adjusting for age, sex, marital status, occupation, education, family income, living area, medical insurance, smoking, binge alcohol drinking, regular exercise, self-health status, HbA1C, body mass index, other disease, and health check-up. P trends were calculated for serial trends of influenza vaccination with increasing age. Student's *t*-test was used to compare the vaccination rates between participants with and without