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Vaccination coverage and associated factors for receipt of the 23-valent pneumococcal polysaccharide vaccine in Taiwan
A nation-wide community-based study

Chang-Hua Chen, MD, MSc, PhD[a,b], Ming-Shiang Wu, MHA[c], I-Chien Wu, MD, MSc, PhD[c,*]

Abstract

Older adults, particularly those with chronic obstructive pulmonary disease, are advised to receive 23-valent pneumococcal polysaccharide vaccine (PPV23). However, the PPV23 vaccination rate in Taiwan and the determinants of receipt remain unclear.

We analyzed the data of 1475 community-dwelling older adults aged ≥75 years who participated in the Healthy Aging Longitudinal Study in Taiwan. Each participant received assessments of PPV23 status, sociodemographic factors (age, sex, education level, marital status, living alone, and occupation), and health-related factors (chronic diseases, smoking status, alcohol intake, physical activities, cognitive status, and physical performance). PPV23 rate was defined as the number of participants who reported receiving free PPV23 divided by the total number of candidates for free PPV23. Multinomial logistic regression analysis was applied to investigate the sociodemographic and health-related determinants of PPV23 status.

A PPV23 vaccination rate of 20.7% (305/1475) was observed. Participants who were female, current smokers, and had a low peak expiratory flow were associated with PPV23 nonreceipt (all $P < .05$). Of the participants who had a low peak expiratory flow, low education status, and physical inactivity were associated with PPV23 nonreceipt (all $P < .05$).

The PPV23 vaccination rate among adults aged ≥75 years was low. Older adults who were women, current smokers, or who had a low PEF were less likely to receive the PPV23. These findings support continual efforts to improve the PPV23 coverage rate in vulnerable populations.

Abbreviations: COPD = chronic obstructive pulmonary disease, HALST = Healthy Aging Longitudinal Study in Taiwan, IADL = Instrumental Activities of Daily Living Scale, MMSE = Mini-Mental State Examination, PEF = peak expiratory flow, PPV23 = 23-valent pneumococcal polysaccharide vaccine, VrPPV23 = vaccination uptake rate of PPV23.

Keywords: 23-valent pneumococcal polysaccharide vaccine, healthy aging longitudinal study in Taiwan cohort, public policy, vaccination

1. Introduction

The 23-valent pneumococcal polysaccharide vaccine (PPV23) prevents invasive pneumococcal diseases and reduces mortality among older adults.[1–3] Older adults are thus advised to receive

[a] Division of Infectious Diseases, Department of Internal Medicine, [b] Center for Aging and Health, Changhua Christian Hospital, Changhua City, [c] Institute of Population Health Sciences, National Health Research Institutes, Zhunan, Miaoli County, Taiwan.

* Correspondence: I-Chien Wu, Institute of Population Health Sciences, National Health Research Institutes, Zhunan, Taiwan, Zhunan, Miaoli County, Taiwan (e-mail: icwu@nhri.org.tw).

the PPV23 according to the recommendations of the US Advisory Committees on Immunization Practices.[4,5] In particular, lower respiratory tract infections, with *Streptococcus pneumoniae* as one of the leading pathogens, is a major cause of mortality among patients with chronic obstructive pulmonary disease (COPD).[6,7] Hence, all people with COPD are highly recommended to receive the pneumococcal vaccination, which provides protection against both lower respiratory tract infections and acute exacerbations of chronic pulmonary diseases.[5,8,9]

Before 2007, the overall pneumococcal vaccination rate was < 1% in Taiwan. However, since 2007, the PPV23 has been provided for free to older adults aged ≥75 years in Taiwan under financial support from a nongovernmental organization. Following the implementation of this national policy in Taiwan, the cumulative vaccination uptake rate of PPV23 (VrPPV23) among adults aged ≥75 years reached 12% in 2007 and 41% in 2008,[9] but only 29.5% in 2015.[10] The reason for this decline in vaccination uptake rate remains uncertain. Studies comprehensively examining the factors associated with the VrPPV23 among older adults are lacking and are urgently needed.

This study analyzed data from the Healthy Aging Longitudinal Study in Taiwan (HALST) cohort. We investigated the VrPPV23 after the implementation of the PPV23 national vaccination policy and identified factors associated with the PPV23 uptake status.

2. Materials and methods

This study was approved by the Institutional Review Board of the National Health Research Institutes and its participating

hospitals. The study design and participants of the HALST have been previously described.[11] Between 2009 and 2013, 5664 community-dwelling HALST participants aged ≥ 55 years were enrolled from multiple catchment areas across Taiwan using a stratified randomized sampling method. Among these initial enrollees, 4188 were excluded because they were <75 years old, and 1 was excluded because of incomplete data. The final study sample consisted of 1475 HALST participants aged ≥75 years.

During the examination, participants were asked whether they had ever received a pneumococcal polysaccharide vaccine. For each enrolled participant, information on sociodemographic status, lifestyle, and diseases was also collected.[11] The health status of each participant was further determined by assessing physical and cognitive functioning using the Barthel Index, Lawton Instrumental Activities of Daily Living Scale (IADL), and Mini-Mental State Examination.[11–13] In addition, each participant underwent a peak expiratory flow (PEF) assessment, which is a simple and cost-effective screening test for pulmonary functioning that indicates cases of COPD among adults aged >40 years.[14] The PEF status of the study participants was interpreted and categorized according to Nunn's equation.[15]

All continuous data were expressed as mean ± standard deviation, and all categorical data were expressed as numbers and percentages. The categorical variables were compared using a χ^2 test or Fisher's exact test, and a 1-way analysis of the variance was applied for the continuous variables. Independent associations of each sociodemographic or health-related variable with PPV23 receipt were examined using multinomial logistic regression analyses. The variables significantly associated with the PPV23 receipt in the univariate analysis were included in the multinomial logistic regression analysis in a stepwise manner. The SPSS V.18.0 (SPSS, Chicago, IL) software package was employed for data analysis in this study and statistical significance (α) was set at .05.

3. Results

Three hundred and five (305/1475, 20.7%) participants reported receiving the PPV23. The univariate analysis revealed that older adults who did not receive the PPV23 were more likely to be women ($P < .001$), less educated ($P < .001$), less physically active ($P < .001$), current smokers ($P = .017$), or to have impaired cognitive functioning ($P < .001$), an IADL disability ($P < .001$), or a low PEF ($P = .004$) (Table 1).

Table 1

Participant characteristics according to 23-valent pneumococcal polysaccharide vaccine uptake status[*].

	All (n=1475)	23-Valent pneumococcal polysaccharide vaccine uptake		P value
		No (n=1170)	Yes (n=305)	
Age, mean (SD), year	80.3 (4.0)	80.2 (3.9)	80.4 (4.0)	.499
Gender				<.001
Men	753 (51.1)	567 (48.5)	186 (61.0)	
Women	722 (48.9)	603 (51.5)	119 (39.0)	
Education				<.001
Illiteracy	281 (19.1)	248 (21.2)	33 (10.8)	
Elementary school	698 (47.3)	585 (50.0)	113 (37.0)	
Junior high school	166 (11.3)	127 (10.9)	39 (12.8)	
≥Senior high school	330 (22.4)	210 (17.9)	120 (39.3)	
Smoking				.017
Never	983 (66.6)	789 (67.4)	194 (63.6)	
Ever	353 (23.9)	263 (22.5)	90 (29.5)	
Current	139 (9.4)	118 (10.1)	21 (6.9)	
Alcohol consumption				.001
Never	977 (66.2)	800 (68.4)	177 (58.0)	
Ever	204 (13.8)	159 (13.6)	45 (14.8)	
Current	294 (19.9)	211 (18.0)	83 (27.2)	
Exercise[†]				<.001
No	434 (29.4)	378 (32.3)	56 (18.4)	
Yes	1041 (70.6)	792 (67.7)	249 (81.6)	
Hypertension[‡]	988 (67.0)	777 (66.4)	211 (69.2)	.360
Diabetes mellitus[§]	451 (30.6)	370 (31.6)	81 (26.6)	.087
Stroke	112 (7.6)	86 (7.4)	26 (8.5)	.491
Heart disease[‖]	434 (29.4)	329 (28.1)	105 (34.4)	.031
Cancer	95 (6.4)	72 (6.2)	23 (7.5)	.379
Lung disease[¶]	79 (5.4)	58 (5.0)	21 (6.9)	.183
Chronic kidney disease[#]	462 (31.3)	368 (31.5)	94 (30.8)	.062
Number of chronic diseases[**]				.372
0	170 (11.5)	132 (11.3)	38 (12.5)	
1	389 (26.4)	318 (27.2)	71 (23.3)	
≥2	916 (62.1)	720 (61.5)	196 (64.3)	
Cognitive impairment[††]	520 (35.3)	448 (38.3)	72 (23.6)	<.001
ADL disability	317 (89.3)	259 (22.1)	58 (19.0)	.237
IADL disability	712 (48.3)	593 (50.7)	119 (39.0)	<.001
Peak expiratory flow				.004
High	152 (11.4)	106 (10.1)	46 (16.1)	
Low	1187 (88.6)	947 (89.9)	240 (83.9)	

[*] Data are numbers (%) unless otherwise specified.

[†] Participants were asked whether they had exercised in the previous year.

[‡] Hypertension was defined according to self-reports, systolic blood pressure ≥130 mm Hg, diastolic blood pressure ≥85 mm Hg, or a history of drug treatment.

[§] Diabetes mellitus was defined according to self-reports, medication use, fasting plasma glucose >126, or hemoglobin A1c >6.5%.

[‖] Heart disease included rheumatoid heart diseases, valvular heart disease, hypertensive heart disease, coronary artery diseases, congenital heart diseases, acute coronary diseases, cardiac arrhythmia, congestive heart diseases, and atrial affiliation.

[¶] Lung disease included emphysema, chronic bronchitis, bronchiectasis, and chronic obstructive pulmonary disease.

[#] Participants with glomerular filtration rates <60 mL/min/1.73 m^2 or chronic kidney disease stage >3 were considered to have chronic kidney disease.

[**] Chronic diseases included hypertension, diabetes mellitus, stroke, heart disease, arthritis, cancer, lung disease, and chronic kidney disease.

[††] Participants with Mini-Mental State Examination scores <24 were considered to have cognitive impairment.

ADL = activities of daily living, IADL = instrumental activities of daily living, SD = standard deviation.

Table 2

Multivariate analysis of factors associated with 23-valent pneumococcal polysaccharide vaccine nonreceipt.

	OR	95% CI	P value
All participants			
Sex			
Men	1.00	Reference	
Women	1.89	1.34–2.65	<.001
Smoking			
Never	1.00	Reference	
Ever	1.15	0.80–1.65	.444
Current	2.07	1.20–3.56	.009
Heart disease			
No	1.00	Reference	
Yes	0.74	0.56–0.98	.036
Peak expiratory flow*			
Good	1.00	Reference	
Poor	1.51	1.03–2.22	.036
Participants with low peak expiratory flow			
Education			
Senior high school and above	1.00	Reference	
Junior high school	1.67	1.05–2.67	.030
Elementary school	3.03	2.15–4.27	<.001
Illiteracy	4.05	2.48–6.62	<.001
Exercise			
Yes	1.00	Reference	
No	1.69	1.19–2.40	.004

The variables included in the multinomial logistic regression analysis were gender, education, smoking, alcohol consumption, exercise, heart disease, cognitive impairment, IADL disability, and peak expiratory flow.

CI = confidence interval, IADL = Instrumental Activities of Daily Living Scale, OR = odds ratio.

* The equations for predicting peak expiratory flow in adults was according to the ref.[15]

We performed multinomial logistic regression analysis that included gender, education, smoking, alcohol consumption, exercise, heart disease, cognitive impairment, IADL disability, and PEF. After adjustment, older adults who were women (OR of PPV23 nonreceipt = 1.89, 95% CI 1.34–2.65, P <.001), current smokers (OR comparing current smokers with nonsmokers = 2.07, 95% CI 1.20–3.56, P = .009), or had low PEF (OR = 1.51, 95% CI 1.03–2.22, P = .036) were less likely to receive the PPV23 (Table 2).

A total of 1187 individuals had a low PEF. Among these participants, the VrPPV23 was 20.2% (240/1187). Factors negatively associated with receipt of the PPV23 in participants with low PEF were low education (OR comparing illiteracy with senior high school and above = 4.05, 95% CI 2.48–6.62, P <.001) and physical inactivity (OR = 1.69, 95% CI 1.19–2.40, P = .004) (Table 2).

4. Discussion

This was the first epidemiological study to identify factors associated with the VrPPV23 in a large cohort of community-dwelling older adults in Taiwan. We demonstrated that 20.7% of the enrolled participants had received the PPV23. Notably, participants who were females, were current smokers, and had low PEF were associated with PPV23 nonreceipt. Additionally, among those with a low PEF, 2 other factors were associated with nonreceipt of PPV23, namely low education status and physical inactivity. The low VrPPV23 among older adults observed in this study is similar to previous studies.[3,16,17] Although the PPV23 has been globally recommended for many years, a large disparity in VrPPV23 exists among various countries.[16,18–22] In addition

to the low VrPPV23 (20.7%) in older adults, we observed that those strongly recommended to receive the PPV23 were actually less likely to receive the vaccine.[3,4] Older adults most likely to receive the PPV23 tended to be men or patients with heart disease. We identified the specific groups of older adults who were less likely to receive the PPV23: women, current smokers, and those with a low PEF. Women, most of whom are busy to handle housework, suspected to be less likely to receive PPV23. Notably, we observed that smoking was negatively associated with PPV23 receipt. Current smokers were significantly less likely to receive PPV23 than nonsmokers. Our finding is in agreement with previous studies showing the associations of unhealthy lifestyles, including active smoking, with not receiving PPV23.[23,24] These evidences lend support to public health interventions targeting at older adults who were smokers.[25] Although pneumococcal vaccines are highly recommended for individuals with chronic pulmonary diseases,[5,8,9] we found that participants with low PEF, indicating COPD,[14] were unlikely to receive PPV23. The VrPPV23 among people aged ≥75 years with a low PEF was only 20.2%. Our results indicate that a national vaccination policy for PPV23 administration that targets older chronic pulmonary diseases patients specifically is of high priority. In this study, factors associated with PPV23 nonreceipt among these particularly vulnerable older adults were further examined. We observed that older adults with a low PEF who were less educated or who were physically inactive were less likely to receive the PPV23. Less educated participants might have limited knowledge of PPV23's health benefit, thereby less likely to receive PPV23. In addition, Chowdhury et al reported older adults were less likely to receive vaccination, and was attributed to various health-risk behaviors, including physical activity.[26]

This study had several limitations. First, because this was a cross-sectional study, a causal relationship between VrPPV23 and the participants' characteristics could not be determined. Second, data regarding PPV23 receipt were collected through self-reports, which raise concerns of internal validity and recall bias, particularly in older adults. Third, findings from the HALST cohort may not be generalizable to the general population in Taiwan. Fourth, the VrPPV23 observed in this cohort might have been overestimated.[10] Fifth, PEF, a practical screening test for pulmonary functioning, was used in this study, yielding results that may have direct public health implications.[14,27] However, a more detailed and accurate assessment of pulmonary functioning would be required to clarify the observed relationship between PPV23 receipt and PEF. And, residual confounding by subclinical diseases (e.g., lung disease) was possible. Finally, the variability of PPV23 effectiveness in different groups of older people needed further investigated,[28] but the pneumococcal vaccination program is highly recommended.[4,5,8,9]

In conclusion, after the implementation of the free pneumococcal vaccination policy, a VrPPV23 of 20.7% was observed in HALST. Older adults who were women, current smokers, or who had a low PEF were less likely to receive the PPV23. Additionally, older adults with a low PEF who were less educated or who were physically inactive were particularly less likely to receive the PPV23. Therefore, these population groups should be the primary targets of public health efforts to promote pneumococcal vaccination. Together with the known influencing determinants, including financial or health service delivery factors, our results may provide a basis for developing vaccination policy models that achieve and maintain a high uptake of pneumococcal vaccination. Further research is warranted.

Acknowledgments

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