



Willingness to get vaccinated against influenza, pneumococcal disease, pertussis, and herpes zoster – A pre-COVID-19 exploration among the older adult population



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ABSTRACT

Background: Older adults are at increased risk for adverse health outcomes when having an influenza, pneumococcal disease, pertussis, or herpes zoster infection. Despite the ability of vaccinations to prevent these adverse outcomes, vaccination coverage is low in the European Union. This study aimed to explore the sociodemographic, lifestyle, and health-related characteristics associated with vaccination willingness for these vaccine-preventable diseases.

Methods: Cross-sectional data from wave 6 (years 2013–2017) of the population-based Doetinchem Cohort Study was analysed, with 3063 participants aged 46–86 years included. The outcome was the self-reported willingness to get vaccinated against influenza, pneumococcal disease, pertussis, and herpes zoster (willing, neutral, not willing). Multinomial logistic regression was used to investigate the socio-demographic, lifestyle and health characteristics associated with vaccination willingness.

Results: For influenza 36 % was willing to get vaccinated, 35 % was neutral and 28 % was not willing to get vaccinated. The willingness to get vaccinated for the relatively unfamiliar vaccine-preventable diseases was lower: 26 % for pneumococcal disease (neutral: 50 %, not willing: 23 %), 26 % for pertussis (neutral 53 %, not willing: 22 %), and 23 % for herpes zoster (neutral 54 %, not willing: 24 %). A relative lower willingness was found among those 46–64 years old (compared to those 65 years or older). Women, having a high SES, being employed and having a good health were all associated with lower willingness to get vaccinated, which was the case for all vaccine-preventable diseases.

Conclusions: Older adults were generally more willing to get vaccinated against influenza than for the three less familiar diseases. Characteristics of those less willing may be used to improve strategies to increase vaccination coverage. Additional studies are needed to investigate the willingness to get vaccinated during and after the COVID-19 pandemic that may have changed the feel of urgency for vaccination.

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1. Introduction

The global population of aging adults is rapidly growing. In 2010, 8 % of the global population was 65 years or older, and this is expected to be 16 % in 2050 [1]. Chronic conditions, such as obesity, diabetes, cancer, and chronic obstructive pulmonary disease

(COPD), are prevalent among older adults, which increases the risk on infectious diseases and related complications [2]. Additionally, the ability of the immune system to respond to pathogens decreases with age, which makes aging adults even more susceptible for adverse health outcomes [2–4]. Vaccine-preventable diseases such as influenza, pneumococcal disease, pertussis, and herpes zoster may result in severe morbidity, hospitalisation, and even death [5–8]. Of these infectious diseases, pneumococcal disease is the most prevalent cause of death with 118,300 estimated deaths annually in the European Union (EU), followed by influenza, with 72,000 estimated deaths in the EU [9,10]. Therefore, high vaccination coverage among older adults is essential to reduce the burden of these vaccine-preventable diseases [11].

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Despite the development of safe and effective vaccinations for influenza and these three generally less familiar diseases [5–8], vaccination coverage among older adults is low in the EU and varies by vaccination, region, and timeframe [12,13]. Studies conducted in the EU demonstrated that willingness to receive an influenza vaccination was higher compared to pneumococcal disease, pertussis, or herpes zoster vaccinations [14,15]. The World Health Organization (WHO) has set the goal of vaccinating against influenza at 75 % of those aged 65 years and older [16]. The years before the COVID-19 pandemic showed a decline in influenza vaccination coverage in most EU nations, and this increased during the COVID-19 pandemic [16,17]. However, most of the countries are still falling short of the 75 % target [17]. The vaccination coverage for people aged 65 years and older in the Netherlands was 68.9 % in 2020, in the first year of the COVID-19 pandemic [18].

To understand why vaccination coverage is low among older adults, it is important to understand which factors are associated with people's willingness to get vaccinated. Epidemiological (cohort) studies has added to this body of knowledge showing that several sociodemographic, lifestyle, and health-related characteristics are associated with willingness to get vaccinated. People with chronic conditions and a high BMI are consistently associated with a higher vaccination willingness, compared to people without these conditions [19,20,22]. However, results are frequently inconsistent for the characteristics sex, education level, smoking status, amount of physical activity, and one's own perceived health. [19,20,22].

In the Netherlands, the estimated disease burden due to infectious diseases was found to be highest for pneumococcal disease (37.223 DALYs/year), compared to influenza (7941 DALYs/year), herpes zoster (942 DALYs/year), and pertussis (812 DALYs/year) [23]. Those aged between 65 and 74 years old had a higher disease burden than people aged 75+, because of the higher number of years of life lost. To decrease the burden of these diseases, the Dutch vaccination program provides a yearly influenza vaccination for risk groups, including older adults (60+), and, since 2021, also a pneumococcal vaccination for older adults is offered, starting with those born between 1948 and 1952 [24]. The herpes zoster and pertussis vaccinations are available and licensed in the Netherlands, but not widely provided to the population.

The willingness to get vaccinated against influenza, pneumococcal disease, pertussis, and herpes zoster in the Netherlands has previously been investigated by means of a Discrete Choice Experiment (DCE). In this study, participants were asked to give their vaccination preferences in different scenarios (attributed to clinical symptoms, susceptibility, mortality, vaccine effectiveness, side effects, and the number of given vaccinations). The DCE demonstrated that respondents tend to have a higher willingness to get vaccinated against pneumococcal disease (68 %), compared to herpes zoster (58 %), influenza (54 %), and pertussis (54 %). Respondents aged between 50 and 65 years were less willing to get vaccinated than people aged 65 years and older [25]. Nevertheless, since little research comparing these four vaccine-preventable diseases has been done, and the literature demonstrates inconsistencies between factors associated with vaccination willingness, additional research is necessary.

The aim of this study was to explore the vaccination willingness for influenza, pneumococcal disease, pertussis, and herpes zoster by using data of a long-running epidemiological cohort study among older adults aged 46–85 years. Although most vaccination programmes are targeted at those aged 65 years and older, we included also participants aged between 46 and 65 years, because they become eligible for vaccination in the next 0–15 years. In addition, we want to evaluate which sociodemographic, lifestyle, and health-related characteristics are associated with vaccination willingness. The choice for these characteristics was based on what

is available in this multipurpose long-running Doetinchem Cohort Study and inspired by the Health Belief Model. The Health Belief Model explains that sociodemographic factors, people's beliefs, and cues to action do impact people's willingness to get vaccinated [26]. The results of this study may help target appropriate interventions for vaccination-promoting campaigns in the future.

2. Methods

2.1. Design, study population and data collection

The Doetinchem Cohort Study is a prospective population-based study that started in 1987. The first wave of the study (between 1987 and 1991) started with a total of 20,154 adults aged 20 to 60 years who were randomly selected from the population register in Doetinchem, with a response of 62 % ($n = 12,405$). A selection of the participants from wave 1 was invited for wave 2. In each following wave, the same respondents were invited as in the second wave, with a response of over 75 % each wave. Those who emigrated or actively withdrew from the study were not re-invited for follow-up measurements. In wave 6, between 2013 and 2017, questions about vaccination willingness and infectious diseases were added to the questionnaire [27]. This paper is based on this wave which included 3089 respondents aged 46–85 years (Fig. 1).

2.2. The four target diseases and the willingness to get vaccinated

The central outcome of this study was the self-reported willingness to get vaccinated against influenza, pneumococcal disease, pertussis, and herpes zoster on a scale from 1 to 7. With exception of influenza - which is expected to be well-known - the question on willingness was preceded by a short description of the clinical symptoms and treatment of pneumococcal disease, pertussis, and herpes zoster (Table 1). Per disease, some additional questions were used. For influenza, participants were asked whether they were vaccinated against influenza during the last flu season. For pneumococcal disease, the respondents filled in whether they had had pneumococcal disease in the past 12 months. For pertussis, a question on coughing for more than 2 weeks in the past 12 months was included. For herpes zoster, participants filled in if they ever have had shingles, including a question on the perception of the severity of shingles, categorized into severe (options 6 and 7 on a scale from 1 to 7) and not severe (options 1 to 5 on a scale from 1 to 7).

The questions on willingness to get vaccinated were asked per disease: *on a scale from 1 to 7, what is your willingness to get vaccinated?* The response options ranged from 1: *I would definitely not vaccinate* to 7: *I would definitely vaccinate*, whereby option 4 was being neutral. The items were converted into categorical items. We defined the neutral group as the original response options 3 to 5 based on a scale from 1 to 7 (options 1 and 2 were defined as not willing, and options 6 and 7 were defined as willing). As a sensitivity analyses we analysed the data using another cut-off value for the neutral group: 1 to 3 were defined as not willing, and 5 to 7 were defined as willing).

2.3. Sociodemographic, lifestyle and health-related characteristics

In order to investigate the key factors associated with vaccination willingness, several sociodemographic, lifestyle, and health-related factors were selected based on prior studies, data availability, and exploration (loneliness, being active, and being hospitalised). The sociodemographic characteristics that were included in this study were sex, age, household composition, education

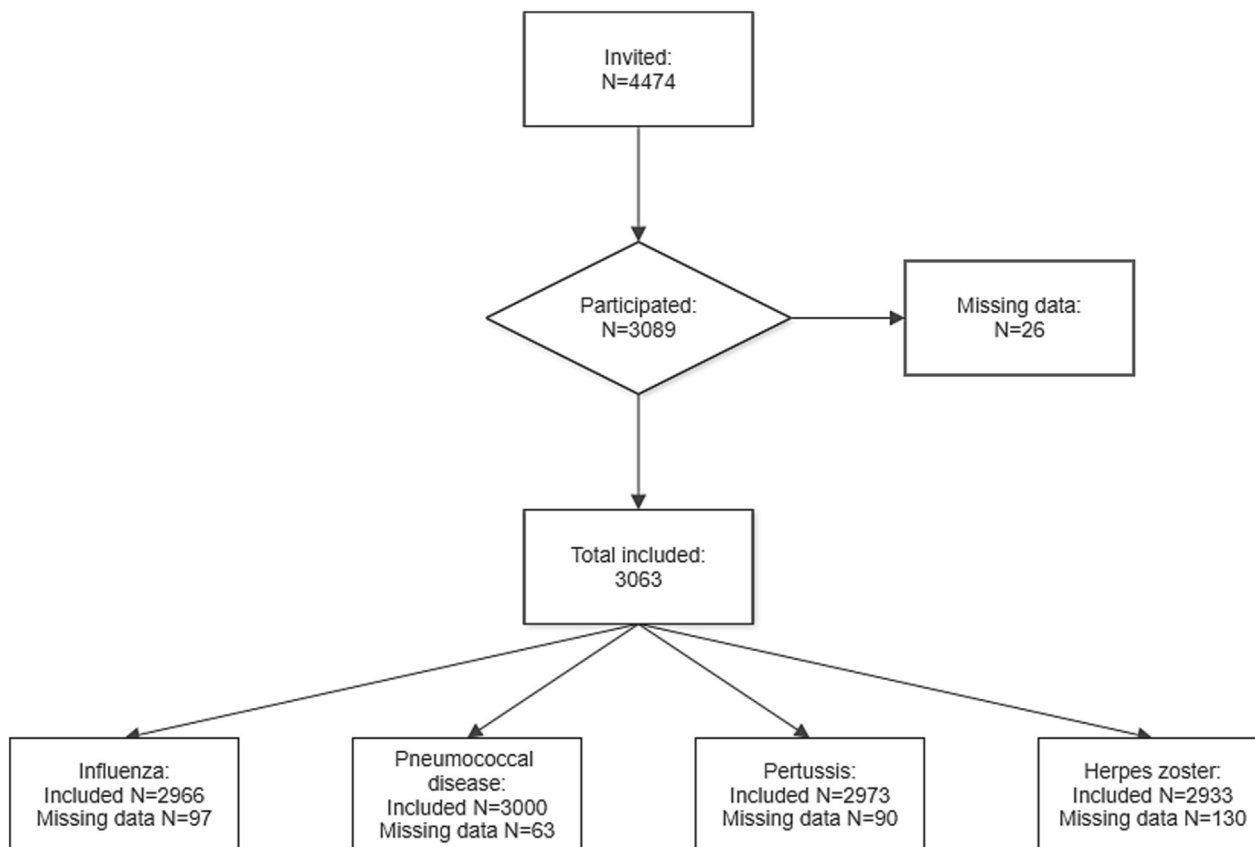


Fig. 1. Flow chart of the selection of participants for this study.

Table 1
Description of the clinical symptoms and treatment of the relatively unfamiliar vaccine-preventable diseases.

Pneumococcal disease	Pertussis (whooping cough)	Herpes zoster (shingles)
<i>Pneumococcal disease causes (high) fever, tightness of the chest, and chest pain when breathing. Pneumonia is generally curable with antibiotics, but some people die.</i>	<i>Pertussis or whooping cough often causes severe and prolonged coughing (sometimes paired with a characteristic “whoop” sound when trying to inhale). Treatment with antibiotics is only favourable when started early after infection.</i>	<i>Herpes Zoster or shingles causes a red skin rash with small fluid-filled blisters at one specific place on the body. These blisters may cause a severe itch and may be painful. The pain is hard to treat and can endure for months or even years.</i>

level, employment status, and loneliness. The determinant sex was divided into being a man or woman, defined at birth as registered in the population registers. Age was categorised into 10-years classes. Household composition was converted into living alone or living with others. Employment status was defined as whether the respondent had work (paid job or voluntary work) or had no work. Socio-economic status based on education level was categorised into low (primary/lower secondary, or vocational school), intermediate (intermediate vocational or higher secondary), or high level of education (higher vocational or university). Loneliness was dichotomised into being lonely and not being lonely, using the short scale for loneliness. This short scale consisted of 6 items. A sum score was made for these items in which a score of 0 and 1 was classified as not lonely and a score of 2 to 6 was classified as lonely [28].

Besides sociodemographic characteristics, several lifestyle factors were included. Smoking status and alcohol consumption were included as indicator for having unfavourable health habits. Other included lifestyle factors were Body Mass Index (BMI) and physical activity. Smoking status was defined as never, former, or current smoker. Alcohol consumption was dichotomised into low (≤ 1 glass per day) and high consumption (>1 glass per day). The BMI was calculated from -both measured- height and weight and categorized into normal weight ($BMI < 25 \text{ kg/m}^2$), overweight (BMI between 25 and 30 kg/m^2) and obesity (BMI of $\geq 30 \text{ kg/m}^2$). Physical activity was dichotomised in being active and not being active based on adherence to the Dutch physical activity guideline. This guideline recommends 30 min of moderate-to-vigorous physical activity per day on at least 5 days per week [29].

A selection of several health-related characteristics was also included in this study. The self-reported chronic conditions that were included were having had cancer, a myocardial infarction, stroke, asthma, diabetes mellitus, recent COPD like symptoms, a severe intestinal disorder, chronic joint inflammation, or a nervous system disease. Respondents were classified as having no, 1- or ≥ 2 chronic conditions. Self-reported perceived health assessed at a 5 point-scale and dichotomised into good perceived health (excellent, very good and good), and poor perceived health (fair and poor) [31]. Also, being hospitalised within the last 12 months was included, as indicator of recent severe health problems.

2.4. Statistical analyses

Descriptive analyses were used to describe the study population, the percentages of the willingness to get vaccinated against influenza, pneumococcal disease, pertussis, and herpes zoster, the

self-reported reasons for being or not being vaccinated against influenza in the previous flu season.

For each of the four vaccine-preventable diseases, univariate analyses were performed to further select the key characteristics associated with vaccination willingness. Statistically significant characteristics (p-value of < 0.05) for one or more outcome variables were selected for the final models using multivariable multinomial logistic regression analyses (Table 3). These multinomial logistic regression analyses were performed for both the total-study population and the population stratified by age (>65 and < 65) [22]. Missing data was < 1.1 %. Odds ratios (ORs) with 95 % confidence intervals (95 %CI) were used to report the results. Analyses were performed using SAS version 9.4.

3. Results

A total of 3063 participants aged 46–86 was included in this study, with slightly more participants younger than 65 years of age (n = 1655) than 65 years of age or older (n = 1480) (Table 2). Participants over the age of 65 were more likely to live alone, be less educated, be unemployed, have comorbidity, have a relative higher BMI and worse overall health compared to participants aged under 65 years.

3.1. Vaccination willingness against the four target diseases

Approximately-one-third of the participants reported being willing, one-third being neutral, and one-third being unwilling to get vaccinated against influenza (Fig. 2). Compared to influenza, higher percentages of participants reported being neutral in the willingness to get vaccinated against pneumococcal disease, pertussis, and herpes zoster. In total 36 % of the population was willing to get vaccinated against influenza, followed by pneumococcal disease (26 %), pertussis (26 %), and herpes zoster (23 %). Higher vaccination willingness was found among those aged 65 years and older, compared to the 46–64 age group: this holds for influenza (56 % vs 21 %), pneumococcal disease (34 % vs 20 %), pertussis (28 % vs 24 %), and herpes zoster (25 % vs 20 %).

The most common reasons for being vaccinated mentioned by those that received the influenza vaccination in the previous season were: 1. to be protected against influenza, 2. Because people perceived themselves as at risk for disease (such as those with a chronic condition or those over 65 years old), and 3. Because the general practitioner recommended the vaccination (Fig. 3). Most common reasons not being vaccinated were: 1. having no or little experience with influenza, and 2. the belief the vaccination was not effective.

Of the participants who were vaccinated against influenza in the previous season, 83 % were again willing to get vaccinated (17 % were neutral and 1 % were not willing). Of those who had pneumococcal disease in the previous year, 47 % (vs 26 % of the total population) were willing, 46 % were neutral, and 7 % were not willing to get vaccinated against the disease. Of the people who coughed for more than 2 weeks in the previous year, 28 % (vs 26 % of the total population) were willing to get vaccinated against pertussis (53 % were neutral and 19 % were not willing). Of the participants who had ever had herpes zoster, 26 % (vs 23 % of the total population) were willing, 52 % were neutral, and 22 % were not willing to get vaccinated. Of those participants who believed that herpes zoster was severe, 49 % were willing to get vaccinated (43 % were neutral and 9 % were not willing).

Table 2
Characteristics of the study population, Doetinchem Cohort Study wave 6.

	Total, % (N = 3063)	Age < 65, % (N = 1655)	Age ≥ 65, % (N = 1408)
<i>Sociodemographic characteristics</i>			
<i>Age</i>			
46–55 years	17.7	32.8	
55–65 years	36.3	67.2	
65–75 years	32.8		71.4
75–86 years	13.2		28.6
Women	52.9	55.0	50.5
Household composition (living alone)	16.4	10.6	23.2
<i>Level of education</i>			
Low	39.5	32.5	47.7
Intermediate	32.8	38.7	25.8
High	27.7	28.8	26.5
Employed (including voluntary work)	68.3	85.0	48.9
Lonely	30.7	28.0	33.9
<i>Lifestyle characteristics</i>			
<i>Smoking status</i>			
Never	37.8	39.2	36.2
Former	50.3	45.4	56.0
Current	11.1	14.7	6.9
Alcohol consumption (high)	32.5	32.2	32.8
<i>BMI</i>			
Normal	36.1	39.1	32.5
Overweight	45.1	43.6	46.9
Obese	18.7	17.3	20.3
Being active	65.3	65.2	65.4
<i>Health-related characteristics</i>			
<i>Chronic condition^a</i>			
None	42.5	49.6	34.2
1	35.2	33.6	37.0
≥2	22.3	16.8	28.8
Hospitalised in the past 12 months	9.7	7.1	12.7
Poor perceived health	15.2	12.9	18.0
<i>Target disease characteristics</i>			
Vaccinated against influenza during the last flu season	41.7	20.7	66.3
Had pneumococcal disease in the past 12 months	2.8	1.7	4.1
Coughed for more than 2 weeks in the past 12 months	24.6	24.5	24.8
Ever had shingles	11.8	10.1	13.9
Shingles was severe	2.6	2.1	3.3

NB: % calculations exclude missing data.

^a myocardial infarction, stroke, asthma, COPD, diabetes, cancer, severe intestinal disorder, chronic joint inflammation, or nervous system disease.

3.2. Overall willingness to get vaccinated

Overall, 60 % of the participants reported being willing or neutral to get vaccinated for all the mentioned diseases together, while 12 % was not willing to get vaccinated against these diseases. Those 12 % who were not willing to get vaccinated against all these diseases were generally 46–55 years of age, without a chronic condition, with a normal BMI and with a high education level.

Of those people who were willing or neutral in the willingness to get vaccinated against influenza, 87 % were willing or neutral to get vaccinated against the other three diseases. However, those who were not willing to get vaccinated against influenza, were more likely to vary in their willingness to get vaccinated for pneumococcal disease, pertussis, and herpes zoster.

Table 3

Results (ORs and 95 %CI) from the multinomial logistic regression analyses on the willingness to get vaccinated per disease with the group not willing as reference (N = 833 for influenza, N = 698 for pneumococcal disease, N = 639 for pertussis and N = 688 for herpes zoster).

Influenza		
	Neutral N = 1032	Willing N = 1068
<i>Sociodemographic characteristics</i>		
<i>Age</i>		
46–55 years (reference)	1.0	1.0
55–65 years	1.11 (0.88–1.41)	2.45 (1.75–3.44)
65–75 years	1.12 (0.84–1.47)	6.28 (4.42–8.93)
75–86 years	0.80 (0.52–1.25)	10.20 (6.58–25.82)
Women	0.98 (0.80–1.19)	0.77 (0.62–0.95)
<i>Level of education</i>		
Low (reference)	1.0	1.0
Intermediate	0.94 (0.75–1.18)	0.76 (0.60–0.97)
High	0.84 (0.66–1.07)	0.81 (0.63–1.04)
Employed (including voluntary work)	0.85 (0.67–1.08)	0.66 (0.52–0.83)
<i>Lifestyle characteristics</i>		
<i>Smoking status</i>		
Never (reference)	1.0	1.0
Former	1.34 (0.98–1.83)	0.99 (0.80–1.23)
Current	0.91 (0.75–1.12)	1.20 (0.84–1.72)
High alcohol consumption	1.40 (1.13–1.72)	1.15 (0.92–1.44)
<i>BMI</i>		
Normal (reference)	1.0	1.0
Overweight	1.19 (0.97–1.47)	1.36 (1.09–1.70)
Obese	1.20 (0.91–1.59)	1.67 (1.25–2.24)
Being active	0.70 (0.57–0.85)	0.78 (0.63–0.97)
<i>Health-related characteristics</i>		
<i>Chronic condition</i>		
None (reference)	1.0	1.0
1	1.17 (0.95–1.44)	1.38 (1.10–1.74)
≥2	1.10 (0.83–1.46)	2.18 (1.65–2.89)
Hospitalised in the past 12 months	1.08 (0.74–1.57)	1.66 (1.16–2.37)
Poor perceived health	1.14 (0.84–1.55)	1.30 (0.95–1.76)
<i>Pneumococcal disease</i>		
	Neutral N=1489	Willing N=779
<i>Sociodemographic characteristics</i>		
<i>Age</i>		
46–55 years (reference)	1.0	1.0
55–65 years	1.20 (0.94–1.53)	1.45 (1.05–2.01)
65–75 years	1.74 (1.31–2.30)	2.81 (1.98–3.99)
75–86 years	2.04 (1.36–3.04)	3.86 (2.44–6.10)
Women	0.85 (0.70–1.03)	0.52 (0.41–0.65)
<i>Level of education</i>		
Low (reference)	1.0	1.0
Intermediate	0.84 (0.67–1.05)	0.71 (0.54–0.92)
High	0.81 (0.64–1.02)	0.68 (0.51–0.89)
Employed (including voluntary work)	0.82 (0.65–1.04)	0.72 (0.56–0.94)
<i>Lifestyle characteristics</i>		
<i>Smoking status</i>		
Never (reference)	1.0	1.0
Former	0.97 (0.79–1.18)	0.98 (0.77–1.24)
Current	1.50 (1.08–2.08)	1.47 (0.99–2.16)
High alcohol consumption	1.10 (0.89–1.36)	1.16 (0.91–1.48)
<i>BMI</i>		
Normal (reference)	1.0	1.0
Overweight	1.31 (1.07–1.61)	1.41 (1.10–1.79)
Obese	1.46 (1.11–1.93)	1.66 (1.20–2.28)
Being active	0.85 (0.69–1.04)	0.86 (0.68–1.08)

Table 3 (continued)

Pneumococcal disease	Neutral N=1489	Willing N=779
<i>Health-related characteristics</i>		
Chronic condition		
None (reference)	1.0	1.0
1	1.21 (0.98–1.49)	1.41 (1.10–1.81)
≥2	1.45 (1.10–1.92)	2.50 (1.83–3.42)
Hospitalised in the past 12 months	1.16 (0.81–1.66)	1.53 (1.04–2.25)
Poor perceived health	1.03 (0.76–1.40)	1.18 (0.84–1.64)
Pertussis		
	Neutral N=1542	Willing N=758
<i>Sociodemographic characteristics</i>		
Age		
46–55 years (reference)	1.0	1.0
55–65 years	1.15 (0.89–1.49)	1.41 (1.03–1.93)
65–75 years	1.27 (0.95–1.69)	1.58 (1.13–2.22)
75–86 years	1.15 (0.79–1.66)	1.26 (0.81–1.93)
Women	1.00 (0.82–1.22)	0.83 (0.66–1.04)
Level of education		
Low (reference)	1.0	1.0
Intermediate	0.73 (0.58–0.91)	0.82 (0.63–1.06)
High	0.74 (0.58–0.94)	0.78 (0.59–1.02)
Employed (including voluntary work)	0.92 (0.73–1.16)	0.76 (0.59–0.99)
<i>Lifestyle characteristics</i>		
Smoking status		
Never (reference)	1.0	1.0
Former	0.91 (0.75–1.12)	1.00 (0.79–1.26)
Current	1.38 (0.98–1.95)	1.44 (0.98–2.13)
High alcohol consumption	1.12 (0.90–1.38)	1.10 (0.86–1.39)
BMI		
Normal (reference)	1.0	1.0
Overweight	1.11 (0.90–1.36)	1.14 (0.90–1.46)
Obese	1.23 (0.93–1.63)	1.51 (1.10–2.07)
Being active	0.92 (0.75–1.13)	0.91 (0.72–1.15)
<i>Health-related characteristics</i>		
Chronic condition		
None (reference)	1.0	1.0
1	1.28 (1.03–1.58)	1.35 (1.05–1.73)
≥2	1.18 (0.90–1.54)	1.60 (1.19–2.17)
Hospitalised in the past 12 months	0.99 (0.71–1.39)	1.15 (0.80–1.67)
Poor perceived health	1.02 (0.76–1.37)	1.15 (0.83–1.59)
Herpes zoster		
	Neutral N=1555	Willing N=656
<i>Sociodemographic characteristics</i>		
Age		
46–55 years (reference)	1.0	1.0
55–65 years	1.29 (1.00–1.65)	1.47 (1.06–2.03)
65–75 years	1.57 (1.19–2.08)	1.70 (1.19–2.41)
75–86 years	1.44 (1.00–2.09)	1.95 (1.26–3.02)
Women	1.05 (0.87–1.28)	0.73 (0.58–0.92)
Level of education		
Low (reference)	1.0	1.0
Intermediate	0.87 (0.70–1.09)	0.81 (0.62–1.06)
High	0.76 (0.60–0.96)	0.66 (0.50–0.88)
Employed (including voluntary work)	0.91 (0.72–1.14)	0.84 (0.64–1.10)
<i>Lifestyle characteristics</i>		
Smoking status		
Never (reference)	1.0	1.0
Former	0.95 (0.78–1.16)	1.00 (0.79–1.27)
Current	1.52 (1.09–2.12)	1.40 (0.94–2.08)
High alcohol consumption	1.04 (0.85–1.28)	1.22 (0.96–1.56)

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Table 3 (continued)

Herpes zoster	Neutral N=1555	Willing N=656
BMI		
Normal (reference)	1.0	1.0
Overweight	1.25 (1.02–1.52)	1.34 (1.04–1.71)
Obese	1.51 (1.14–1.99)	1.68 (1.21–2.34)
Being active	0.86 (0.70–1.05)	0.84 (0.66–1.06)
Health-related characteristics		
Chronic condition		
None (reference)	1.0	1.0
1	1.17 (0.95–1.44)	1.17 (0.90–1.51)
≥2	1.15 (0.88–1.50)	1.58 (1.16–2.14)
Hospitalised in the past 12 months	1.06 (0.76–1.49)	1.36 (0.93–1.99)
Poor perceived health	0.92 (0.69–1.23)	1.14 (0.82–1.58)

NB: statistically significant results are highlighted in bold (P < 0.05).

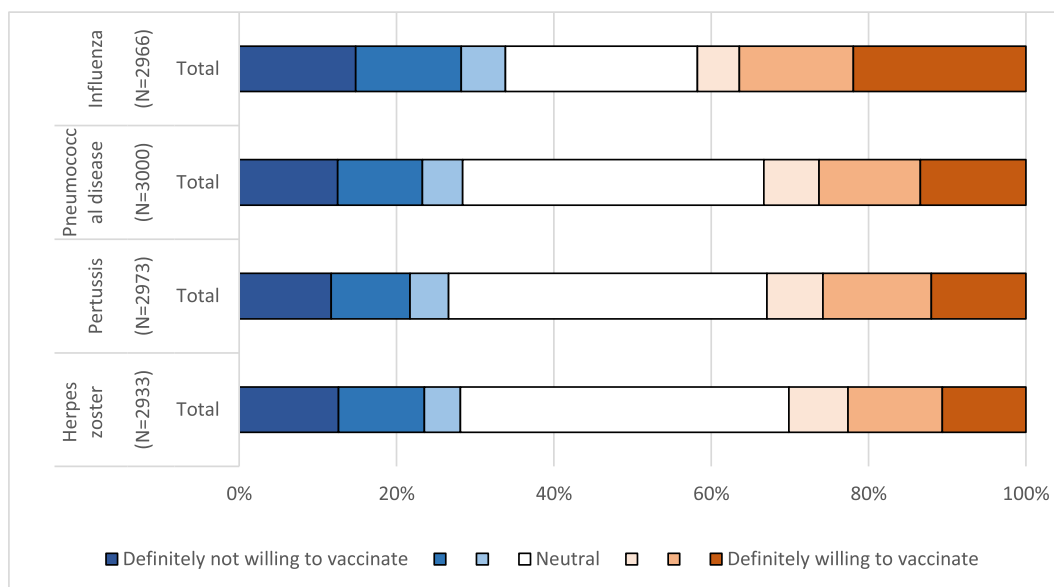


Fig. 2. The willingness to get vaccinated against four vaccine-preventable diseases based on a 7-point Likert-scale.

3.3. Characteristics associated with vaccination willingness

The determinants household composition and loneliness were excluded from the multivariable multinomial logistic regression analysis, due to a p-value of > 0.05 in the univariate analyses.

Higher age was associated with willingness to get vaccinated for all four vaccine-preventable diseases (Table 3). Also those with a higher BMI or those reporting a chronic conditions show a higher willingness to get vaccinated for all four vaccine-preventable diseases.

Woman show a lower vaccination willingness for influenza (OR: 0.77, 95 %CI: 0.62–0.95), pneumococcal disease (OR:0.52, 95 %CI: 0.41–0.65), and herpes zoster (OR:0.73, 95 %CI: 0.58–0.92) compared to men, but no association was found for pertussis. Compared to those with a low education level, intermediate education level was associated with a lower vaccination willingness for influenza (OR 0.76, CI95%: 0.60–0.97), while having a high

education level was associated with lower vaccination willingness for pneumococcal disease (OR: 0.68, 95 %CI: 0.51–0.89) and herpes zoster (OR: 0.66, 95 %CI: 0.50–0.88). Being employed was associated with a lower vaccination willingness for influenza (OR:0.66, 95 %CI: 0.52–0.83), pneumococcal disease (OR: 0.72 95 %CI: 0.56–0.94), and pertussis (OR: 0.76, 95 %CI: 0.59–0.99), but not for herpes zoster. Current smoking was associated with being neutral for pneumococcal disease (OR: 1.50, 95 %CI: 1.08–2.08) and herpes zoster vaccinations (OR: 1.52, 95 %CI: 1.09–2.12), compared to the group that was not willing to get vaccinated. No associations were found between willingness to get vaccinated and perceived health.

The associations shown in Table 3 were not stratified by age, because the results showed no difference by age, with only a few exceptions. The higher willingness of men and those with high BMI and BMI was mainly found in the age group under 65 years (data not shown).

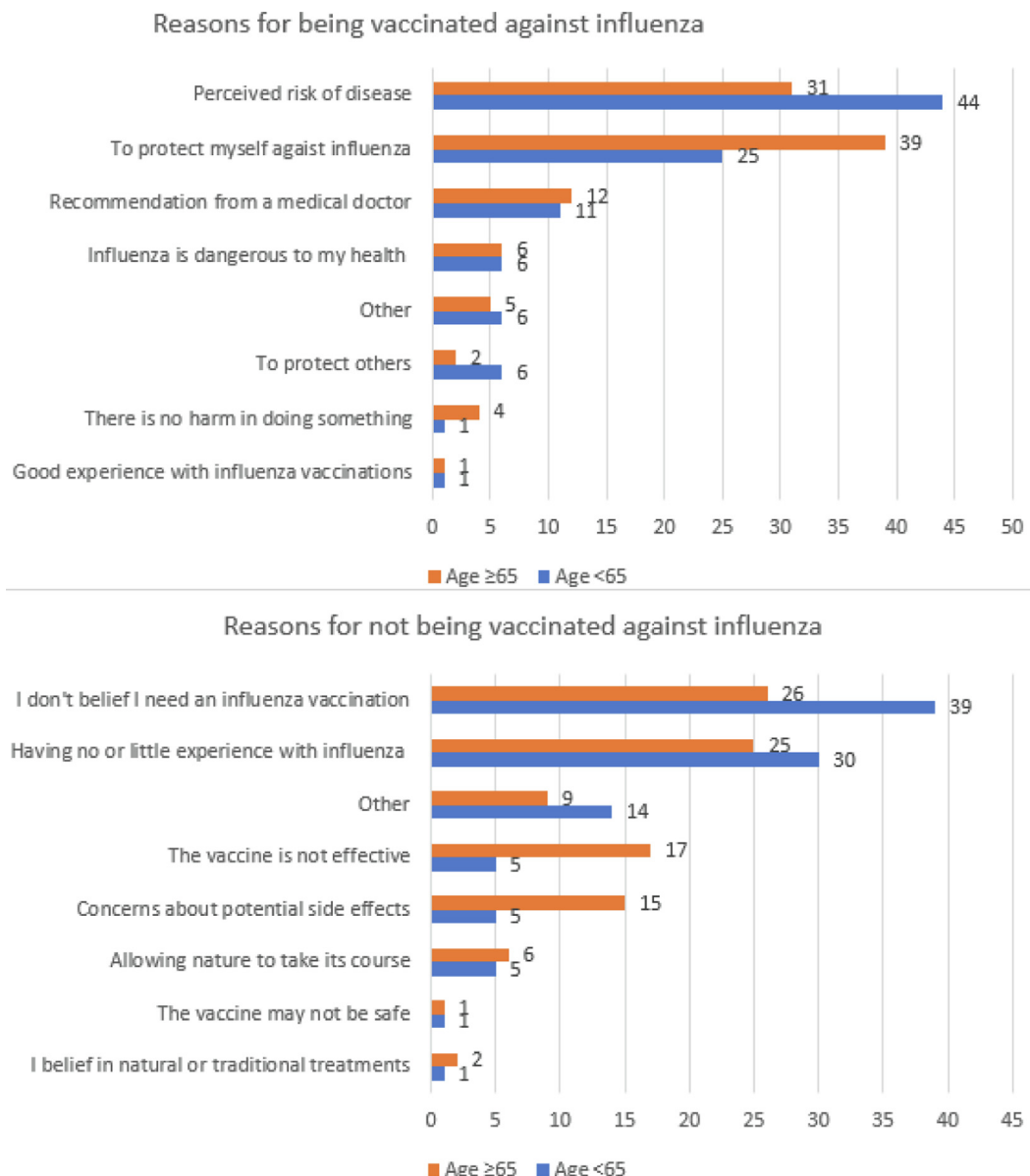


Fig. 3. Reported reasons for being or not being vaccinated against influenza during the previous flu season in %, for those being vaccinated (<65 years (n = 302) and 65+ (n = 609)) and those not being vaccinated (<65 years (n = 1136) and 65+ (n = 440)).

3.4. Sensitivity analyses

The results of the analyses with neutral group being only class '4', so using slightly different cut-of points show largely similar findings (data not shown).

4. Discussion

This study shows that vaccination willingness was highest for influenza (36 %), followed by pneumococcal disease (26 %), pertussis (26 %), and herpes zoster (23 %). A relative higher willingness to get vaccinated was found for all vaccine-preventable diseases among people with a higher age, men, and among those not working, having a low education level, having a higher BMI, and having chronic conditions.

Consistent with the present study, previous cross-sectional studies found that adults over 65 years were generally more willing to get vaccinated against influenza, than for the relatively

unfamiliar diseases being pneumococcal disease, pertussis, and herpes [14,15]. This may indicate that people prefer to get vaccinated against a more known disease, or that getting an influenza vaccination has become a habit. Those who were willing to get vaccinated against influenza were generally also willing to get vaccinated against the less familiar diseases. Therefore, vaccination coverage for the less familiar diseases could be increased by reaching those who have received an influenza vaccination.

In this study we found that a large group - approximately 50 % of the respondents - is neutral towards vaccination. In particular before the COVID-19 pandemics this may reflect a sense of indifference towards vaccination and infectious diseases in general in the population. During and after the COVID-19 pandemics we expect that the both the categories 'willing' and 'not-willing' will increase. With the follow-up of the Doetinchem Cohort Study we expect the data to study this. The large group of those who are neutral towards vaccination also suggest that there is room to increase vaccination uptake.

The Health Belief Model (HBM) explains that sociodemographic factors, people's beliefs, and cues to action do impact people's willingness to get vaccinated [26]. Because these three components are important in the willingness to get vaccinated, this model was used as framework to discuss our findings. The HBM model was also used in previous studies [19,20,32].

We found that several sociodemographic factors were associated with vaccination willingness. Older participants were more willing to get vaccinated than younger persons. This was also found in previous studies [19,20,31]. Furthermore, this study found that men were more willing to get vaccinated. It might be argued that women are more aware of potential side effects of vaccinations than men. However, previous studies in western countries show inconsistent findings [33]. Some studies suggest that women were more willing to get vaccinated [34,35], while other studies suggest that men were more willing to get vaccinated [36,37].

For influenza, an intermediate level of education (vs low level of education) was associated with lower vaccination willingness, while for pneumococcal disease and herpes zoster a high level of education (vs low level of education) was associated with lower vaccination willingness. Previous studies on level of education and influenza vaccination coverage demonstrated also inconsistent findings: a low level of education was associated with higher vaccination coverage in Italy, Ireland, and Spain. In contrast, a higher education level was associated to a higher vaccination coverage in Austria and Poland [38].

Having a high BMI and having chronic conditions were associated with a higher vaccination willingness for all four vaccine-preventable diseases, which is in line with other studies, [19,20,39].

People with these conditions may perceive themselves as more susceptible for adverse health outcomes when having an infectious disease compared to those without these conditions and thus, be more willing to get vaccinated. Among those with a chronic condition, the most often self-reported reason to be vaccinated against influenza was because they perceived themselves as at increased risk for adverse health effects. Perceived severity may also play a role in the willingness to get vaccinated, because people who reported that herpes zoster was severe, were generally more willing to get vaccinated against the disease compared to the people that reported the disease was not severe. That perceived susceptibility and perceived severity of the disease are important factors in the intention to get vaccinated is in line with previous studies [34,40].

More than 50 % of the people aged 65 years or older reported they did not want an influenza vaccination in the previous flu season because “they did not need it” or “they had no experience with influenza”. However, people over 65 years of age are at increased risk for adverse health outcomes when getting an influenza infection. Therefore, awareness programs on the dangers of influenza may increase vaccination coverage for influenza among this target group.

The WHO has set the goal of vaccinating 75 % of the adults above 65 years old against influenza [16]. The self-reported influenza coverage among older adults over 65 years was 66 % in this study. This percentage is comparable to the actual coverage between 2012 and 2016 in the Netherlands, which was on average 68.8 % among adults aged 65 years and over [41]. Despite influenza vaccinations were widely available in the Netherlands, the vaccination coverage was under the WHO's recommendation of 75 %. However, the information of this study was assessed in the years before the COVID-19 pandemic, i.e., 2013–2018, and the vaccination coverage for influenza increased during the COVID-19 pandemic (2020–2022) in the Netherlands [18]. Further research is needed to investigate which factors contributed to a higher

vaccination coverage during the COVID-19 pandemic in the Netherlands.

In accordance with other studies, those who were vaccinated against influenza in the previous flu season were again willing to get vaccinated against the disease [39,19]. Some people in this study reported that receiving an influenza vaccination has become a habit, which may indicate that vaccination promoting campaigns could permanently increase the vaccination coverage. The general practitioner (GP) may play an important role in vaccination promoting campaigns, because the GP was shown to be an important link in the cue to action in the current and previous studies [39].

4.1. Strengths and limitations

To our knowledge, this is the first observational study that investigates the vaccination willingness against the four infectious diseases: influenza, pneumococcal disease, pertussis, and herpes zoster in the same study. The main strengths of this study are the high number of respondents included (N = 3063), and the wide variety of sociodemographic, lifestyle, and health-related variables. The open-ended question on the reasons for being or not being vaccinated against influenza was added, so that respondents could report their own decision-making rather than select an answer from a list of options.

Another limitation was that the Doetinchem Cohort Study was only conducted in a middle-sized town in the east of the Netherlands. Because studies on COVID-19 have shown that vaccination willingness varies within countries [13], this study may not be completely representative for the Dutch population. Additionally, data from wave 6 of the Doetinchem Cohort Study was used. People who participated in follow-ups during this study were relatively higher educated and healthier compared to the general Dutch population [42].

For the question on willingness to vaccinate, using data from an epidemiological study gives only a limited perspective. Studies conducted from a policy perspective have included other variables in the analysis that have been known to affect uptake of vaccination. Examples are (perceived) effectiveness of the vaccine, (perceived) safety of the vaccine, source of information advising the vaccine.[43] Studies with a background in social sciences may include behavior or attitude of the social context of people deciding to take a vaccine or not.[44] Psychological oriented papers have also included beliefs about the vaccination and the institutional context of administering and safety control.[45] At this moment it is not possible to evaluate what would change when all these types of different variables were included in the same model. However, we still expect that health behaviours correlate and we expect the findings that life style and current health status are associated with vaccination preference will hold.

The same questions on the willingness to get vaccinated are part of wave 7 from the Doetinchem Cohort Study which is carried out between 2018 and 2023, with also some delays due to the COVID-19 lockdowns. In addition, half of the respondents also participated in a COVID-19 vaccination-response study. When these data collections are finalized we can study the stability of self-reported willingness of vaccination, the effect of COVID-19 pandemic on willingness to get vaccinated and the relation between vaccination willingness for the four diseases studied in this paper and COVID-19 vaccination uptake.

5. Conclusions

People were more willing to get vaccinated against influenza than against the less familiar diseases being pneumococcal disease,

pertussis, and herpes zoster. Vaccination willingness was in general higher among those who were older, men, lower SES, not working and those with health challenges (a higher BMI or a chronic disease).

Approximately a quarter of the population did not want to get vaccinated against those vaccine-preventable disease. To increase vaccination rates, it is relevant to gain more insights into how to reach this group and determine what influences people most when deciding whether or not to get vaccinated. Additional studies are needed to investigate the willingness to get vaccinated over time, particularly during and after the COVID-19 pandemic.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Statement of Ethics.

The study was conducted according to the principles of the World Medical Association Declaration of Helsinki and its amendments since 1964, and in accordance with the Medical Research Involving Human Subject Act (WMO). The protocols for wave 6 was approved by the Medical Ethical Committee (Medisch-Ethische Toetsingscommissie) of University Medical Center Utrecht. All participants gave written informed consent.

Disclosure Statement.

The authors have no ethical conflicts to declare.

Author contributions.

KM performed the analyses and wrote the first version of the manuscript. HSJP and WMMV were responsible for the data collection. All authors contributed to conception and design of the research, interpretation of data, writing of the article and all approved of the submitted version.

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