



Vaccination Motivators and Deterrents Among Undervaccinated Older Adults in North Dakota

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Abstract

Despite increased risk of morbidity and mortality among older adults due to preventable infectious diseases such as influenza, shingles, pneumonia, and COVID-19, many forego receiving some, if not all, of these vaccinations. This study examines vaccination motivators and deterrents for undervaccinated older adults in North Dakota (ND). Adults aged 65+ in ND were mailed a survey ($n = 901$) with questions gauging vaccination behaviors and perceptions, with 132 of these indicating not receiving certain vaccinations. Further questions assessed reasons they have not been vaccinated against the following diseases: influenza, shingles, pneumonia, and COVID-19 (e.g., “Concerned about side effects”, “Vaccines are dangerous”, “I’m healthy and I do not need it”) and what would make it more likely to get a vaccine (e.g., “More information”, “Doctor recommendation”, “Easy access to vaccines”). Reasons for remaining unvaccinated varied by vaccine. For influenza and pneumococcal vaccines, respondents were more likely to indicate they are healthy and do not need the vaccine. For shingles and COVID-19, respondents were more likely to indicate concerns about side effects. Factors reported to motivate increasing the likelihood of getting a vaccine were receiving a doctor recommendation, receiving more information, and having a vaccine provided at no cost. These results contribute to our understanding of vaccination behaviors among older adults and underscore specific issues around which to frame interventions tailored to increase vaccine uptake for this population.

Keywords Vaccines · Older adults · Behaviors · Shingles · COVID-19

Introduction

Older adults are at an increased risk of complications, hospitalizations and death due to many vaccine-preventable diseases, including, but not limited to, COVID-19, shingles, pneumonia, and influenza [1–4]. They are also more likely to be vaccinated than their younger counterparts [5–7]. However, even with elevated health risks and government recommendations for immunizations [8], some older adults are reluctant to get vaccinated. Moreover, vaccination rates for older adults can vary geographically. In North Dakota

(ND), data from the North Dakota Department of Health and Human Services (NDDoHHS) indicate that immunization rates for many vaccines among adults aged 65 and older remain lower than those seen nationally, including for influenza (US: 69.7%, ND: 56.6%); COVID-19 (at least one dose) (US: 95%, ND: 79.7%); pneumococcal (US: 70%, ND: 59.4%); and shingles (at least one dose) (US: 45.7%, ND: 41.3%) [9–14]. Lower vaccination rates among ND older adults could be due to the rural nature of the state as research has shown more rural areas in the US have lower vaccination rates than urban areas [15, 16]. However, to improve vaccine uptake among older adults, especially those located in more rural areas, it is important to better understand the factors that deter this population from getting vaccinated as well as those that might motivate positive vaccination behaviors.

Many factors have been shown to positively influence overall vaccine uptake among older adults. Physician recommendations are impactful at increasing immunization rates among older adults [17, 18]. Healthcare providers are seen as a trusted source of vaccine information for older adults [19], and physician recommendations have consistently been

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associated with increased vaccine uptake for a variety of vaccines including, but not limited to, COVID-19 and influenza [20, 21]. Recommendations from family and friends have also been found to influence immunization behaviors among older adults [22, 23]. A recent study of factors influencing older adult influenza uptake [23] found family and peer input to be a vital part of vaccine decision-making for older adults as it provides an opportunity for individuals to be exposed to additional vaccine information and viewpoints, although this source of input has been associated with both high and low vaccine uptake among older adults. Increased access to accurate information, thereby increasing knowledge of vaccine-preventable diseases and the importance of vaccines, has also been associated with increased vaccination rates among older adults [24]. However, little research has focused specifically on understanding vaccine motivators of older adults located in rural contexts, or specifically among those with lower vaccination rates.

Conversely, previous research has also identified a variety of issues which can deter older adults from accepting recommended vaccines. Structural barriers, such as limited physical access to vaccines, have been identified in the literature [25] and linked to lower vaccination rates. Such barriers include a lack of access to primary care, such as limited clinics or pharmacies at which to obtain a vaccination, which can be more prevalent in rural areas [26, 27]. Cost has also been identified as a deterrent to vaccination among older adults [28], but especially for the shingles vaccine [17]. Individual perceptions related to disease susceptibility and health beliefs have also been recognized as deterrents to being immunized for older adults. Specifically, a myriad of research has identified having a low perceived susceptibility to specific diseases (e.g., perceiving good health) as a rationale for many older adults to not get vaccinated [29–32]. A fear of adverse and unintended side effects of the vaccine itself has also been shown to be a major barrier to getting vaccinated among older adults [33–35].

A lack of information (1) related to the importance of getting vaccinated [33], (2) on the safety and efficacy of vaccines [34], and (3) from physicians about recommended vaccines [36], have been shown to contribute to a reduction in vaccine uptake among older adults. Additionally, while not a new issue, since the development and dissemination of COVID-19 vaccines, trust and confidence issues have become major deterrents to vaccination among older adults. For instance, both a lack of trust in the COVID-19 vaccine development process due to the relatively quick development of both the primary series and subsequent boosters [37] and limited trust and confidence in healthcare and government agencies recommending COVID-19 vaccines to older adults [38], have been deterrents recently.

Despite this burgeoning research on immunization motivators and deterrents for older adults, there is a relative lack

of research focused on older adults in more rural geographic areas, such as ND. The aim of this study was to identify motivators and deterrents which may influence vaccine decisions among undervaccinated older adults in North Dakota. Better understanding these issues for older adults, specifically North Dakota older adults, may assist public health professionals to address these concerns among populations in rural states, through the design of tailored interventions, thereby increasing vaccination uptake and improving health outcomes for this population.

Methods

A mail survey was conducted with community-residing older adults in North Dakota (ND) aged 65 and older from May to June 2022. As part of this larger, cross-sectional study, one of the goals of the survey was to determine vaccine deterrents and potential vaccine motivators among those older adults considered under-vaccinated. This research was approved by the North Dakota State University Institutional Review Board and informed consent was obtained from participants prior to completing the survey.

Sample

Study inclusion criteria included being 65 years of age or older, living in ND, being community-dwelling, and English-speaking. Using primary COVID-19 vaccine completion as a surrogate for vaccine status, counties in ND were categorized and identified as either a “high vaccine county”, with at least a 75% completion rate (73.6% of ND counties were categorized as a “high vaccine county”), or a “low vaccine county”, with less than a 75% completion rate (26.4% of ND counties were categorized as a “low vaccine county”). A sample of 4000 adults aged 65 and older were randomly selected to receive the mail survey, with equal proportions representing high- and low-vaccination designated counties. Participant addresses were used to determine county of participants. Rural respondents were oversampled [39]. An overall survey response rate of 23.4% was attained based on the 901 completed and returned surveys, following adjustments for surveys mailed to inaccurate addresses and individuals who had died.

Measures

Vaccination Status. Respondents were asked to indicate their vaccination status for five different vaccines: influenza (number received in the last 5 years), pneumococcal (yes/no), shingles (yes/no), and COVID-19 (number received 0–4). An overall vaccine score was calculated for each individual by summing the total vaccinations

received. The potential total vaccine score was 11 if an individual received all of the potential vaccines. Respondents were considered to be *undervaccinated* if they received less than half of the potential vaccines (5 or fewer), and were considered to be *mostly/fully vaccinated* if they received at least half of the potential vaccines (6 or more).

Vaccination Motivators. All respondents, regardless of vaccination status, were asked to indicate what would make it more likely they would get any vaccine from a list of potential vaccine motivators, including: more information; doctor/healthcare provider recommendation; friends/family recommendation; easy access to the vaccine; vaccine given as a nasal spray; and having the vaccine provided at no cost. Respondents were also given the opportunity to provide any additional motivators for receiving a vaccine (as an open-ended response).

Vaccination Deterrents. For each vaccine type, respondents who indicated they had not received the vaccine at least one time (for influenza in the past 5 years) were asked to specify why. Participants indicated potential deterrents by vaccine-type from a list that included: concerned about side effects; vaccines are dangerous; I'm healthy and do not need it; I don't have enough information; and I don't like to get shots. Respondents were also given the opportunity to provide any additional deterrents for not receiving a vaccine (as an open-ended response).

Data Analysis

SPSS 29 was used for data analysis (IBM Corp, Armonk NY). Chi square tests were used to assess differences in vaccination status by demographic characteristics as well as by vaccine uptake. Chi square tests were also used to assess differences in vaccine motivators by vaccination status. Differences in vaccine deterrents for undervaccinated individuals were examined for each vaccine.

Results

Descriptive Statistics

Most respondents (82.1%) were mostly/fully vaccinated, whereas 17.1% were undervaccinated or unvaccinated. As shown in Table 1, there were significant differences between vaccination status groups by age (Undervaccinated: 73.1; Mostly/fully vaccinated: 74.9, $p=0.01$) and rurality (Undervaccinated: 81.7%; Mostly/fully vaccinated: 69.3%, $p=0.004$). There were no significant differences between vaccine status groups by gender (Female: Undervaccinated—54.2%; Mostly/fully vaccinated—53.5%), marital status (Married: Undervaccinated—64.4%; Mostly/fully vaccinated—68.7%), or education (Some college or more: Undervaccinated—69.9%; Mostly/fully vaccinated—77.2%).

Table 1 Demographic characteristics and vaccination status

	Un/under-vaccinated		Mostly/fully vaccinated		<i>p</i>
	<i>n</i>	%	<i>n</i>	%	
Age [Mean (SD)]	73.1 (6.89)		74.9 (7.43)		0.01
Gender					
Female	71	54.2	342	53.5	NS
Male	60	45.8	297	46.5	
Marital status					
Married	65	64.4	375	68.7	NS
Widowed, separated, divorced	36	35.6	171	31.3	
Education (some college or more)					
High school or lower	31	30.1	125	22.8	NS
Some college or more	72	69.9	424	77.2	
Rurality					
Rural	107	81.7	442	69.3	0.004
Urban	24	18.3	196	30.7	
Vaccines					
Un/undervaccinated	132	100.0	0	0.0	
Mostly/fully vaccinated	0	0.0	640	100.0	
COVID-19 (1 or more)	76	57.6	630	98.4	<0.001
Pneumococcal (yes)	43	32.6	557	87.0	<0.001
Shingles (yes)	47	35.6	506	79.1	<0.001
Influenza (>1 shot previous 5 years)	46	34.8	637	99.5	<0.001

NS not significant

Undervaccinated respondents were significantly less likely than mostly/fully vaccinated respondents to receive any of the specified vaccines (For all vaccines [COVID-19, pneumococcal, shingles, influenza]: $p < 0.001$). Undervaccinated respondents were most likely to indicate they had received at least one COVID-19 vaccine (57.6%), followed by the shingles vaccine (35.6%), receiving the influenza vaccine at least once in the past 5 years (34.8%), and the pneumococcal vaccine (32.6%). Mostly/fully vaccinated respondents were mostly likely to indicate they had received the influenza vaccine at least once in the past 5 years (99.5%), followed by at least one of the COVID-19 vaccines (98.4%), the pneumococcal vaccine (87.0%), and the shingles vaccine (79.1%).

Vaccine Motivators

Table 2 presents the prevalence of motivators by vaccination status grouping: undervaccinated and mostly/fully vaccinated. For undervaccinated individuals, *more information* was the most frequently indicated motivator for getting a vaccine. They were nearly twice as likely as mostly/fully vaccinated individuals to indicate that having *more information* about vaccines would make it more likely they would get a vaccine (43.5% vs. 23.1%, $p < 0.001$). Undervaccinated individuals were significantly less likely than mostly/fully vaccinated individuals to indicate that *having a doctor or healthcare provider recommendation* was a motivator for getting a vaccine (42.4% vs. 72.7%, $p < 0.001$). Undervaccinated participants were significantly less likely than mostly/fully vaccinated individuals to indicate that *offering no cost vaccines* would make it more likely they would get a vaccine (22% vs. 37.8%, $p < 0.001$). Additionally, undervaccinated individuals were significantly less likely than mostly/fully vaccinated participants to specify that *easy access to vaccines* would make it more likely they would get a vaccine (17.4% vs. 36.7%, $p < 0.001$). There were no significant differences between groups in their endorsement of *having a vaccine as a nasal spray* or *having a friend or family recommendation* as vaccine motivators.

Additional open-ended responses are provided in Table 3. The most common response was related to *addressing safety*

Table 3 Additional vaccination motivators

Other motivators	<i>n</i>	%
Address safety and concerns regarding vaccine efficacy	17	36.2
Less disinformation	10	21.3
Increase trust in information and sources	6	12.8
Nothing (total refusal to get vaccinated)	6	12.8
Decrease political influence	4	8.5
Preference for alternative vaccine forms	2	4.3
Address skepticism about vaccine necessity	1	2.1

Note: Percentages are based on total respondents who responded to this question. Percentages do not total 100 due to multiple responses from individual respondents

and *vaccine efficacy concerns* (e.g. “You would have to prove to me that vaccines are safer/effective”). The next most common response provided focused on *reducing disinformation*, with several respondents asking for “the truth” about vaccines. Respondents were also concerned about *trust in information and sources of information* (e.g. “More trust in healthcare (too controlled by government)”).

Vaccine Deterrents

Table 4 indicates the prevalence of endorsement of vaccine deterrents for each of the four vaccines. Respondents were provided the opportunity to offer other reasons as to why they made the decision not to get the respective vaccines, if applicable, and these responses are provided in Table 5.

Influenza. Individuals who had received no influenza vaccines in the past 5 years ($n = 93$) were most likely to indicate it was because they were healthy and did not need it (49.5%). They were least likely to indicate it was because they did not have enough information (4.3%). However, approximately one-third were concerned about side effects of influenza vaccination. The most common “other” qualitative response was distrust in vaccine effectiveness.

Shingles. Individuals who had not received the shingles vaccine ($n = 239$) were most likely to indicate their rationale was concern about side effects (23.4%), and least likely to

Table 2 Vaccination motivators by vaccine status

Motivators	Un/under vaccinated ($n = 131$) (%)	Mostly/fully vaccinated ($n = 636$) (%)	<i>p</i>
More information	43.5	23.1	<0.001
Doctor/healthcare provider recommendation	42.4	72.7	<0.001
Vaccine at no cost	22.0	37.8	<0.001
Easy access to vaccine	17.4	36.7	<0.001
Friends/family recommendation	13.6	13.0	NS
Vaccine given as a nasal spray	9.1	5.5	NS

NS not significant

Table 4 Vaccination deterrents by vaccine type for undervaccinated older adults

	Concerned about side effects (%)	Vaccines are dangerous (%)	I'm healthy and do not need it (%)	I don't have enough information (%)	I don't like to get shots (%)
Influenza (no shots in 5 years) (<i>n</i> = 93)	32.3	7.5	49.5	4.3	9.7
No shingles (<i>n</i> = 239)	23.4	2.6	18.8	11.2	6.0
No pneumococcal (<i>n</i> = 186)	16.8	3.2	37.3	18.4	4.9
No COVID-19 (<i>n</i> = 76)	61.8	19.7	28.9	19.7	3.9

Note: Percentages are based on total respondents who responded to these questions. Percentages do not total 100 due to multiple responses from individual respondents

indicate vaccines being dangerous (2.6%). Respondents who offered other reasons as to why they have not received the shingles vaccines were most likely to state that it was due to cost.

Pneumococcal. Those who had not received the pneumococcal vaccine (*n* = 186) were most likely to indicate their rationale was being healthy and not needing it (37.3%), and least likely to indicate that it was due to vaccines being dangerous (3.2%). Of respondents who provided other reasons why they did not get the pneumococcal vaccine, the most common response was a lack of perceived necessity, such as not being susceptible to the disease, or having a strong immune system.

COVID-19. Finally, individuals who had not received any of the COVID-19 vaccines (*n* = 76) were most likely to indicate that their rationale was a concern about side effects (61.8%), and least likely to indicate that it was due to not liking shots (3.9%). The most common “other” open-ended response volunteered was distrust in vaccine effectiveness.

Conclusions

Although older adults have an increased risk of morbidity and mortality due to several vaccine-preventable diseases, some older adults remain hesitant about getting recommended vaccines. The main aim of this study was to identify overall motivators and deterrents of vaccine uptake among undervaccinated older adults in North Dakota. This paper contributes to the literature on understanding vaccination rates among older adults and provides specific context to undervaccinated older adults residing in a rural state with low overall immunization rates.

A key vaccination motivator identified for undervaccinated older adults is having more information about specific vaccines. Moreover, the most common *additional* factor provided for increasing the likelihood of getting vaccinated was focused on addressing safety issues and concerns about vaccine efficacy, consistent with previous studies [40], thus emphasizing the need for additional information among undervaccinated individuals. Previous

research has highlighted the desire for additional information about vaccines among more vaccine hesitant populations including older adults [41], focusing on such topics as efficacy and safety [42]. However, a potential related issue is that since the beginning of the COVID-19 pandemic there has been a flood of information regarding vaccines, which has been muddled by a related increase in misinformation [38]. While our research did not specify as such, what these individuals may in fact be seeking is additional *reliable* and *valid*, and potentially *more trustworthy*, information about vaccines. The results of the present study indicate that the provision of accurate information regarding vaccine safety and efficacy may be key in increasing immunization rates among older adults.

Additionally, having healthcare provider recommendations was also a primary motivator for vaccine uptake among undervaccinated older adults. However, they were significantly less likely than their mostly/fully vaccinated counterparts to indicate this would influence their vaccine decisions. Research has shown that healthcare providers play a vital role in the vaccination decision-making process for older adults [19–21]. However, our results show that physicians and other healthcare professionals may play a more diminished role among undervaccinated individuals as compared to their mostly/fully vaccinated counterparts in regards to immunization uptake. This may indicate that undervaccinated older adults do not fully trust their healthcare providers [43]. This is an issue, as trust in healthcare providers is associated with increased vaccine uptake among older adults [44]. Additionally, undervaccinated older adults, especially those in more rural areas, have been found to engage less with the healthcare system than their urban counterparts, due in part to limited access to clinics and hospitals, and the results of this study may be an indication of this trend [26, 27, 45]. This finding has implications for public health, and highlights the need to address increasing trust in and access to healthcare providers among older adults. Additionally, future research should delve deeper into further understanding those who would be considered the most trusted messengers among undervaccinated older adults.

Table 5 Additional vaccination deterrents by vaccine type for undervaccinated older adults

Other deterrents	<i>n</i>	%
<i>Influenza (n = 24)</i>		
Distrust in vaccine effectiveness	7	29.2
Don't need it/don't want it	5	20.8
Rarely/never get sick	3	12.5
Natural immunity	2	8.3
Issues with other vaccines	2	8.3
Overuse of medication	1	4.2
Preexisting condition prohibits flu vaccine	1	4.2
Unsure of ingredients	1	4.2
None of your business	1	4.2
Personal health decisions	1	4.2
<i>Shingles (n = 129)</i>		
Cost/insurance issues	51	39.5
Procrastination	22	17.1
Confusion about vaccine requirements	13	10.1
Physician didn't recommend	11	8.5
Personal health decisions	9	7.0
Availability	9	7.0
Concerns about vaccine effectiveness	7	5.4
Natural immunity	4	3.1
Required delay due to health issues	4	3.1
Lack of awareness or forgetfulness	4	3.1
<i>Pneumococcal (n = 59)</i>		
Lack of perceived necessity	15	25.4
Lack of physician recommendation	11	18.6
Procrastination/forgot	10	16.9
Personal health decisions	6	10.2
Lack of awareness	5	8.5
Skepticism and mistrust	4	6.8
Cost	3	5.1
Don't know	3	5.1
Physician recommended not getting it	1	1.7
Availability	1	1.7
<i>COVID-19 (n = 29)</i>		
Distrust in vaccine efficacy	18	46.2
Health and safety concerns	6	15.4
Natural immunity	6	15.4
Mistrust in government and pharmaceutical companies	4	10.3
Misinformation and skepticism	2	5.1
Doctor recommended not to get it	2	5.1
Personal health decisions	1	2.6

Note: Percentages are based on total respondents who responded to the individual questions by vaccine type. Percentages may not total 100 due to multiple responses from individual respondents

Other factors, such as cost and improving access to vaccines, were overall less likely to motivate undervaccinated older adults to get vaccinated. This suggests that motivators

for undervaccinated older adults may extend beyond logistics and financial concerns, highlighting the complex decision-making process for this population. In regards to cost, our results are unique, as much of the previous research has found affordability to be a more widespread motivator for vaccine uptake for older adults than was indicated in our study [18, 23, 46]. ND is a mostly rural state, and the cultural and social issues associated with rurality, including conservatism, as indicated by our previous work [47], might influence vaccine behaviors to a greater extent than affordability considerations. Additionally, as compared to other influencers, improving access to vaccines was also less likely to be cited as an immunization motivator among undervaccinated older adults. However, although not listed as a primary influencer of vaccine behaviors, previous research has shown that expanding access points to vaccinations for older adults can increase immunization rates among this population [18].

The most common deterrent for not obtaining the influenza or pneumococcal vaccine cited by undervaccinated older adults was that they perceived themselves as healthy and thus do not need it. The focus on good current health status as a reason not to get vaccinated, especially for influenza and pneumococcal vaccines, is borne out in prior research [29–31, 48]. Perceived susceptibility to disease, defined as ones' perceived risk of contracting a disease, has been extensively researched as a barrier to vaccine uptake, and low perceived susceptibility has been associated with lower vaccination rates among older adults (e.g. [29, 49, 50]). Several factors influence perceived susceptibility among older adults, including, but not limited to, a lack of understanding of older adults' increased susceptibility to certain infectious diseases, such as influenza [51], lack of understanding of the seriousness of symptoms of specific infectious diseases [52], and a lack of awareness of the existence of vaccines for specific conditions, such as the pneumococcal vaccine [32]. These factors can be addressed through the provision of immunization information via trusted sources of accurate information, such as healthcare providers. Thus, the barrier of low perceived susceptibility related to specific vaccine-preventable diseases could potentially be addressed through vaccine-specific healthcare provider information and recommendation provision.

Concern about side effects was the most common deterrent cited by individuals for not receiving the shingles or COVID-19 vaccines. Previous research has found that the perceived prevalence and/or severity of vaccine side effects, especially for shingles and COVID-19 vaccines, is a common barrier for getting vaccinated, particularly among older adults [19, 35, 43]. The concern about side effects is often due to misinformation spread through social media or from peers or family members [53, 54], highlighting the importance of ensuring accurate information is being disseminated through trusted sources of information, such as

healthcare providers. An additional deterrent cited by many respondents specific to the shingles vaccine was related to cost. This finding is similar to previous research focusing on barriers to shingles uptake among older adults [55], and also highlights the importance of affordability in the vaccine decision-making process. It should be noted that since this study was conducted, the Inflation Reduction Act was implemented, expanding Medicare benefits and lowering drug costs, including making recommended vaccines available at no cost for individuals with Medicare prescription drug coverage [56].

Limitations

While this research expands our understanding of vaccination behaviors among undervaccinated older adults, there are several limitations that should be considered. Due to the focus on older adults in North Dakota, these results are not generalizable to a larger population. Nevertheless, the study provides greater insight into the vaccination influencers and barriers for older adults in more rural states. Additionally, the study sample was racially homogenous, and although this lack of diversity is representative of North Dakota, it restricts interpretation of results to a more diverse population. Future research should endeavor to explore vaccine motivators and deterrents among a more racially heterogeneous population. Moreover, these results relied on self-report data, for immunization status as well as motivators and deterrents, which may have influenced individuals' responses to be more favorable, including more likely to indicate having received specific vaccines. Finally, respondents were primed to consider specific motivators and deterrents of immunizations, and this may have resulted in a lack of consideration of other factors which may positively or negatively impact vaccine uptake.

Conclusions

Our results support many established research findings in vaccine hesitancy research among older adults, namely the necessity to provide accurate information about vaccines, the need for trust-building, as well as addressing low perceived susceptibility for vaccine-preventable diseases. However, this research also highlights unique aspects, including the reduced influence of healthcare provider recommendations for undervaccinated older adults, and heightened focus on side effects. These results suggest a need for tailoring interventions for older undervaccinated adults in rural states to address these distinct vaccination motivators and deterrents and increase vaccine uptake.

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Declarations

Conflict of interest Authors have no conflicts of interest to share.

Research Involving Human Participants This research was approved by the North Dakota State University Institutional Review Board.

Informed Consent Informed consent was obtained from participants prior to completing the survey.

References

1. Henig, O., & Kaye, K. S. (2017). Bacterial pneumonia in older adults. *Infectious Disease Clinics*, 31(4), 689–713.
2. Keilich, S. R., Bartley, J. M., & Haynes, L. (2019). Diminished immune responses with aging predispose older adults to common and uncommon influenza complications. *Cellular Immunology*, 345, 103992.
3. Schmader, K. E., Johnson, G. R., Saddier, P., Ciarleglio, M., Wang, W. W., Zhang, J. H., Chan, I. S., Yeh, S. S., Levin, M. J., Harbecke, R. M., Oxman, M. N., Shingles Prevention Study Group. (2010). Effect of a zoster vaccine on herpes zoster-related interference with functional status and health-related quality-of-life measures in older adults [See editorial comments by Dr. Roy Fried, pp 1799–1800]. *Journal of the American Geriatrics Society*, 58(9), 1634–1641.
4. Shahid, Z., Kalayanamitra, R., McClafferty, B., Kepko, D., Ramgobin, D., Patel, R., Aggarwal, C. S., Vunnam, R., Sahu, N., Bhatt, D., Jones, K., Golamari, R., & Jain, R. (2020). COVID-19 and older adults: What we know. *Journal of the American Geriatrics Society*, 68(5), 926–929.
5. Black, C. L. (2023). Influenza, updated COVID-19, and respiratory syncytial virus vaccination coverage among adults—United States, fall 2023. *Morbidity and Mortality Weekly Report*, 72(51), 1371–1376.
6. Diesel, J., Sterrett, N., Dasgupta, S., Kriss, J. L., Barry, V., Vanden Esschert, K., Whiteman, A., Cadwell, B. L., Weller, D., Qualters, J. R., Harris, L., Bhatt, A., Williams, C., Fox, L. M., Meaney Delman, D., Black, C. L., & Barbour, K. E. (2021). COVID-19 vaccination coverage among adults—United States, December 14, 2020–May 22, 2021. *Morbidity and Mortality Weekly Report*, 70(25), 922.
7. Takayama, M., Wetmore, C. M., & Mokdad, A. H. (2012). Characteristics associated with the uptake of influenza vaccination among adults in the United States. *Preventive Medicine*, 54(5), 358–362.
8. Centers for Disease Control and Prevention (CDC). (n.d). *What vaccines are recommended for you*. Retrieved from <https://www.cdc.gov/vaccines/adults/rec-vac/index.html>
9. CDC. (2024). *Flu vaccination coverage, United States, 2022–23, influenza season*. National Center for Immunization and Respiratory Diseases. Retrieved from <https://www.cdc.gov/flu/fluview/coverage-2223estimates.htm>

10. CDC. (2024). *COVID data tracker*. U.S. Department of Health and Human Services, CDC. Retrieved from <https://covid.cdc.gov/covid-data-tracker>
11. CDC. (2024). *Vaccination coverage among adults*. AdultVaxView. Retrieved from <https://www.cdc.gov/vaccines/imz-managers/coverage/adultvaxview/data-reports/general-population/index.html>
12. North Dakota Department of Health and Human Services (NDDoHHS). (2024). *Influenza vaccine dashboard*. Retrieved January 11, 2024 from <https://www.hhs.nd.gov/health/diseases-conditions-and-immunization/immunizations/coverage-rates>
13. NDDoHHS. (2024). *COVID-19 vaccine dashboard*. Retrieved January 11, 2024, from <https://www.hhs.nd.gov/health/coronavirus/covid-19-vaccine-dashboard>
14. NDDoHHS. (2024). *Adult vaccine dashboard*. Retrieved January 11, 2024, from <https://www.hhs.nd.gov/health/diseases-conditions-and-immunization/immunizations/coverage-rates>
15. Jain, B., Paguio, J. A., Yao, J. S., Jain, U., Dee, E. C., Celi, L. A., & Ojikutu, B. (2022). Rural–urban differences in influenza vaccination among adults in the United States, 2018–2019. *American Journal of Public Health, 112*(2), 304–307.
16. Saelee, R., Zell, E., Murthy, B. P., Castro-Roman, P., Fast, H., Meng, L., Shaw, L., Gibbs-Scharf, L., Chorba, T., Harris, L. Q., & Murthy, N. (2022). Disparities in COVID-19 vaccination coverage between urban and rural counties—United States, December 14, 2020–January 31, 2022. *Morbidity and Mortality Weekly Report, 71*(9), 335.
17. Draper, M., & Stergiopoulos, S. (2021). Shingles vaccination uptake in Massachusetts adults aged 50 years and older. *Vaccine, 39*(46), 6781–6786.
18. Eiden, A. L., Barratt, J., & Nyaku, M. K. (2023). A review of factors influencing vaccination policies and programs for older adults globally. *Human Vaccines and Immunotherapeutics, 19*(1), 2157164.
19. Bhagianadh, D., & Arora, K. (2022). COVID-19 vaccine hesitancy among community-dwelling older adults: The role of information sources. *Journal of Applied Gerontology, 41*(1), 4–11.
20. Lu, P.-J., Srivastav, A., Amaya, A., Dever, J. A., Roycroft, J., Kurtz, M. S., O'Halloran, A., & Williams, W. W. (2018). Association of provider recommendation and offer and influenza vaccination among adults aged ≥ 18 years—United States. *Vaccine, 36*, 890–898.
21. Reiter, P. L., Pennell, M. L., & Katz, M. L. (2020). Acceptability of a COVID-19 vaccine among adults in the United States: How many people would get vaccinated? *Vaccine, 38*(42), 6500–6507.
22. McIntyre, A., Zecevic, A., & Diachun, L. (2014). Influenza vaccinations: Older adults' decision-making process. *Canadian Journal on Aging/La Revue Canadienne du Vieillessement, 33*(1), 92–98.
23. Xu, Y., See, M. T. A., Aloweni, F., Koh, C. H. F., Tan, C. G. I., Xin, X. H., Gan, W. H., Low, L. L., & Lim, S. F. (2023). Factors influencing the uptake of seasonal influenza vaccination among community-dwelling older adults during COVID-19: A mixed methods study. *Vaccines, 11*(3), 641.
24. Ho, H. J., Chan, Y. Y., Bin Ibrahim, M. A., Wagle, A. A., Wong, C. M., & Chow, A. (2017). A formative research-guided educational intervention to improve the knowledge and attitudes of seniors towards influenza and pneumococcal vaccinations. *Vaccine, 35*(47), 6367–6374.
25. Madhavan, S. S., Borker, R. D., Fernandes, A. W., Amonkar, M. M., & Rosenbluth, S. A. (2008). Assessing predictors of influenza and pneumonia vaccination in rural senior adults. *Journal of Health and Social Policy, 18*(2), 71–93.
26. Bennett, K. J., Pumkam, C., & Probst, J. C. (2011). Rural–urban differences in the location of influenza vaccine administration. *Vaccine, 29*(35), 5970–5977.
27. Gatwood, J., Shuvo, S., Hohmeier, K. C., Hagemann, T., Chiu, C. Y., Tong, R., & Ramachandran, S. (2020). Pneumococcal vaccination in older adults: An initial analysis of social determinants of health and vaccine uptake. *Vaccine, 38*(35), 5607–5617.
28. Patterson, B. J., Myers, K., Stewart, A., Mange, B., Hillson, E. M., & Poulos, C. (2021). Preferences for herpes zoster vaccination among adults aged 50 years and older in the United States: Results from a discrete choice experiment. *Expert Review of Vaccines, 20*(6), 729–741.
29. Bödeker, B., Remschmidt, C., Schmich, P., & Wichmann, O. (2015). Why are older adults and individuals with underlying chronic diseases in Germany not vaccinated against flu? A population-based study. *BMC Public Health, 15*, 1–10.
30. Santos, A. J., Kislaya, I., Machado, A., & Nunes, B. (2017). Beliefs and attitudes towards the influenza vaccine in high-risk individuals. *Epidemiology and Infection, 145*(9), 1786–1796.
31. Sulis, G., Basta, N. E., Wolfson, C., Kirkland, S. A., McMillan, J., Griffith, L. E., & Raina, P. (2022). Influenza vaccination uptake among Canadian adults before and during the COVID-19 pandemic: An analysis of the Canadian Longitudinal study on Aging (CLSA). *Vaccine, 40*(3), 503–511.
32. Trent, M. J., Salmon, D. A., & MacIntyre, C. R. (2022). Predictors of pneumococcal vaccination among Australian adults at high risk of pneumococcal disease. *Vaccine, 40*(8), 1152–1161.
33. Bhanu, C., Gopal, D. P., Walters, K., & Chaudhry, U. A. (2021). Vaccination uptake amongst older adults from minority ethnic backgrounds: A systematic review. *PLoS Medicine, 18*(11), e1003826.
34. Eilers, R., Krabbe, P. F. M., & De Melker, H. E. (2014). Factors affecting the uptake of vaccination by the elderly in Western society. *Preventive Medicine, 69*, 224–234.
35. Veronese, N., Saccaro, C., Demurtas, J., Smith, L., Dominguez, L. J., Maggi, S., & Barbagallo, M. (2021). Prevalence of unwillingness and uncertainty to vaccinate against COVID-19 in older people: A systematic review and meta-analysis. *Ageing Research Reviews, 72*, 101489.
36. You, Y., Li, X., Jiang, S., Liang, J., Xie, P., Zou, X., Liu, G., & Han, X. (2023). Can primary care physician recommendation improve influenza vaccine uptake among older adults? A community health centre-based experimental study in China. *BMC Primary Care, 24*(1), 1–9.
37. Szilagyi, P. G., Thomas, K., Shah, M. D., Vizueta, N., Cui, Y., Vangala, S., Fox, C., & Kapteyn, A. (2021). The role of trust in the likelihood of receiving a COVID-19 vaccine: Results from a national survey. *Preventive Medicine, 153*, 106727.
38. Wu, Y., & Brennan-Ing, M. (2023). Information consumption, trust dynamics and COVID-19 vaccine hesitancy among older adults: Implications for health messaging. *Vaccines, 11*(11), 1668.
39. Zahnd, W. E., Askelson, N., Vanderpool, R. C., Stradtman, L., Edward, J., Farris, P. E., Petermann, V., & Eberth, J. M. (2019). Challenges of using nationally representative, population-based surveys to assess rural cancer disparities. *Preventive Medicine, 129*, 105812.
40. Piltch-Loeb, R., Penrose, K., Stanton, E., Parcesepe, A. M., Shen, Y., Fleary, S. A., & Nash, D. (2023). Safety, efficacy, and ill intent: Examining COVID-19 vaccine perceptions among the new under-vaccinated moveable middle in a US cohort, October 2022. *Vaccines, 11*(11), 1665.
41. Eilers, R., Krabbe, P. F., & de Melker, H. E. (2015). Motives of Dutch persons aged 50 years and older to accept vaccination: A qualitative study. *BMC Public Health, 15*(1), 1–10.
42. Giese, H., Neth, H., Wegwarth, O., Gaissmaier, W., & Stok, F. M. (2023). How to convince the vaccine-hesitant? An ease-of-access nudge, but not risk-related information increased Covid vaccination-related behaviors in the unvaccinated. *Applied Psychology Health and Well-Being*. <https://doi.org/10.1111/aphw.12479>

43. Nicholls, L. A. B., Gallant, A. J., Cogan, N., Rasmussen, S., Young, D., & Williams, L. (2021). Older adults' vaccine hesitancy: Psychosocial factors associated with influenza, pneumococcal, and shingles vaccine uptake. *Vaccine*, *39*(26), 3520–3527.
44. Tan, M., Straughan, P. T., & Cheong, G. (2022). Information trust and COVID-19 vaccine hesitancy amongst middle-aged and older adults in Singapore: A latent class analysis Approach. *Social Science and Medicine*, *296*, 114767.
45. Hunold, K. M., Richmond, N. L., Waller, A. E., Cutchin, M. P., Voss, P. R., & Platts-Mills, T. F. (2014). Primary care availability and emergency department use by older adults: A population-based analysis. *Journal of the American Geriatrics Society*, *62*(9), 1699–1706.
46. Elekwachi, O., Wingate, L. M. T., Clarke Tasker, V., Aboagye, L., Dubale, T., Betru, D., & Algatan, R. (2021). A review of racial and ethnic disparities in immunizations for elderly adults. *Journal of Primary Care and Community Health*, *12*, 21501327211014070.
47. Fuller, H. R., Huseh-Zosel, A., Van Vleet, B., Hajdar, M., & Carson, P. J. (2023). Vaccine attitudes and acceptance among older adults in North Dakota: Understanding demographic characteristic variability. *Vaccine*, *41*(42), 6350–6358.
48. Bakhshi, S., & While, A. E. (2014). Maximising influenza vaccination uptake among older people. *British Journal of Community Nursing*, *19*(10), 474–479.
49. Huang, J., Bai, Y., Ding, H., Wang, B., Ngai, C. H., Kwok, K. O., Wong, E. L. Y., Wong, M. C. S., & Yeoh, E. K. (2021). Acceptance of pneumococcal vaccination in older adults: A general population-based survey. *Vaccine*, *39*(47), 6883–6893.
50. Kan, T., & Zhang, J. (2018). Factors influencing seasonal influenza vaccination behaviour among elderly people: A systematic review. *Public Health*, *156*, 67–78.
51. Yu, D. S. F., Low, L. P., Lee, I. F., Lee, D. T., & Ng, W. M. (2014). Predicting influenza vaccination intent among at-risk Chinese older adults in Hong Kong. *Nursing Research*, *63*(4), 270–277.
52. Zhang, C. Q., Chung, P. K., Liu, J. D., Chan, D. K., Hagger, M. S., & Hamilton, K. (2019). Health beliefs of wearing facemasks for influenza A/H1N1 prevention: A qualitative investigation of Hong Kong older adults. *Asia Pacific Journal of Public Health*, *31*(3), 246–256.
53. Hwang, J. (2020). Health information sources and the influenza vaccination: The mediating roles of perceived vaccine efficacy and safety. *Journal of Health Communication*, *25*(9), 727–735.
54. Zimmerman, T., Shiroma, K., Fleischmann, K. R., Xie, B., Jia, C., Verma, N., & Lee, M. K. (2023). Misinformation and COVID-19 vaccine hesitancy. *Vaccine*, *41*(1), 136–144.
55. Hurley, L. P., O'Leary, S. T., Dooling, K., Anderson, T. C., Crane, L. A., Cataldi, J. R., Brtnikova, M., Beaty, B. L., Gorman, C., Guo, A., Lindley, M. C., & Kempe, A. (2023). Survey of physician practices, attitudes, and knowledge regarding recombinant zoster vaccine. *Journal of General Internal Medicine*, *38*(4), 986–993.
56. Centers for Medicare & Medicaid Services. (2023). Anniversary of the Inflation Reduction Act: Update on CMS implementation. Retrieved from <https://www.cms.gov/newsroom/fact-sheets/anniversary-inflation-reduction-act-update-cms-implementation>

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