



## Factors associated with vaccination status among Korean submariners who are eligible for free non-mandatory influenza vaccination



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### ABSTRACT

**Introduction:** Submarine crews live in a confined setting and are vulnerable to influenza. Thus, it would be useful to identify factors that are associated with influenza vaccination. In this study, we investigated the influenza vaccination rate and the influence of health beliefs on the vaccination rate among submariners who were eligible for a free but non-mandatory vaccination program.

**Methods:** A total of 487 Korean submariners participated in this study after the closing of a free influenza vaccination program in 2015. Data regarding the participants' general characteristics and health beliefs (based on the health belief model [HBM]) were collected using a self-administered questionnaire, and their vaccination status was determined using their medical records. Multiple logistic regression analysis were performed to evaluate the associations of the HBM components with influenza vaccination.

**Results:** The overall vaccination rate was 78% (921/1183). The unvaccinated and vaccinated respondents exhibited similar characteristics, although the vaccinated group was significantly more likely to have high-risk family members (chronic disease, age of <2 years, or age of  $\geq 65$  years;  $p = 0.025$ ). Among the HBM components, perceived severity (odds ratio: 1.38,  $p = 0.019$ ) and cue to action (odds ratio: 1.74,  $p = 0.002$ ) were significantly associated with a higher likelihood of influenza vaccination.

**Conclusion:** Vaccination policies that emphasize the severity of influenza and prompt individuals to undergo vaccination are needed to increase the vaccination rate among people who live in confined environments or institutions with non-mandatory vaccination programs.

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### 1. Introduction

Influenza is a highly contagious disease that is associated with considerable morbidity and socioeconomic burden [1]. Annual vaccination against influenza is the most effective protective measure. Therefore, the American Advisory Committee on immunization practices recommends routine annual influenza vaccination for all people who are  $\geq 6$  months old [2]. In Korea, the Korean Society of Infectious Diseases recommends vaccination for adults who are  $\geq 19$  years old and have no contraindications, and the Korean government offers free influenza vaccination  $\geq 65$ -year-old individuals and 6–12-month-old infants [3].

Naval personnel, and especially submarine crew members (submariners), may be especially vulnerable to influenza because they

spend prolonged periods in a confined setting. For example, several influenza outbreaks have occurred in settings where >95% of the crew had undergone vaccination at the time of the outbreak [4–6]. Several Korean Armed Forces trainees have also died at boot camps as a result of idiopathic pneumonia during seasonal influenza epidemics, which led to the introduction of seasonal influenza vaccinations by the Korean Ministry of National Defense for new military recruits in 2004 and for all active-duty soldiers in 2012 [7]. However, despite the implementation of the free vaccination program, the influenza vaccination rates among Korean military personnel (approximately 80% in 2012) are relatively low, compared to the immunization rates among US Armed Forces personnel (almost 100%), who undergo mandatory annual influenza vaccination [7,8].

It can be challenging to improve the vaccination rate among vulnerable populations with suboptimal vaccination coverage, even in a setting with free influenza vaccination. Thus, it is important to identify factors that are linked to vaccination. Several studies have revealed that a greater likelihood of vaccination is

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associated with a higher socioeconomic status, free vaccination, advanced age, and medical conditions that are associated with a high risk of influenza [9–13]. In addition, health belief components have been suggested as factors that can affect the decision to undergo influenza vaccination, because these factors are closely linked to health behaviors [14]. Studies in the community have also demonstrated that “perceived benefits” and “cue to action” were associated with higher vaccination rates among all age groups [15–17]. In addition, “perceived susceptibility” was positively associated with vaccination among young adults and elderly individuals, whereas perceived barriers were associated with a decreased probability of vaccination [17]. Furthermore, self-efficacy was positively associated with influenza vaccination among children [15]. However, it remains unclear what factors might influence the influenza vaccination rate among military personnel who live in confined environments or institutions with non-mandatory vaccination programs. Therefore, the present study aimed to evaluate the influenza vaccination rate, and the influences of health belief factors on vaccination, among submariners who were eligible for a free but non-mandatory vaccination plan.

## 2. Methods

### 2.1. Study participants

The present study evaluated Korean submariners who had finished a submarine training course or who were on shore duty and had  $\geq 1$  year of service time in a submarine. During December 2015, emails were sent to distribute a questionnaire and invite 1183 submariners to participate, and this recruitment was performed after the free seasonal influenza vaccination program was completed (October–November 2015). Among the invited individuals, 487 crew members (41%) voluntarily participated in the study after providing their written informed consent. This study was approved by the institutional review board of the Armed Forces Medical Command in Seongnam, South Korea (AFMC-15088-IRB-15-079).

### 2.2. Evaluations

The participants completed a self-administered questionnaire, and we collected information regarding their socio-demographic characteristics (age, education level, and marital status), occupational characteristics (years of submarine service), health behaviors (smoking, alcohol consumption, and physical activity), personal and family histories of chronic diseases that necessitate influenza vaccination (diabetes, cancer, chronic kidney disease, asthma, chronic lung disease, immunosuppression, heart disease, and neurological disease), the presence of high-risk family members (who had a chronic disease, age of  $< 2$  years, or age of  $\geq 65$  years), and health beliefs. Two subgroups were created for educational status (high school or below and college or above), marital status (married and other), and alcohol consumption ( $< 140$  g/week and  $\geq 140$  g/week). Three subgroups were created for smoking status (current smoker, ex-smoker, and non-smoker) and physical activity (low, moderate, and high), according to the International Physical Activity Questionnaire [18].

Questions for assessing health beliefs regarding influenza vaccination were developed based on the health belief model and relevant items that were used in previous studies [15–17]. A five-point Likert scale (strongly disagree: 1, strongly agree: 5) was used to evaluate the health belief items. The health belief model was originally developed by social psychologists [19], was subsequently revised [20], and was then translated into Korean and validated by Lee et al. [21]. The health belief model consists of six constructs:

perceived susceptibility (perceived vulnerability to a disease or the risk of contracting it), perceived severity (perceived seriousness of the consequences of contracting the disease), perceived benefits (perceived positive results of steps that are taken to avoid contracting the disease), perceived barriers (perceived negative effects of performing health-related behaviors), cue to action (beliefs and behaviors that can trigger health-related behaviors, which include compliance with advice promoting vaccination), and self-efficacy (belief that one can successfully execute a behavior that will lead to a desirable outcome). The questionnaire was reviewed by independent researchers (including two Chief Petty Officers) to improve its clarity and remove words that might be misinterpreted by the submariners.

The participants' body weight (kg) and height were measured by trained research assistants, and the participants' body mass indexes ( $\text{kg}/\text{m}^2$ ) were calculated as weight divided by height squared. The individuals' influenza vaccination statuses were evaluated by reviewing their medical records from the naval clinic after the influenza vaccination program was closed.

### 2.3. Statistical analyses

The distributions of characteristics and health belief components were compared between the vaccinated and unvaccinated groups using the chi-square test and *t*-test. We also used Cronbach's alpha statistic to estimate the internal consistency between the items that comprised each health belief component in the questionnaire [22]. The independent associations between vaccination and each health belief component were evaluated using multiple logistic regression analysis. Alcohol consumption and the presence of high-risk family members were selected as potentially confounding covariates for the multivariable adjusted analysis, based on these factors having univariate *P*-values of  $< 0.1$ . All statistical analyses were performed using PASW Statistics software (version 21.0; SPSS Inc., Chicago, IL, USA). Two-tailed *p*-value of  $< 0.05$  was considered statistically significant.

## 3. Results

Among the 1183 eligible individuals, a search of their medical records revealed that 921 submariners (78%) had received the seasonal influenza vaccine in 2015. Table 1 shows the 487 participants' characteristics according to their influenza vaccination status. The vaccinated and unvaccinated respondents exhibited similar distributions of age, marital status, education level, smoking status, obesity, coexisting chronic diseases, and years of submarine service (all,  $p > 0.05$ ). The vaccinated group exhibited a trend towards a higher likelihood of greater alcohol consumption ( $\geq 140$  g/week), compared to the unvaccinated group ( $p = 0.078$ ). The vaccinated group also exhibited a significantly higher frequency of having high-risk family members, compared to the unvaccinated group ( $p = 0.025$ ).

Table 2 shows the distributions of the mean scores for each health belief component according to vaccination status. Vaccinated individuals exhibited higher scores for perceived severity and cue to action, compared to the unvaccinated group. The vaccinated group exhibited significantly greater awareness regarding the effects of influenza on their daily life (3.61 vs. 3.37,  $p = 0.031$ ), submarine duty (3.46 vs. 3.18,  $p = 0.019$ ), and medical costs (3.69 vs. 3.42,  $p = 0.012$ ). The vaccinated group was also more likely to consider influenza as being seriously contagious (3.87 vs. 3.68,  $p = 0.05$ ). Furthermore, the vaccinated group was more likely to be affected by a colleague's advice (3.16 vs. 2.94,  $p = 0.048$ ) or pro-vaccination messages from the medical department (3.23 vs. 2.94,  $p = 0.01$ ). The vaccinated group was also more likely to

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