

ADULT VACCINATION ATTITUDES AND UPTAKES IN BULGARIA: A CROSS-SECTIONAL STUDY OF INFLUENZA, COVID-19, AND PNEUMOCOCCAL VACCINES

Vanya Rangelova¹, Nevena Ivanova^{2,3}, Ani Kevorkyan¹, Sara Sariyan^{4,5}, Meri Hristamyan¹

¹ Department of Epidemiology and Disaster Medicine, Faculty of Public Health, Medical University of Plovdiv, Plovdiv, Bulgaria

² Department of Urology and General medicine, Faculty of Medicine, Medical university of Plovdiv, Plovdiv, Bulgaria

³ St. Karidad MBAL, Karidad Medical Health Center, Cardiology, Plovdiv, Bulgaria

⁴ Department of Diagnostic Imaging, Faculty of Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria

⁵ SMDL Mediscan, Plovdiv, Bulgaria

ABSTRACT

Background: Vaccination rates for adults in Eastern Europe are still not satisfactory, especially for influenza, COVID-19, and pneumococcal disease. There is scarce information available about the number of Bulgarian adults that get vaccinated and the factors affecting their decision to do so. This study sought to evaluate vaccination coverage, attitudes, and barriers concerning influenza, COVID-19, and pneumococcal vaccines among hospitalized people in Bulgaria.

Methods: A cross-sectional study was conducted from June to September 2023, with 222 individuals hospitalized in Plovdiv, Bulgaria. A structured questionnaire assessed sociodemographic factors, comorbidities, immunization practices, and perceptions re-

garding adult immunization. We employed SPSS v25 for descriptive statistics and comparative analyses.

Results: The average participants' age was 58 years, with 63.5% identifying as female and 55.9% disclosing at least one comorbid health condition. From the cohort, 52.2% received at least one of the three immunizations. However, the number of individuals who received each of the three vaccines was minimal. 23.3% of participants with comorbidities and 18.4% of those without comorbidities indicated they had the influenza vaccine in the prior season ($p=0.363$). Approximately 5% of individuals were immunized against pneumococcal illness, and fewer than 20% possessed awareness of it. The apprehension of adverse effects was a significant concern, particularly for individuals with preexisting health issues. The absence of a physician's recommendation significantly contributed to the low uptake of the pneumococcal vaccine (45.2% vs. 28.6%, $p=0.011$). Approximately one in four respondents expressed belief in COVID-19 conspiracy theories. Respondents indicated that they were more likely to trust public institutions and general practitioners for information.

In conclusion, the findings of this study suggest that immunization rates among the surveyed hospitalized population in Plovdiv are low, especially for pneumococcal illness. Concerns about vaccine safety and the lack of physician recommendation are two major problems. To get more adults to get vaccinated in this context, it is important to enhance the way health-care providers work together and the way public health messages are issued.

Keywords

Vaccines, influenza, COVID-19, *Streptococcus pneumoniae*, comorbidities, adult vaccination

INTRODUCTION

Every year, there is a considerable burden of influenza, pneumococcal community-acquired pneumonia, and COVID-19 infections among adults, including the incidence of infections, consultations with general practitioners (GPs) and emergency rooms, as well as associated and non-associated hospitalisations and deaths [1, 2]. Worldwide, influenza is projected to result in over 32 million cases and 5.7 million hospitalizations due to influenza-related lower respiratory tract disease in adults each year, with the highest hospitalization rates occurring in individuals aged 65 years and older.

ADDRESS FOR CORRESPONDENCE:

Vanya Rangelova, MD, PhD
Department of Epidemiology and Disaster Medicine
Faculty of Public Health
Medical University of Plovdiv,
15 A Vasil Aprilov Blvd, 4000 Plovdiv, Bulgaria
phone: +359883403683
email:vanya.rangelova@mu-plovdiv.bg

Pneumococcal disease continues to be a predominant cause of community-acquired pneumonia in adults, representing roughly 10-13% of all pneumonia hospitalizations. *Streptococcus pneumoniae* is the predominant bacterial agent responsible for community-acquired pneumonia globally, but its incidence differs by area, accounting for roughly 30% of cases in Europe and 10-15% in the United States [5]. For every case of bacteremic pneumococcal pneumonia, there exist a minimum of three additional cases of non-bacteremic pneumococcal pneumonia, underscoring the significant underestimate of disease burden when depending exclusively on invasive disease monitoring [6].

Vaccination, the most efficacious method for avoiding influenza, pneumococcal, and COVID-19 infections and accompanying consequences, is advised for at-risk individuals [7]. Current guidelines advocate for influenza vaccination for older adults (mostly those aged ≥ 65 years), individuals with chronic medical conditions, healthcare professionals, and pregnant women [8]. Pneumococcal vaccination is likewise advised for elderly individuals and those with certain risk factors, such as chronic respiratory disease, cardiovascular disease, diabetes, and immunocompromising disorders [4]. Notwithstanding these recommendations and the significant illness load, vaccination coverage in Europe remains inadequate, especially in Eastern European nations.

Unlike in the pediatric population where vaccinations are routine and often mandatory, adult vaccinations are often elective and highly dependent on consumers' decisions and behaviors, resulting in an overall lower vaccination rate in adults [9]. In Europe, influenza vaccination coverage among older adults varies widely, ranging from 1.1% in Estonia to 74.5% in Scotland, with a median coverage of 35.3% [10]. Pneumococcal vaccination coverage is even lower, with studies reporting rates of only 4.5-9.9% among at-risk adults in France and 21% among multimorbid older adults across European centers [11, 12]. Only one European country reached the World Health Organization target of 75% influenza vaccination coverage in older persons by 2014/2015, and many countries have reported declining vaccination uptake over time [10].

The barriers to adult immunization are complex and encompass both individual and systemic issues. Individual-level challenges encompass apprehensions

regarding vaccine safety and adverse effects, distrust in healthcare systems and pharmaceutical companies, minimal perceived risk of vaccine-preventable illnesses, and insufficient awareness of vaccination guidelines [13, 14]. Systemic hurdles encompass restricted access to vaccination services, absence of reminder systems, poor healthcare professional awareness of adult vaccination standards, and inadequate monitoring of vaccination coverage among adult populations [15]. Factors that promote vaccination include robust recommendations from healthcare providers, prior vaccination history, higher level of education, existence of chronic medical illnesses, and confidence in medical professionals as trustworthy sources of health information [16, 17].

Bulgaria, as an Eastern European country, represents a particularly important context for studying adult vaccination attitudes and uptake. Limited data exist on vaccination coverage and determinants of vaccine acceptance in Bulgarian adults, despite the country's position within a region characterized by low vaccine confidence and suboptimal vaccination rates. Understanding the specific factors influencing vaccination decisions in Bulgarian context is essential for developing targeted interventions to improve vaccine uptake and protect vulnerable populations from vaccine-preventable diseases. This cross-sectional study aims to assess the current state of influenza, COVID-19, and pneumococcal vaccination coverage among Bulgarian adults and to identify the key determinants of vaccination attitudes and behaviors in this population.

MATERIALS AND METHODS

Study design and settings

A cross-sectional survey was conducted between the months of June and September 2023 to assess the attitudes, and practices regarding vaccination against influenza, COVID-19, and *Streptococcus pneumoniae* among hospitalized adults in Plovdiv, Bulgaria. Participants were recruited using a convenience sampling approach and included adult patients (≥ 18 years) who were hospitalized in the Cardiology department at the Multiprofile hospital "St. Karidad" in Plovdiv, Bulgaria during the study period. Patients were eligible if they were clinically stable and able to provide informed consent. Individuals with severe cognitive impairment or inability to complete the questionnaire were excluded.

Study questionnaire design

Following a thorough review of the relevant literature, the research team comprising two epidemiologists (each with postgraduate specialization in Epidemiology) and one specialist with a postgraduate specialization in general medicine—adapted the questionnaire for the study's objectives. The adaptation process included:

- ensuring clarity and comprehensibility of items for hospitalized adult patients,
- simplifying medical terminology where necessary,
- selecting questions relevant to the Bulgarian healthcare context,
- conducting internal expert review for content validity.

The structured questionnaire consisted of three major sections:

1. Demographic information - gender, age, place of residence, education, employment status, financial situation, comorbidities.
2. Practices regarding influenza, COVID-19, and pneumococcal vaccination
3. Attitudes towards vaccination in general and in particular regarding the influenza, COVID-19 and the pneumococcal vaccine.

STATISTICAL ANALYSIS

Descriptive statistics were utilized for both quantitative and qualitative variables. Continuous data were reported as means with standard deviations or, where distributional assumptions were violated, as medians with interquartile ranges (25th–75th percentile). Categorical variables were presented as frequencies and percentages (n, %). The Kolmogorov–Smirnov test was employed to evaluate the normality of continuous variables. Comparisons between groups for non-normally distributed continuous variables were performed using the Mann–Whitney U test, and changes in proportions between two groups were assessed using the Z-test. Statistical tests were considered statistically significant if the p-value was below 0.05. Data management and statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA; released 2017).

RESULTS

A total of 222 persons took part in the study, with 63.5% (n=141) being female. The median age of the

respondents was 58 years. Concerning the employment situation of the participants, approximately one-third were retired, and 42.3% reported being current smokers. In all, 55.9% of respondents indicated the presence of at least one comorbidity. The predominant comorbidities were heart disorders (n=72, 32.4%) and diabetes (n=27, 12.2%).

Table 1. Demographic characteristics of the respondents (n=222)

Variable	All respondents (n=222) n, (%)
Age, mean±Std	58 (46.75;68)
Gender, n (%)	
Male	81 (36.5)
Female	141 (63.5)
Level of education	
Primary education	4 (1.8)
Secondary education	114 (51.4)
Bachelor's degree	46 (20.7)
Master's degree	54 (24.3)
PhD degree	4 (1.8)
Work status	
Unemployed	13 (5.9)
Employed	116 (52.3)
Retired	74 (33.2)
Retired but currently employed	19 (8.6)
Smoker	
Yes	94 (42.3)
No	128 (57.7)
Comorbidities	
Yes	124 (55.9)
No	98 (44.1)

Practices regarding influenza, COVID-19 and pneumococcal vaccines

Overall, 116 (52.2%) respondents have decided to get vaccinated with either influenza, COVID-19 or pneumococcal vaccine. Of them the majority have received one vaccine (n=77, 66.4%) or 2 vaccines (n=38, 32.8%). Only one of all respondents was vaccinated with all the three vaccines.

The uptake and perceptions of influenza and COVID-19 immunizations among those with comorbidities were essentially similar to those without comorbidities. In the previous season, 23.3% of participants with comorbidities and 18.4% of those without reported having received the influenza vaccination (p=0.363). The inclination to receive influenza vaccine upon a general practitioner's recommendation was comparable between groups (54.0% vs. 52.0%, p=0.768). Concerns about adverse effects following immunization were significantly more common as a reason for influenza vaccination hesitancy among pa-

Table 2. Respondents' practices regarding influenza, COVID-19 and pneumococcal vaccination.

Variable	Comorbidities		p-value
	Yes (n=124)	No (n=98)	
	Participants that responded affirmatively		
Flu vaccination in the previous season	29 (23.3)	18 (18.4)	0.363
Plans to receive the flu vaccine in the current season	22 (17.7)	33 (33.7)	0.475
Would you recommend the influenza vaccine to family members	48 (38.7)	37 (29.8)	0.884
Would you receive the influenza vaccine if the GP recommends it to you	67 (54.0)	51 (52.0)	0.768
Reasons for hesitation to receive the influenza vaccine			
- fear of possible adverse events following immunization	62 (63.3)	35 (35.7)	0.033
- assumes the vaccine is not effective enough to prevent an illness	18 (14.5)	21 (21.4)	0.179
- has not received enough information about the vaccine	33 (26.6)	36 (36.7)	0.106
- assumes indluenza is not so dangerous	13 (10.5)	16 (16.3)	0.200
COVID-19 vaccination in the previous season	49 (39.5)	49 (50)	0.118
Would you recommend the COVID-19 vaccine to family members	53 (42.7)	36 (36.7)	0.364
Does not believe that a sufficiently detailed public campaign about the effectiveness and safety of vaccines against COVID-19 is conducted.	67 (54.0)	59 (60.2)	0.357
Reasons for hesitation to receive the COVID-19 vaccine			
- fear of possible adverse events following immunization	68 (54.8)	55 (56.1)	0.848
- assumes the vaccine is not effective enough to prevent an illness	23 (18.5)	19 (19.4)	0.874
- has already recovered from COVID-19	27 (21.8)	24 (24.5)	0.633
Has heard of the pneumococcal vaccine before	22 (17.7)	19 (19.4)	0.754
Has been vaccinated with the pneumococcal vaccine	6 (4.8)	5 (5.1)	0.928
Reasons for lack of pneumococcal vaccination			
- the vaccine has not been recommended by a doctor	56 (45.2)	28 (28.6)	0.011
- fear of adverse events following immunization	23 (18.5)	9 (9.2)	0.049
- assumes the vaccine is not effective enough to prevent an illness	4 (3.2)	5 (5.1)	0.482
- has not received enough information about the vaccine	48 (38.7)	52 (53.1)	0.033
Would receive the pneumococcal vaccine if recommended by a doctor	52 (41.9)	43 (43.9)	0.772

tients with comorbidities (63.3% vs. 35.7%, $p=0.033$). The vaccination coverage and attitudes regarding COVID-19 showed no significant change according to comorbidity status. Approximately 50.0% of respondents without comorbidities and 39.5% of those with comorbidities reported prior vaccination ($p=0.118$), and concerns over vaccine safety and efficacy were similar in both groups. Both groups demonstrated little awareness and adoption of pneumococcal vaccination, with fewer than 20% of respondents knowledgeable about the vaccine and approximately 5% reporting vaccination status. Participants with comorbidities exhibited a significantly greater propensity to report the lack of physician recommendation (45.2% vs. 28.6%, $p=0.011$), fear of adverse events (18.5% vs. 9.2%, $p=0.049$), and insufficient information regarding the vaccine (38.7% vs. 53.1%, $p=0.033$) as justifications for non-vaccination. However, the propensity to accept pneumococcal vaccine based on a physician's

suggestion was similar between the groups (41.9% vs. 43.9%, $p=0.772$).

When asked about the trusted source of information regarding vaccines in general most respondents indicated the official sources such as the Ministry of Health, World Health Organization ($n=121$, 54.5%). General practitioners were the second most trusted source were the ($n=117$, 52.7%).

Attitudes towards influenza, COVID-19 and pneumococcal vaccines

In our study we also wanted to explore the attitudes and possible beliefs that might influence our respondents' decision about receiving influenza, COVID-19 or pneumococcal vaccine.

Vaccination attitudes were largely comparable for respondents with and without comorbidities. Approximately 50% of the individuals from both groups favored natural immunity (50.8% vs. 57.1%, $p=0.806$), while almost 20% voiced skepticism over

Table 3. Participants' beliefs regarding vaccines in general and vaccines against influenza, COVID-19 and *Streptococcus pneumoniae*

Variable	Comorbidities		p-value
	Yes (n=124)	No (n=98)	
	Participants that responded affirmatively (strongly agree/agree)		
I do not have time to get vaccinated with recommended vaccines.	20 (16.1)	11 (11.2)	0.716
I prefer to build immunity naturally.	63 (50.8)	56 (57.1)	0.806
I do not believe that vaccines effectively protect against disease.	29 (23.4)	18 (18.4)	0.324
I am having a hard time making an appointment with my doctor to get vaccinated.	12 (9.7)	(8.2)	0.002
I believe that the influenza vaccine is safe	36 (29.0)	43 (43.9)	0.246
When infected with influenza, older adults and people suffering from chronic diseases have a higher risk of serious complications.	63 (50.8)	59 (60.2)	0.619
Flu vaccine reduces the risk of complications if the disease occurs	52 (41.9)	52 (53.1)	0.327
COVID-19 vaccines are important for limiting the spread of the infection	49 (39.5)	48 (49.0)	0.436
COVID-19 vaccines protect against severe illness, hospitalization, and death	45 (36.3)	44 (44.9)	0.361
COVID-19 vaccines are part of a conspiracy plan to reduce the population, and the virus was artificially created for this purpose.	32 (25.8)	25 (25.5)	0.923
COVID-19 vaccines were developed too quickly, raising questions about their safety	56 (45.2)	56 (57.1)	0.160
I believe the pneumococcal vaccine is effective in preventing pneumonia.	29 (23.4)	22 (22.4)	0.860
If I have a health condition that increases the risk of pneumonia, I will get immunized.	40 (32.2)	46 (46.9)	0.024

vaccination efficacy (23.4% vs. 18.4%, $p = 0.324$). Time restrictions were rarely cited as an impediment to immunization (16.1% vs. 11.2%, $p = 0.716$). Perceptions on influenza vaccination were moderate: 29.0% of respondents with and 43.9% without comorbidities considered the influenza vaccine safe ($p=0.246$). Approximately 50% of the participants acknowledged that older adults and those with chronic illnesses are at an elevated risk of severe influenza complications (50.8% vs. 60.2%, $p=0.619$), while 41.9% vs. 53.1% agreed that vaccination mitigates problems ($p=0.327$). Perceptions on COVID-19 vaccination were varied. Approximately 39.5% of individuals with and 49.0% of those without comorbidities concurred that COVID-19 vaccines were crucial for mitigating transmission ($p=0.436$), whereas 36.3% vs. 44.9%, respectively, asserted that vaccines protect against severe illness ($p=0.361$). Approximately one quarter of respondents in both groups indicated conspiracy ideas (25.8% vs. 25.5%, $p=0.923$), and apprehensions over the rapid development of vaccines were prevalent (45.2% vs. 57.1%, $p=0.160$). Perceptions on pneumococcal vaccination were predominantly unfavorable, with only approximately one quarter of participants considering the vaccine

effective in preventing pneumonia (23.4% vs. 22.4%, $p=0.860$). Respondents without comorbidities were significantly more inclined to get vaccinated in case of a health condition elevating pneumonia risk (46.9% vs. 32.2%, $p=0.024$).

DISCUSSION

The overall vaccination coverage with at least one of the vaccines against influenza, COVID-19 and *Streptococcus pneumoniae* was 52.2%, illustrating the issues of adult immunization in Eastern Europe. The influenza vaccination rates of 23.3% for participants with comorbidities and 18.4% for those without align with the poor coverage rates recorded throughout the region. Research from neighboring countries indicates comparably low vaccination rates. Poland has documented influenza vaccination coverage ranging from 39% to 61% depending on the demography of the examined sample, while Ukraine exhibits even lower figures, with 67-73% of participants having never received an influenza vaccine [18,19]. The median influenza vaccine coverage in Europe is roughly 35.3%, with Eastern European nations persistently reporting lower rates [10,20].

The COVID-19 vaccine coverage in this study was 39.5% for respondents without comorbidities and

50% for those with comorbidities, which is much lower than the rates reported in Western European countries [20] but consistent with the trends observed in Eastern Europe during the pandemic. Eastern European nations, and Bulgaria in particular, expressed significant vaccine hesitation during COVID-19 immunization initiatives, primarily fueled by skepticism towards national governments and medical professionals as credible sources of medical information [21]. Vaccine trust in Eastern European and Central Asian nations averaged 43.7%, markedly lower than the EU-27 average of 49.97% [22].

The pneumococcal vaccination coverage of roughly 5% and awareness below 20% signals an important deficiency in preventive healthcare. This coverage is significantly lower as compared to European nations where pneumococcal vaccine coverage among at-risk individuals varies from 4.5% to 9.9% in France, reaching 21% among multimorbid older adults across European centers [11,12, 23]. The limited awareness and adoption of pneumococcal immunization in Bulgaria indicates deficiency in patients' education and healthcare providers' referral mechanisms for this vaccine.

The finding that 45.2% of participants with comorbidities identified the lack of physician recommendation as a barrier to pneumococcal vaccination is notably troubling, as those were the individuals for whom vaccination is most strongly recommended [4]. This fact reveals a systemic failure in adult preventive healthcare. Evidence indicates that the implementation of standing orders, electronic health record reminders, and routine assessment of vaccination status during each clinical encounter can significantly enhance vaccination rates [24,25]. Clinician reminders to order vaccinations were demonstrated to increase vaccination rates by 4-32%, whereas packaged interventions incorporating various methods could enhance immunization rates by 4-42% [26].

The prevalence of safety concerns as an impediment to vaccination, especially among individuals with comorbidities (63.3% for the influenza vaccine), signifies a wider trend of vaccine reluctance in Eastern Europe and among patients with chronic illnesses worldwide. Apprehensions regarding vaccine-induced disease exacerbations, adverse reactions, and the expedited development of COVID-19 vaccinations (45.2-57.1% of respondents) align with results from earlier research including individuals with chronic

diseases [27, 28]. Individuals with chronic illnesses frequently encounter added difficulty in vaccination choices, considering their increased vulnerability to severe infection outcomes and the ambiguous effects of vaccines on their preexisting disorders [29]. Our finding that almost 25% of participants supported vaccine-related conspiracy theories aligns with the significant levels of disinformation and distrust recorded in the area [21]. The dependence on official sources (Ministry of Health, WHO) and general practitioners as credible information sources (54.5% and 52.7%, respectively) indicates that focused public health campaigns and provider-led education may be beneficial in this demographic. However, the disparity between trust in official sources and the actual vaccination rates demonstrates that information alone is inadequate; proactive endorsement and vaccination facilitation are crucial.

Limitations and Strengths

This study has several limitations. The cross-sectional design precludes assessment of causality or temporal relationships. The findings should be interpreted in the context of the study population, which consisted of hospitalized adults from a single city, and may not be fully representative of the general population in Bulgaria.. Self-reported vaccination status was not verified against medical records, which may introduce recall bias. Additionally, the study did not assess specific interventions or their effectiveness in improving vaccination rates.

Despite these limitations, our study provides valuable data on adult vaccination in Bulgaria, a country with limited published evidence on the topic. A key strength of this study is the detailed assessment of attitudes and beliefs toward vaccination. The findings highlight the central role of physician recommendation, concerns about vaccine safety, and the presence of misinformation, including conspiracy beliefs, as major drivers of vaccine hesitancy. These factors are modifiable and should be a primary focus of future public health interventions.

CONCLUSION

The present study highlights important gaps in adult immunization among a hospital-based population in Bulgaria, especially for pneumococcal vaccination, despite a strong desire to receive vaccinations when recommended by healthcare providers. The results highlight the essential requirement for enhanced

healthcare professional involvement, focused patient education on safety issues, and systemic actions to promote immunization. Rectifying these deficiencies is crucial for safeguarding at-risk individuals from vaccine-preventable illnesses and alleviating the significant impact of influenza, pneumococcal disease, and COVID-19 within this demographic. Future studies should aim to include larger and nationally representative samples in order to validate these findings and support the development of targeted immunization strategies at the national level.

REFERENCES

1. Troeger C.E., Blacker B.F., Khalil I.A., Zimsen S.R.M., Albertson S.B., Abate D, et al. Mortality, morbidity, and hospitalisations due to influenza lower respiratory tract infections, 2017: An analysis for the Global Burden of Disease Study 2017. *Lancet Respir. Med.* 2019; 7, 69–89. [https://doi.org/10.1016/S2213-2600\(18\)30496-X](https://doi.org/10.1016/S2213-2600(18)30496-X)
2. Torres, A, Cillóniz, C, Blasi F, Chalmers J.D., Gaillat J, Dar-tois N, et al. Burden of pneumococcal community-acquired pneumonia in adults across Europe: A literature review. *Respir. Med.* 2018; 137, 6–13. <https://doi.org/10.1016/j.rmed.2018.02.007>.
3. Lafond KE, Porter RM, Whaley MJ, Suizan Z, Ran Z, Al-eem MA, et al. Global burden of influenza-associated lower respiratory tract infections and hospitalizations among adults: A systematic review and meta-analysis. *PLoS Med.* 2021;18(3):e1003550. <https://doi.org/10.1371/journal.pmed.1003550>.
4. Kobayashi M, Pilishvili T, Farrar JL, Leidner AJ, Gierke R, Prasad N, et al. Pneumococcal Vaccine for Adults Aged ≥19 Years: Recommendations of the Advisory Committee on Immunization Practices, United States, 2023. *MMWR Recomm Rep.* 2023;72(3):1-39. <https://doi.org/10.15585/mmwr.rr7203a1>.
5. Reyes LF, Conway Morris A, Serrano-Mayorga C, Derde LPG, Dickson RP, Martin-Loeches I. Community-acquired pneumonia. *Lancet.* 2025;406(10517):2371-2388. [https://doi.org/10.1016/S0140-6736\(25\)01493-X](https://doi.org/10.1016/S0140-6736(25)01493-X).
6. Said MA, Johnson HL, Nonyane BA, Deloria-Knoll M, O'Brien KL; AGEDD Adult Pneumococcal Burden Study Team et al. Estimating the burden of pneumococcal pneumonia among adults: a systematic review and meta-analysis of diagnostic techniques. *PLoS One.* 2013;8(4):e60273. <https://doi.org/10.1371/journal.pone.0060273>.
7. HCSP. Vaccination des Personnes Immunodéprimées ou Aspléniques. In *Recommandations Actualisées*; Haut Conseil de la Santé Publique: Paris, France. Available online: <http://www.hcsp.fr/explore.cgi/avisrapportsdomaine?clefr=504>.
8. ECDC Technical report Seasonal influenza vaccination recommendations and coverage rates in EU/EEA member states, 2023. [Last accessed 23 February 2026]. Available online: <https://www.ecdc.europa.eu/sites/default/files/documents/Seasonal-flu-vacc-recs-coverage-rates-EU-EEA.pdf>
9. Tan L. Adult vaccination: Now is the time to realize an unfulfilled potential. *Hum Vaccin Immunother.* 2015;11(9):2158-66. <https://doi.org/10.4161/21645515.2014.982998>.
10. Blank PR, van Essen GA, Ortiz de Lejarazu R, Kyncl J, Nitsch-Osuch A, Kuchar EP, et al. Impact of European vaccination policies on seasonal influenza vaccination coverage rates: An update seven years later. *Hum Vaccin Immunother.* 2018;14(11):2706-2714. <https://doi.org/10.1080/21645515.2018.1489948>.
11. Wyplosz B, Fernandes J, Sultan A, Roche N, Roubille F, Loubet P, et al. Pneumococcal and influenza vaccination coverage among at-risk adults: A 5-year French national observational study. *Vaccine.* 2022;40(33):4911-4921. <https://doi.org/10.1016/j.vaccine.2022.06.071>.
12. Papazoglou DD, Baretella O, Feller M, Del Giovane C, Moutzouri E, Aujesky D, et al. Cross-sectional study on the prevalence of influenza and pneumococcal vaccination and its association with health conditions and risk factors among hospitalized multimorbid older patients. *PLoS One.* 2021;16(11):e0260112. <https://doi.org/10.1371/journal.pone.0260112>.
13. Kumar S, Shah Z, Garfield S. Causes of Vaccine Hesitancy in Adults for the Influenza and COVID-19 Vaccines: A Systematic Literature Review. *Vaccines (Basel).* 2022;10(9):1518. <https://doi.org/10.3390/vaccines10091518>.
14. Larson HJ, Gakidou E, Murray CJL. The Vaccine-Hesitant Moment. *N Engl J Med.* 2022;387(1):58-65. <https://doi.org/10.1056/NEJMr2106441>.
15. Bach AT, Kang AY, Lewis J, Xavioer S, Portillo I, Goad JA. Addressing common barriers in adult immunizations: a review of interventions. *Expert Rev Vaccines.* 2019;18(11):1167-1185. <https://doi.org/10.1080/14760584.2019.1698955>.
16. Cunningham-Erves J, George W, Sanderson M, Stewart E, Jin SW, Davis J, Brandt HM. Predictors of seasonal influenza and COVID-19 vaccination coverage among adults in Tennessee during the COVID-19 pandemic. *Front Public Health.* 2024;12:1321173. <https://doi.org/10.3389/fpubh.2024.1321173>.
17. Sulis G, Basta NE, Wolfson C, Kirkland SA, McMillan J, Griffith LE, Raina P; Canadian Longitudinal Study on Aging (CLSA) Team. Influenza vaccination uptake among Canadian adults before and during the COVID-19 pandemic: An analysis of the Canadian Longitudinal study on Aging (CLSA). *Vaccine.* 2022;40(3):503-511. <https://doi.org/10.1016/j.vaccine.2021.11.088>.
18. Chen C, Liu X, Yan D, Zhou Y, Ding C, Chen L, et al. Global influenza vaccination rates and factors associated with influenza vaccination. *Int J Infect Dis.* 2022;125:153-163. <https://doi.org/10.1016/j.ijid.2022.10.038>.
19. Zaprutko T, Kremin Y, Michalak M, Bernatoniene J, Zaprutko L, Hudz N, et al. Social Attitude to COVID-19 and Influenza Vaccinations after the Influenza Vaccination Season and between the Second and Third COVID-19 Wave in Poland, Lithuania, and Ukraine. *Int J Environ Res Public Health.* 2022;19(4):2042. <https://doi.org/10.3390/ijerph19042042>.
20. Achterbergh RCA, McGovern I, Haag M. Co-Administration of Influenza and COVID-19 Vaccines: Policy Review and Vaccination Coverage Trends in the European Union, UK, US, and Canada between 2019 and 2023. *Vaccines (Basel).* 2024;12(2):216. <https://doi.org/10.3390/vaccines12020216>.
21. Toshkov D. What accounts for the variation in COVID-19 vaccine hesitancy in Eastern, Southern and Western Europe? *Vaccine.* 2023;41(20):3178-3188. <https://doi.org/10.1016/j.vaccine.2023.03.030>.
22. Eagan RL, Claessens T, Hendrickx G, Larson HJ, Karafillakis E. The state of vaccine confidence among the general public in Eastern Europe and Central Asia. *Vaccine.* 2025;67:127849. <https://doi.org/10.1016/j.vaccine.2025.127849>.
23. Wyplosz B, Grenier B, Roche N, Roubille F, Loubet P, Sultan A, et al. Pneumococcal vaccination at 65 years and vaccination coverage in at-risk adults: A retrospective population-based study in France. *PLoS One.* 2025;20(8):e0329703. <https://doi.org/10.1371/journal.pone.0329703>.
24. Bridges CB, Hurlley LP, Williams WW, Ramakrishnan A, Dean AK, Groom AV. Meeting the Challenges of Immunizing Adults. *Am J Prev Med.* 2015;49(6 Suppl 4):S455-64. <https://doi.org/10.1016/j.amepre.2015.05.004>.

- p>org/10.1016/j.amepre.2015.08.014.
25. Hurley LP, Lindley MC, Allison MA, O'Leary ST, Crane LA, Brtnikova M, et al. Physicians' Use of Evidence-Based Strategies to Increase Adult Vaccination Uptake. *Am J Prev Med.* 2020;59(3):e95-e103. <https://doi.org/10.1016/j.amepre.2020.03.020>.
26. Wheeler SG, Beste LA, Overland MK, Wander PL. Interventions in primary care to increase uptake of adult vaccines: a systematic review. *J Public Health (Oxf).* 2025;47(2):222-231. <https://doi.org/10.1093/pubmed/fdaf008>.
27. Fuller A, Hancox J, Vedhara K, Card T, Mallen C, Van-Tam JSN, Abhishek A. Barriers and facilitators to vaccination uptake against COVID-19, influenza, and pneumococcal pneumonia in immunosuppressed adults with immune-mediated inflammatory diseases: A qualitative interview study during the COVID-19 pandemic. *PLoS One.* 2022;17(9):e0267769. <https://doi.org/10.1371/journal.pone.0267769>.
28. Zhao Y, Du J, Li Z, Xu Z, Wu Y, Duan W, et al. It is time to improve the acceptance of COVID-19 vaccines among people with chronic diseases: A systematic review and meta-analysis. *J Med Virol.* 2023;95(2):e28509. <https://doi.org/10.1002/jmv.28509>.
29. Choi T, Chan B, Grech L, Kwok A, Webber K, Wong J, et al. Factors Influencing COVID-19 Vaccine Hesitancy among Patients with Serious Chronic Illnesses during the Initial Australian Vaccine Rollout: A Multi-Centre Qualitative Analysis Using the Health Belief Model. *Vaccines (Basel).* 2023; 11(2):239. <https://doi.org/10.3390/vaccines11020239>.
30. Tan LLJ, A review of the key factors to improve adult immunization coverage rates: What can the clinician do? *Vaccine,* 2018;36(36):5373-5378. <https://doi.org/10.1016/j.vaccine.2017.07.050>.
31. Siciliani L, Wild C, McKee M, Kringos D, Barry MM, Barros PP, et al. Strengthening vaccination programmes and health systems in the European Union: A framework for action. *Health Policy,* 2020; 124(5):511-518. <https://doi.org/10.1016/j.healthpol.2020.02.015>.