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SOCIAL AND STRUCTURAL DETERMINANTS OF HEALTH AS PREDICTORS OF

COVID-19 VACCINE HESITANCY AMONG OLDER ADULTS IN THE UNITED STATES

by

KINGSLEY KALU

(Under the Direction of Gulzar Shah)

ABSTRACT

Background: Although vaccination is one of the greatest accomplishments in public health, some people, especially older adults, are reluctant to take vaccines. This study examined the association between the social and structural determinants of health and COVID-19 vaccine hesitancy among older adults in the United States.

Methods: Secondary data from the Health and Retirement Study (HRS) was used. The HRS participants were 65 years and older, and the sample size was 2311. Multinomial multivariable logistic regression models were conducted for this study.

Results: The study shows that social determinants of health (marital status, educational level) and structural determinants of health (religiosity) were associated with COVID-19 vaccine hesitancy among older adults in the United States. Intrapersonal level (sociodemographic factors and perceived risk of disease such as comorbidities, vaccine concern, and history of flu vaccination) and interpersonal level (marital status and awareness of death from family) were associated with COVID-19 vaccine hesitancy among older adults in the United States.

Conclusion: The study shows that addressing certain factors within the social and structural determinants of health may reduce the impact of vaccine hesitancy among older adults.

INDEX WORDS: Vaccine Hesitancy, Older Adults, Social Determinants of Health, Religiosity,

SOCIAL AND STRUCTURAL DETERMINANTS OF HEALTH AS PREDICTORS OF

COVID-19 VACCINE HESITANCY AMONG OLDER ADULTS IN THE UNITED STATES

by

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in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PUBLIC HEALTH

SOCIAL AND STRUCTURAL DETERMINANTS OF HEALTH AS PREDICTORS OF

COVID-19 VACCINE HESITANCY AMONG OLDER ADULTS IN THE UNITED STATES

by

KINGSLEY KALU

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Electronic Version Approved:

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DEDICATION

I dedicate this dissertation to Yeshua Hamashiach, my source and provider. May all praise be to

God almighty.

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First and foremost, I acknowledge the LORD GOD ALMIGHTY, who has been faithful and true to me to complete this program successfully.

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CHAPTER 1

INTRODUCTION

Background of Problem

Since the 18th-century smallpox pandemic, vaccination has been one of the most significant accomplishments in public health. This process has reduced the incidence and prevalence of vaccine-preventable infectious diseases in the vaccinated population (CDC, 2019; Riedel, 2005). Vaccination has ridiculed preventable infectious diseases of severe consequences (i.e., influenza, diphtheria, and tuberculosis) that were commonplace less than a century ago (Rodrigues & Plotkin, 2020) and also ensured herd immunity in the unvaccinated population (Randolph & Barreiro, 2020). Despite its effectiveness, it has been considered unsafe and unwanted by many populations (Riedel, 2005).

'Vaccine hesitancy refers to a delay in acceptance or refusal of vaccination despite the availability of vaccination services; it is a complex and context-specific, varying across time, place, and vaccines, which is influenced by factors such as complacency, convenience, and confidence' (Dubé et al., 2014; MacDonald, 2015). Vaccine hesitancy is a continuum of behaviors and beliefs that can lead to individual delay, partial vaccination, adjustment of the recommended vaccination schedule, or decline of all vaccinations (Beleche et al., 2021). Since the smallpox vaccination in the 19th century up to the present, numerous vaccine controversies have led to anti-vaccine campaigns and activities (Gostin, 2005; Rawlings et al., 2022). In the United States, there have been reports of the re-emergence of certain vaccine-preventable diseases that were thought to be extinct and decreased administration of certain vaccine-preventable diseases such as influenza (Srivastav et al., 2023; Uwishema et al., 2023).

In 2021, there were approximately 55.7 million United States older adults aged 65 years and older, with the majority of older Americans being female and having at least one chronic disease (Administration for Community Living, 2021). Due to the limited regenerative capacity, immunocompromised nature, and presence of co-morbidities, older adults are at risk of adverse health outcomes when an infection occurs (Wang, Tong et al., 2021). In the United States, documentary evidence showed that 84% of older adults received their first COVID-19 vaccine dose, and about 72% were fully vaccinated during the COVID-19 pandemic outbreak. Although a large percentage of older adults in the United States had received the first dose of the COVID-19 vaccine during the COVID-19 pandemic outbreak, there have been reports of increased COVID-19 deaths among older adults 65 years and older to about 88% in September 2023 (Freed, Neuman, et al., 2022). Moreover, there were unequal COVID-19 vaccination rates among older adults, and states with low vaccination rates had significant COVID-19 death rates (Coustasse et al., 2020; Freed et al., 2021; Havers, 2022). Rural counties also had lower first-dose coverage compared to urban counties in terms of gender and age group (Sun & Monnat, 2021). From 2020-2023, the older population who refused vaccination experienced adverse health outcomes and healthcare burdens (Centers for Disease Control and Prevention, 2020b; Freed et al., 2021). Globally, approximately 3 billion people were unvaccinated, with documented evidence showing COVID-19 vaccine hesitancy prevalent among older respondents in Qatar, France, India, Italy, and Ethiopia (Abdul Karim et al., 2022; Abebe et al., 2021; Detoc et al. 2020; Wang et al., 2020).

'*Social determinants of health (SDOH) are the conditions in which people are born, grow, work, live and the wider set of forces and systems shaping the conditions of daily life*' (Centers for Disease Control and Prevention, 2020b). The non-medical factors associated with health

outcomes and inequities are also known as the social determinants of health (World Health Organization, 2024). Five domains represent the SDOH: social and community context, neighborhood and built environment, economic stability, healthcare access, and quality, and education access and quality (Centers for Disease Control and Prevention, 2020a). These SDOH domains are important because Social Security Income (SSI) benefit programs have been linked to socioeconomic health disparities (Li & Mutchler, 2020; Romig, 2024). Spouses provide cognitive, social, and emotional support and social integration within the community (Liu et al., 2023; Wang & Yi, 2023). Studies show that older American adults (i.e., African American and Latino seniors) do not have and cannot access broadband internet at home, which is a significant determinant of health (Jess, 2022; Zickuhr & Madden, 2012). Education as a determinant of health has been linked to health outcomes, especially in older adults (U.S. Department of Health and Human Services, 2023). Although the COVID-19 vaccine is free regardless of vaccination status, individuals with health insurance can inquire about health information from their primary care provider (Reiter et al., 2020). The immigrant population, especially undocumented migrants, immigrants, and refugees, has been identified as being under-immunized and may lack access to healthcare services (Chang, 2019; Daniels et al., 2022).

Structural determinants of health (StrDOH) are cultural, political, social, and economic structures that form the distribution of symbolic power, materials, and resources (Heller et al., 2024). Several studies show that these structural determinants of health predictors, such as racial and ethnic groups, political affiliation, institutional practice, and governance, impact health disparities and are associated with vaccine intention (Heller et al., 2024; Peña et al., 2023; Viswanath et al., 2021; Wang & Liu, 2022). Religion has been associated with health outcomes, and most older adults in the United States consider themselves spiritual or religious (Kaplan,

2023; Pew Research Center, 2022). Religion has been shown to influence gender, race, political affiliation, and admittance to electoral offices in the United States (Hammell, 2021; Taylor, 1998). Other determinants such as beliefs, values, misinformation, socioeconomic status, institutional practices, state immunization laws that permit religious, culturally insensitive healthcare systems, and segregation have been associated with vaccine hesitancy (Golden, 2022; Heller et al., 2024; Peretti-Watel et al., 2015; Razai et al., 2021; Siddiqui et al., 2013).In this study, different domains of SDOH and a domain to represent StrDOH were assessed to provide insight into the association with COVID-19 vaccine hesitancy among older adults in the United States.

This study also focused on the multi-dimensional approach that impacts older adults' experiences and learning through their interaction with the environment. This is because vaccine hesitancy is not entirely associated with human behaviors but can also result from a decision-making process (Peretti-Watel et al., 2015; Troiano & Nardi, 2021). Although models such as the Health Belief Model (HBM) and Theory of Planned Behavior (TPB) predict human behavior, the Social Ecological Model (SEM) identifies various multi-level factors that impact vaccine hesitancy in humans (Baldwin et al., 2023; Boston University, 2019; Enyinnaya et al., 2024; Wisconsin Department of Health Services, 2023).

Statement of the Problem

Studies have shown that old age increases the risk of being immunocompromised, and a chronic disease increases their predisposition to being hospitalized when exposed to an infectious disease such as COVID-19 (O'Neill & Delk, 2015). Chronic diseases are common among older adults, with many of them having at least one chronic condition (CDC, 2020). Chronic diseases such as high blood pressure, chronic respiratory disease, diabetes, and cancer are the leading

causes of death in the United States (O'Neill & Delk, 2015). Combining vaccine-preventable infections such as COVID-19 and multiple comorbidities in older adults deleteriously affects their health outcomes (Beusekom, 2023; Taylor, 2023). Vaccine hesitancy is a public health challenge in battling infectious diseases and a threat to global health (Cascini et al., 2021; Donovan, 2022; Saelee et al., 2022). It is important to note that vaccine hesitancy can occur as a continuum and cause a barrier to establishing herd immunity, thereby increasing the risk of morbidity and mortality of immunocompromised people (i.e., older adults, children, and pregnant women) within the community (Arora et al., 2018; Beleche et al., 2021; Gerretsen et al., 2021; Gorman et al., 2022).

Since the discovery of vaccines, vaccine hesitancy has been a long-aged public health challenge that has led to increased healthcare burden, morbidity, and mortality of individuals. It is noteworthy that there has been a re-emergence of measles cases in the United States after the elimination period due to vaccine hesitancy (Uwishema et al., 2023). Moreover, less than half of the United States adult population received the influenza vaccination in the 2021-2022 season (Srivastav et al., 2023). From 2019-2022, the unvaccinated older adult population experienced the highest number of hospitalizations throughout the COVID-19 pandemic, and the mortality rate due to COVID-19 infection in the United States was approximately 385,000 (CDC, 2020). During the Delta and Omicron variant outbreak, states with low vaccination rates among older adults had a significant COVID-19 mortality rate (Centers for Disease Control and Prevention, 2019; Freed et al., 2021; Havers, 2022). These adverse health outcomes cause a significant healthcare burden (Nicholls et al., 2021; Talbird et al., 2020) and contribute to the estimated annual healthcare expenditure of about $4.1 trillion for older adults with chronic and mental health conditions (Centers for Disease Control and Prevention, 2023).

In all age groups, numerous studies indicate that vaccine hesitancy may be due to mistrust, anxiety, misinformation, misconception, confidence, and poor health and psychosocial determinants (Abdul Karim et al., 2022; Chia & Hartanto, 2021; Zhang et al., 2022). Other studies have shown that factors such as employment, gender, political affiliation, and income are associated with vaccine hesitancy (Khubchandani et al., 202). Although several studies have examined the factors associated with vaccine hesitancy in the population, not much has been considered to identify how the multiple factors within the SODH and StrDOH are associated with COVID-19 vaccine hesitancy among older adults in the United States; few studies have (Corbie-Smith, 2021; Lacy & Solosi, 2022; Majee et al., 2022). To the best of my knowledge, none of the studies have used a nationally representative dataset of older adults to evaluate the association between the social and structural determinants of health and vaccine hesitancy in older adults resident in the United States. Few studies have focused on COVID-19 vaccine intention, perception, and acceptability (Cimone Durojaiye et al., 2022; Davtyan et al., 2022). In addition, this study provided new information on the role of the social and structural determinants of health in COVID-19 vaccine hesitancy among older adults in the United States.

Purpose of the Study

The purpose of this study is four-fold:

- To determine the association of the social determinants of health with COVID-19 vaccine hesitancy among older adults in the United States.

- To analyze the association of the structural determinants of health with COVID-19 vaccine hesitancy among older adults in the United States.

- To gauge the association of the social and structural determinants of health with COVID-19 vaccine hesitancy among older adults in the United States.

- To assess the specific levels within the SEM (i.e., intrapersonal and interpersonal levels) that are associated with COVID-19 vaccine hesitancy among older adults in the United States

Research Questions

The research questions for this study are as follows:

1. Which specific social determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States?

2. Which specific structural determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States?

3. Which specific social and structural determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States?

4. Which specific factors in the intrapersonal level of the SEM are associated with COVID-19 vaccine hesitancy among older adults?

5. Which specific factors in the interpersonal level of the SEM are associated with COVID-19 vaccine hesitancy among older adults?

Hypothesis

This study will test the following hypotheses:

To determine which specific social determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States

H_{1A}- Internet access is associated with COVID-19 Vaccine Hesitancy among older adults

H_{2A}- Medical insurance is associated with COVID-19 Vaccine Hesitancy among older adults

H_{3A}- Social Security Income (SSI) is associated with COVID-19 Vaccine Hesitancy among older adults

H_{4A}- Educational level is associated with COVID-19 Vaccine Hesitancy among older adults

Null Hypothesis

H_{10}- Internet access is not associated with COVID-19 Vaccine Hesitancy among older adults

H_{20}- Medical insurance is not associated with COVID-19 Vaccine Hesitancy among older adults

H_{30}- Social Security Income (SSI) is not associated with COVID-19 Vaccine Hesitancy among older adults

H_{40}- Educational level is not associated with COVID-19 Vaccine Hesitancy among older adults

To determine which specific structural determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States

H_{5A}- Religiosity is associated with COVID-19 Vaccine Hesitancy among older adults.

Null Hypothesis

H_{50}-Religiosity is not associated with COVID-19 Vaccine Hesitancy among older adults.

To determine which specific social and structural determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States

H_{6A}- Marital status is associated with COVID-19 Vaccine Hesitancy among older adults

H_{7A}- Education is associated with COVID-19 Vaccine Hesitancy among older adults

H_{8A}- Medical coverage is associated with COVID-19 Vaccine Hesitancy among older adults

H_{9A}- Social security income is associated with COVID-19 Vaccine Hesitancy among older adults

H_{10A}- Internet access is associated with COVID-19 Vaccine Hesitancy among older adults

H_{11A}- Religiosity is associated with COVID-19 Vaccine Hesitancy among older adults

Null Hypothesis

H_{60}- Marital status is not associated with COVID-19 Vaccine Hesitancy among older adults

H_{70}- Education is not associated with COVID-19 Vaccine Hesitancy among older adults

H_{80}- Medical coverage is not associated with COVID-19 Vaccine Hesitancy among older adults

H_{90}- Social security income is not associated with COVID-19 Vaccine Hesitancy among older adults

H_{100}- Internet access is not associated with COVID-19 Vaccine Hesitancy among older adults

H_{110}- Religiosity is not associated with COVID-19 Vaccine Hesitancy among older adults

To determine which specific factors of the intrapersonal level are associated with COVID-19 vaccine hesitancy among older adults

H_{12A}- Sociodemographic characteristics are associated with COVID-19 Vaccine Hesitancy among older adults

H_{13A}- Immigration status is associated with COVID-19 Vaccine Hesitancy among older adults

H_{14A}- The presence of comorbidities is associated with COVID-19 Vaccine Hesitancy among older adults

H_{15A}- History of flu vaccination is associated with COVID-19 Vaccine Hesitancy among older adults

H_{16A}- Education is associated with COVID-19 Vaccine Hesitancy among older adults

H_{17A}- Vaccine concerns are associated with COVID-19 Vaccine Hesitancy among older adults

Null Hypothesis

H_{120}- Sociodemographic characteristics are not associated with COVID-19 Vaccine Hesitancy among older adults.

H_{130}- Immigration status is not associated with COVID-19 Vaccine Hesitancy among older adults.

H_{140}- The presence of comorbidities is not associated with COVID-19 Vaccine Hesitancy among older adults.

H_{150}- History of flu vaccination is not associated with COVID-19 Vaccine Hesitancy among older adults.

H_{160}- Education is not associated with COVID-19 Vaccine Hesitancy among older adults

H_{170}- Vaccine concerns are not associated with COVID-19 Vaccine Hesitancy among older adults

To determine which specific factors of the interpersonal level are associated with COVID-19 vaccine hesitancy among older adults

H_{18A}- Marital status is associated with COVID-19 Vaccine Hesitancy among older adults

H_{19A}- The death of a family member is associated with COVID-19 Vaccine Hesitancy among older adults.

Null Hypothesis

H_{180}- Marital status is not associated with COVID-19 Vaccine Hesitancy among older adults

H_{190}- Death of a family member is not associated with COVID-19 Vaccine Hesitancy among older adults.

Study Significance

There is not much evidence on the association of the social and structural determinants of health on COVID-19 vaccine hesitancy among older adults in the United States. Understanding the factors associated with COVID-19 vaccine hesitancy among older adults will provide insight that will help address barriers related to other vaccine intakes, such as Flu and Respiratory Syncytial Virus, which can be fatal for infected older adults. Vaccination is a preventive health behavior that can lead to reduced hospitalizations, morbidity, and mortality, resulting in reduced healthcare expenditure for the government, which is mainly responsible for insurance in this age group. Information from this study can be used to develop public health interventions that will address the underlying issues, reducing the likelihood of passing this construct on to the younger generation. Study findings can also provide more knowledge on how community organizations such as faith-based organizations can be leveraged to increase their awareness of the benefits of vaccination.

Study Scope

This study used secondary data from the COVID-19 core interview questionnaire of the Health and Retirement Study (HRS). For this study, the nationally representative HRS was restricted to respondents aged 65 years and older.

Delimitation

The most significant delimitation of this study was its focus on specific SDOH domains (e.g., internet access and medical insurance, social security income, marital status, education) and StrDOH domains (religiosity) even though other aspects of these determinants can impact vaccine hesitancy (Kupferwasser et al., 2023; Peña et al., 2023). Only one domain of religiosity (i.e.frequency of religious service) was assessed even though there were several domains of religiosity (Corcoran et al., 2021; Garcia & Yap, 2021; Tolstrup Wester et al., 2022). The choice of assessing only older adult participants was another delimitation, even though the COVID-19 vaccine was approved for all of the United States population (CDC, 2023). This study examined the role of risk perception, knowledge, and some factors of the interpersonal level of the SEM. In contrast, other levels and factors could impact COVID-19 vaccine hesitancy among older adults. For example, community, institutional, and policy levels could be facilitators and barriers to vaccine intention (Vincenzo et al., 2023; Zheng et al., 2021). Lastly, the study methodology operated within a quantitative framework, making the study conclusion objective and geared towards generalizations (Polit & Beck, 2010; University of Southern California Libraries, 2022).

Definition of Terms

For this research, vaccine hesitancy will be operationalized as the likelihood of older adults not taking a COVID-19 vaccine if available. Social determinants of health will be operationalized to access high-speed internet access, social security income, marital status,

education, and medicare coverage that causes health inequities and disproportionate health outcomes. Structural determinants of health will be operationalized as religiosity within socioeconomic groups, which impacts their decisions towards policies and interventional programs and affects health outcomes. The social-ecological model (SEM) will be operationalized to assess only questions associated with interpersonal and intrapersonal levels.

CHAPTER 2

LITERATURE REVIEW

Background

Vaccine Hesitancy

This chapter will review works of literature on social and structural determinants of health and their relevance to vaccine hesitancy. It will discuss the gaps in the existing literature and the relevance of medicare coverage, immigration status, marital status, internet access, social security income, and religiosity to COVID-19 vaccine hesitancy among older adults in the United States. It will also describe how the levels of the SEM are associated with COVID-19 vaccine hesitancy among older adults, with more focus on the intrapersonal and interpersonal levels of the SEM. In addition, this chapter will describe the conceptual framework relevant to vaccine hesitancy and its application.

The Sage Working Group (WG) on vaccine hesitancy concluded that *'vaccine hesitancy refers to a delay in acceptance or refusal of vaccination despite the availability of vaccination services; it is a complex and context-specific, varying across time, place, and vaccines which is influenced by factors such as complacency, convenience, and confidence'* (Dubé et al., 2014; MacDonald, 2015). *Vaccine hesitancy can occur as a continuum between high vaccine demand and complete denial of vaccine, encompassing a range of beliefs, attitudes, ideologies, emotional orientations, and health-seeking behavior (Beleche et al., 2021; Moore et al., 2022).*

The WG highlighted that vaccine hesitancy is a behavioral phenomenon weighed against the expectation of attaining a specific vaccination coverage goal, given the availability of vaccination services. However, hesitancy and demand were not harmoniously related

(MacDonald, 2015). It is noteworthy that hesitant individuals involve various people who differ

from the small percentage who refuse vaccination and are confident about it (MacDonald, 2015).

History of Vaccine Hesitancy

The term vaccine was derived from *'vaccinia,' the smallpox virus responsible for over*

400,000 deaths per year, with a 75% fatality rate in 18th-century Europe. Despite its

effectiveness in eradicating vaccine-preventable disease since its discovery, it has always been

met with skepticism due to concerns, misconceptions, protests, and outrage (Albert et al., 2001;

MacNeill, 2022; Wolfe, 2002). Since the mid-19th century, several vaccine controversies have

surrounded smallpox, Diptheria-Tetanus-Pertusis (DTP), and Measles-Mumps-Rubella (MMR),

causing neurological complications. This alleged misinformation regarding vaccination and the

history of unethical research done on people of color attracted a lot of media attention, igniting

public distrust, confusion, and fear. The public health impact of these controversies caused a

decrease in vaccination rate and herd immunity, leading to increased vaccine-related deaths

(Gostin, 2005; Rawlings et al., 2022; The College of Physicians of Philadelphia, 2022). In the

United States, vaccine-preventable diseases such as pertussis and measles are becoming

prevalent (Porteous et al., 2016). Notwithstanding the elimination of the measles virus, there has

been a re-emergence of cases, and less than 50% of the United States adult population was

administered the influenza vaccination in the 2021-2022 season (Srivastav et al., 2023;

Uwishema et al., 2023). In 2017, there was a terrible Measles outbreak in Minnesota, and in

2018, there were 220 Measles, including unvaccinated individuals in New Jersey, New York,

Kansas, and Missouri (Hotez, 2019). The waning of certain vaccine effectiveness, the

antivaccination movement, and traveling to endemic areas have been implicated as the cause of

the new emergence of vaccine-preventable diseases (Porteous et al., 2016). From 2014-2019,

pneumococcal vaccination varied across states. About 46.2 % of older adults 65 years and older received the pneumococcal vaccine, consistent with low pneumococcal vaccine coverage in the United States (Centers for Disease Control and Prevention, 2023). Despite decades of research debunking vaccine controversies, many people still believe it, and this has led to a partial or complete refusal of vaccines, most especially during the COVID-19 pandemic in the United States (Deer, 2011).

It is of essence to point out that about 20 million lives were saved in the first year of the COVID-19 vaccination globally, and in the United States, an estimated 11 million deaths and 10.3 million hospitalizations were averted with an estimated 900 billion in healthcare costs expenditure saved (Lalani et al., 2023; The Commonwealth Fund, 2021). Among the vaccine-hesitant groups, however, there has been a significant number of vaccine-preventable deaths (Frenkel, 2021). During the flu season in the United States, the unvaccinated older adult population resulted in approximately 150,000 hospitalizations and 5,00 deaths (Centers for Disease Control and Prevention, 2019; Freed et al., 2021). During the COVID-19 pandemic outbreak, there were approximately 385,000 flu-related deaths among the older population with comorbidities (CDC, 2019; Freed et al., 2021). Although there was a decline in COVID-19-related deaths among older adults after widespread vaccination, there was an uneven trend and a rise in the number of COVID-19 deaths among older adults despite being the primary vaccination series in the United States. (Freed et al., 2022; Duong et al., 2023). This trend was observed across the United States during the Delta and Omicron variant outbreaks, with the lowest vaccination rates in certain states like Alabama, Nevada, Georgia, and Arkansas and especially among older adults in Utah (58%) (CDC, 2019; Freed et al., 2021; Havers, 2022). American older adults 65 years and older experienced increased COVID-19 hospitalizations

compared to younger adults during the Omicron BA.2 and Delta variant predominance in 2022 (Havers, 2022).

From 2020-2023, there were approximately 868,831 COVID-19-related deaths among the American older adult population 65 years and older, with close to 53% mortality occurring in men (Centers for Disease Control and Prevention, 2020b). Although there was a decrease in COVID-19 mortality among older adults during the rollout of vaccination in December 2020 in the United States, COVID-19 deaths were reported to have increased to about 88% in September 2022 (Freed, Neuman, et al., 2022).

In September 2022, 76% of older adults aged 65 years and older who were hospitalized for COVID-19 had not received the bivalent dose despite the recommendation of the bivalent COVID-19 vaccine by the Advisory Committee on Immunization Practices (ACIP), and 16% had not received any COVID-19 vaccine (Taylor, 2023). In 2023, older adults comprised about 90% of COVID-19-related deaths in the United States, and they make up 63% of all COVID-related hospitalizations, with most of them having multiple comorbidities; only 24% had received the recommended COVID-19 bivalent vaccine (Beusekom, 2023; Taylor, 2023). The COVID-19 pandemic led to adverse health outcomes, which can cause a significant healthcare burden (Briss et al., 2023). Due to the combination of commodities and immunocompromised nature, the older adult population who refused vaccination encountered increased healthcare burden and unfavorable health outcomes such as morbidity, increased hospitalization, and significant COVID-19 death rates (Centers for Disease Control and Prevention, 2019; Havers, 2022).

A study revealed that rural counties had lower first-dose coverage compared to urban counties in terms of gender and age group in the United States (Saelee et al., 2022). As of 2023, about 1 million COVID-19 deaths were reported in the United States, of which 75% of COVID-

19 deaths occurred among older adults (Cubanski et al., 2022; Duong et al., 2023). These public health statistics show why the importance of vaccination among older adults in the United States cannot be over-emphasized. In addition, it is pertinent to understand the gap in knowledge as to why there are concerns about vaccination and why vaccine hesitancy exists despite its validated benefits in improving health outcomes in older adults. While several studies have shown that vaccine hesitancy is influenced by more than an individual's health behavior, the socio-ecological model is an excellent framework to assess factors that are deeply associated with vaccine hesitancy among older adults in the United States (Lun et al., 2022; Naidoo et al., 2023).

Impact of Vaccine Hesitancy on Older Adults

As of 2020, the older population in the United States aged 65 years and older was about 55.7 million. This represents 17% of the population, with 30.8 million women and 24.8 million men. 95% of the older adult population had at least one chronic condition, and more than two-thirds of Medicare beneficiaries had more than one chronic medical condition (Administration for Community Living, 202; Lochner & Shoff, 2015). Chronic diseases are the leading cause of death in the United States, and the top six are cancer, chronic lung disease, heart disease, stroke, cancer, and diabetes. Moreover, the majority of the nation's $4.1 trillion of the United States annual healthcare budget is spent on individuals with chronic and mental health conditions (Centers for Disease Control and Prevention, 2023; National Council on Aging, 2021). During the COVID-19 pandemic outbreak, the older population was considered one of the high-risk groups for significant adverse health outcomes and was prioritized to receive the COVID-19 vaccination (Lau & Sosa, 2022).

The impact of vaccine-preventable diseases among older adults can be harmful due to their immunocompromised nature. The age group 65-74 years had a 40-fold increase in being

hospitalized and 1,300 times more likely to die from COVID-19; older adults 74-85 years had a

fold increase in being hospitalized and 3,200 times more likely to die from COVID-19 infection

(Isasi et al., 2021). As of October 2022, 75% of all COVID-19 were among adults 65 years and

older, and as of 2023, the number of COVID-19 deaths among adults 65 years and older was

about 868,831 (Freed et al., 2022).

Factors Associated with Vaccine Hesitancy

The social-ecological model will highlight the multi-level factors associated with vaccine

hesitancy through the interaction with their physical and sociocultural environment.

Individual Level

This level identifies individual beliefs, knowledge, and biological factors that could impact

an individual's health behavior toward vaccination. Social demographic factors such as age,

gender, race, socioeconomic status, and degree of education have been linked to vaccine

hesitancy. Some studies show that adults 50 years and older born in the United States were more

likely to be vaccine-hesitant due to a long history of misconception and misinformation about

vaccination use (Chia & Hartanto, 2021). Due to a long history of mistrust in the government,

African Americans were more likely to be vaccine-hesitant (Padamsee et al., 2022). The female

gender and people with lower educational levels were more likely to be vaccine-hesitant (Khairat

et al., 2022; Morales et al., 2022). Low employment rate has been associated with vaccine

hesitancy due to decreased participation in the labor force, reduced income, and inability to

access health insurance (Guo et al., 2022).

Personal health beliefs and knowledge often stem from their perceived risk of the disease and

vaccine in terms of its safety, history of vaccine acceptance, research, or specific religious beliefs

towards vaccination. These have been shown to be associated with vaccine hesitancy (Sallam, 2021).

Interpersonal Level

This identifies close relationships associated with vaccine hesitancy, such as peers, marital partners, and close relatives. Studies show that marital partners, friends, and close relatives were significant predictors of vaccine uptake and had more impact on individuals' decision-making than other members of social networks (Konstantinou et al., 2021; Rahman et al., 2021). In addition, studies revealed that the higher the number of people in their immediate social networks, such as spouses, children, and friends, who receive the vaccine, the more likely an individual is to get vaccinated (Shmueli, 2021).

Community Level

This highlights neighborhoods, religious centers, resources (e.g., broadband internet), and health burdens within the community where social relationships occur. It seeks to evaluate these factors as they relate to vaccine hesitancy. Access to broadband Internet increases access to misinformation and conspiracy theories are directly correlated with vaccine hesitancy (Garett & Young, 2021). Racial residential segregation and minority communities are more likely to have limited access to vaccine sites (Cho, 2022; Medcalfe & Slade, 2023).

Organization Level

This level explores rules, regulations, and structures correlated with vaccine hesitancy. Lack of adequate healthcare access has been implicated in COVID-19 vaccine hesitancy due to long-standing discrimination and equity (Morales et al., 2022; McElfish et al., 2022). Culturally insensitive healthcare systems towards minority groups have been implicated in vaccine

hesitancy due to the continuous underrepresentation in the healthcare system and research (Hildreth & Alcendor, 2021).

Policy Level

This level evaluates local, state, and federal policies that regulate health actions for early detection, control, and disease prevention and its association with vaccine hesitancy. Studies show that systemic racism may impact vaccine hesitancy among individuals (Lasher et al., 2022; Peretti-Watel et al., 2015), and the presence of health disparity and equity among minority groups increases the likelihood of being vaccine-hesitant (CDC, 2021). In addition, political affiliation can impact the willingness to be vaccinated. This has been evident among conservatives compared to liberals (Jones & McDermott, 2022; Sharfstein et al., 2021; Stewart, 2021).

Consequences of Vaccine Hesitancy at the Community Level

Vaccine hesitancy may act as a barrier to establishing herd immunity within the community, posing a significant risk to older adults, immunocompromised, pregnant women, and children (Gerretsen et al., 2021; Gorman et al., 2022). This barrier can increase the risk of harm and increase vaccine-preventable mortality and morbidity among these immunocompromised groups (Centers for Disease Control and Prevention, 2019; Freed et al., 2021). Another consequence is the potential of the 'spillover' effect of beliefs regarding the COVID-19 vaccine, which may increase reluctance to use future vaccines (Baldwin et al., 2023).

This study is unique because it assesses different domains of the SDOH and religion as a StrDOH determinant with COVID-19 vaccine hesitancy among older adults in the United States. This study assesses the association of both determinants with COVID-19 vaccine hesitancy among older adults in the United States. The study also assesses the COVID-19 vaccine hesitancy among

older adults in the United States before the onset and during the COVID-19 vaccine administration. This aligns with the definition of vaccine hesitancy as a behavioral phenomenon and can occur as a continuum. This research may unravel the gap and add to the body of knowledge regarding vaccine hesitancy among older adults, which could lead to a behavior change.

Social Determinants of Health and Vaccine Hesitancy

'*Social determinants of health are the conditions in which people are born, grow, work, live and the wider set of forces and systems shaping the conditions of daily life*' (Centers for Disease Control and Prevention, 2020a). The Social Determinants of Health (SDOH) are non-medical factors (i.e., economic systems and policies, social norms, social policies, and political agendas) that are closely related to health outcomes and health inequities (Centers for Disease Control and Prevention, 2020a; World Health Organization, 2010). Solar and Irwin developed the social determinants of health (SDOH) framework adopted by the World Health Organization (W.H.O). It describes the distinct forms of social determinants of health and the causal connection between these determinants and health. The SDOH is grouped into five domains: economic stability (e.g., employment programs, policies that aid housing, food, education, and healthcare), healthcare access and quality (e.g., health insurance, access to healthcare professionals, access to healthcare services and medications), social and community context (e.g., relationships with family, co-workers, friends and community members) neighborhood and built environment (e.g., safe neighborhood and housing, broadband internet access, injury prevention) and education access and quality (e.g., access to education, and provision of high-quality educational opportunities) (Centers for Disease Control and Prevention, 2020a).

The Role of Internet Access in Vaccine Hesitancy

Since 2012, half of the American adults aged 65 and older have internet access, and 70% of them now use the internet. However, approximately 22 million older adults, especially African American and Latino seniors, do not have broadband access at home, and this is a significant determinant of health (Jess, 2022; Zickuhr & Madden, 2012). Approximately 40% of older adults who died from COVID-19-related deaths were unable to access vital online resources from home (Humana Foundation, 2021). Older adults without internet access are unable to have better access to healthcare and health-related information such as telehealth medicine, vaccine availability, efficacy, and notification through contact tracing and safety (Jess, 2022; Sun et al., 2020).

The Role of Health Insurance in Vaccine Hesitancy

As of 2021, 299 million Americans were enrolled in healthcare coverage; older adults 65 years and older comprised 18.2% (60 million) of people enrolled in Medicare and 21.1% in Medicaid (Congressional Research Service, 2023). Although the COVID-19 vaccines were administered free of charge in the United States regardless of insurance status (Tolbert et al., 2022), Individuals with health insurance are more exposed to health information by their primary care provider (Reiter et al., 2020). It is essential to assess the impact of this health information among older adults with health insurance coverage because a large number of people were skeptical about taking the COVID-19 vaccine when it became available due to the growing source of misinformation (Mathis & Rooks, 2022).

The Role of Education in Vaccine Hesitancy

Education is uniquely linked to health outcomes, especially for older adults because it enables them to comprehend complex health information and improve personal health literacy

(U.S. Department of Health and Human Services, 2023). In 1970, the number of older adults who were high school graduates in the United States was less than 40% (i.e., 30% were older Caucasian and 9% were African American); between 1970 and 2021, it rose to 79%. In 2021, 33% had a bachelor's degree or higher. There were also racial disparities in the educational level of older adults (Administration for Community Living, 2021). Due to the educational inequity and disparity of older adults who are educated, it is important to assess their willingness to COVID-19 vaccine uptake during the pandemic.

The Role of Social Security Income in Vaccine Hesitancy

Social Security Income (SSI) may serve as a bedrock of economic security and income support programs to alleviate the burden of United States older adults (Li & Mutchler, 2020). Although such a program may seem insufficient, it has been associated with socioeconomic health disparities. SSI is an important predictor because about 16.5 million older adults depend upon social security benefits to be above the poverty line and protect minority groups and people of color (Romig, 2024). A study also shows that a higher SSI was linked to a positive health outcome (Arno et al., 2011; Herd et al., 2008).

The Role of Marital Status in Vaccine Hesitancy

In 2021, about 18 million older men and 15 million older women lived with their spouses in the United States. Approximately 15.2 million American older adults live alone in the community, with a large percentage being women (33%). There is a three-fold increase in the number of widows (9.1 million) compared to widowers (2.6 million), and 16 % of all older adults are divorced and separated (Administration for Community Living, 2021). This is important because spouses provide social, cognitive, and emotional support as well as social integration within the community (Liu et al., 2023; Wang & Yi, 2023). More importantly,

marital status, a social determinant of health predictors, has been associated with health outcomes in an increasingly diverse aging population, with the married population having better health outcomes compared to the divorced population (Hosseinpoor et al., 2012; Wang & Yi, 2023). Due to the unequal vaccination rate and increased risk of morbidity and mortality common among older adults in the United States, it is crucial to determine how marital status in the older adult population is associated with COVID-19 vaccine-making decisions.

Structural Determinants of Health and Vaccine Hesitancy

Structural determinants of health (StrDOH) are cultural, political, social, and economic structures that form the distribution of resources, material, and symbolic power; it maintains social stratification, which, in turn, impacts an individual socioeconomic class based on education, gender, income, occupation, and ethnicity. The StrDOH is derived from governance, policies, laws, institutional practices, beliefs, values, norms, and culture (Heller et al., 2024). The structural determinants of health (StrDOH) focus on the interplay between socio-political factors and are the basis of health inequities because they determine the quality of the Social Determinants of Health experienced by people in their neighborhoods and communities (Illinois Department of Health, 2022; WHO, 2010).

The Role of Religiosity in Vaccine Hesitancy

Religion as a structural determinant of health is a personal or institutionalized system of religious beliefs, attitudes, and practices (Paul Victor & Treschuk, 2019). Religion has been seen as a social and a structural determinant of health. However, the latter can impact socioeconomic and institutional conditions such as policy, political and economic decisions, racism, colonialism, sexism, patriarchy, poverty, misogyny, stigma, and admittance to electoral offices which shapes a major aspect in most of the older adult populations in the United States (Hammell, 2021;

Taylor, 1998). There are five dimensions of religiosity: religious belief, religious exclusivity, external practice (i.e., religious service attendance, social activities, and group membership), personal practice, and religious salience (Pearce et al., 2017).

In 2020, 70% of Americans identified as Christians, of which 40% identify as white Christians, close to 30% identify as Christians of color, and about 25% of Americans are religiously unaffiliated, while 5% identify as non-Christian religions (PRRI Staff, 2021). More than 95% of those born before the 1940s were raised Christian and were still Christian from ages 30 to 65. e.g., 91% of Americans born in the 1960s were still Christian at age 30, but 83% identify as Christian today. In addition, religion has been researched to positively impact individual health outcomes via social support (Idler et al., 2017; Pew Research Center, 2022; Roof, 1980).

Religiosity is fluid, dynamic and multidimensional. More than 90% of American older adults consider themselves to be spiritual or religious, and this is based on the frequency of religious services attendance (i.e., about 50% attend religious services at least weekly), frequency of private religious practices, and religious coping mechanisms such as trust in God, praying, and turning problems over to God (Kaplan, 2023). Few studies have been conducted regarding religiosity and COVID-19 vaccine hesitancy. First, a study showed that scientific and medically sound evidence is influenced by religious beliefs, leading to vaccine hesitancy (Garcia & Federick, 2021). Another study showed that religious identity is associated with COVID-19 vaccine intention (Chu et al., 2021). While a study examined common religious beliefs that are associated with vaccine hesitancy and its consequences (Kibongani Volet et al., 2022), another focused on religiosity and spirituality contributing to ongoing COVID-19 vaccination rates (Martens & Rutjens, 2022). This study assesses how the frequency of religious service

attendance associated with COVID-19 vaccine hesitancy can provide an alternate reason for the failure of numerous interventions that seem prevalent among older adults in the United States.

Theoretical Framework for Vaccine Hesitancy

Several theoretical approaches validate examining vaccine hesitancy because it is a decision-making process. The first is the risk culture, and Healthism centered on the concept of distrust as the major influence for vaccine hesitancy ((Beck et al., 1992; Giddens, 1992). However, several studies oppose the concept of distrust by citing that vaccine hesitancy or other health-related controversies are based on individuals' ideologies toward vaccines and research that support their ideology of vaccine refusal (Henrich & Holmes, 2008; Opel et al., 2011; Siddiqui et al., 2013). The theory of Planned Behavior (TPB) is centered on the psychological factors that influence vaccines and incorporates a behavior change intervention. In addition, it uses theoretical constructs that assist in responding to various health-related research gaps from a social-cognitive aspect. However, the TPB does not account for environmental factors, economic factors, and behavioral factors like perceived threats that impact an individual intention to perform a behavior (Boston University, 2019; Limbu, Gautam, & Zhou, 2022).

The social cognitive theory focuses on how an individual acquires and maintains behavior while considering the experience and social environment in which an individual performs a behavior. However, it suggests that abrupt changes in the environment lead to changes in a person and does not focus on emotion and motivation for a behavior change or individual behavior (Boston University, 2019; Zhu et al., 2022).

Although the transtheoretical model focuses on an individual's decision-making through a continuous cyclical process, it assumes individuals always make coherent and logical decisions and ignores social contexts like income and social-ecological status. It also focuses on a single

unhealthy behavior without accounting for other confounding health behaviors (Boston University, 2019; Raihan & Cogburn, 2023; Zhu et al., 2022).

The Health Belief Model (HBM) helps to predict specific health behaviors based on individuals' perceptions of susceptibility or severity to the disease, combined with perceived barriers and benefits to the behavior (Mckellar & Sillence, 2020). It utilizes constructs such as perceived susceptibility, perceived severity, perceived barrier, perceived benefits, and self-efficacy that have been used to explain vaccine hesitancy (Shmueli, 2021). However, it does not reflect the attitude or intention of people toward vaccine hesitancy, nor does it explain the psychological factors and multi-level factors that may influence vaccine hesitancy (Green et al., 2020; Romate et al., 2022; Rosentock, 1974; Shmueli, 2021).

The SEM considers multiple levels that are closely related to affect health outcomes and identifies multiple factors that could impact healthcare decisions. In 1970, the SEM was first proposed as an ecological systems theory by Broffenbrenner and McLeroy et al. redefined as a framework to promote health-related behavioral change (Bronfenbrenner, 1977; McLeroy et al., 1988). The SEM framework was utilized to critically evaluate the range of factors associated with a health outcome (Scarneo et al., 2019).

The SEM frame consists of 5 levels: intrapersonal, interpersonal, organizational, community, and policy (Scarneo et al., 2019). The SEM is an appropriate theoretical model to examine the multi-level factors that are closely related to vaccine hesitancy and not only the individual determinants such as beliefs, perceived risk, and past vaccine acceptance (Kumar et al., 2011). It also addresses a broad range of health issues and approaches related to vaccine hesitancy by targeting the five levels of correlation for health behaviors (Nyambe et al., 2016).

Figure 1:

Social Ecological Model Components

Source: Multinomah Healthy HomeToolkit: (Wisconsin Department of Health Services, 2023).https://www.dhs.wisconsin.gov/publications/p03361.pdf

Application of the SEM Constructs to COVID-19 Vaccine Hesitancy

The SEM provides answers to serious problems concerning the potential 'spillover' effect of

beliefs from other vaccines that contributed to COVID-19 vaccine hesitancy (Baldwin et al.,

2023). Furthermore, the multifaceted levels within the SEM target individual, behavioral,

environmental, and social policy changes that aid in making health choices (Alghzawi &

Ghanem, 2021). Although the determinants of vaccination involve all the levels of the SEM, the

decision-making is ultimately an individual-level belief, which is imperative in understanding

vaccine hesitancy (Baldwin et al., 2023). The SEM also lays out the initial framework for health

behavior and mediations that address individual health outcomes (Ewald et al., 2023; Limbu,

Gautam, & Pham, 2022). However, there is a wide range of determinants that impact the

initiation of a change in health behavior, and these determinants may include and are not limited to attitude, social influence, knowledge, experience, and social and structural determinants of health predictors (Meillier et al., 1997).

The study will focus on the intrapersonal and interpersonal levels of the SEM to determine its correlation with individual-level beliefs and COVID-19 vaccine hesitancy among older adults in the United States.

Intrapersonal Level

This is based on individual characteristics (i.e., knowledge, belief, behavior, attitudes, and skills), perceived risk of disease, and other personal characteristics such as education, income, age, and health history that impact and motivate health behaviors (Betsch et al., 2018; Brewer et al., 2017). American older adults are overly affected by chronic diseases, with nearly 95% having at least one chronic disease (Silberman, 2022). In addition, the leading causes of mortality among older American adults are cancer, heart disease, stroke, diabetes, and COVID-19 infection (Centers for Disease Control and Prevention, National Center for Health Statistics, 2021). This accounts for 66% of all healthcare burdens and 93% of Medicare spending, with fewer United States healthcare dollars spent on public health prevention (National Council on Aging, 2021).

In 2019, about 44.9 million of the United States population were foreign-born, and 38.3 million native-born Americans had at least one immigrant parent living in the United States. There are approximately 590,070 active Deferred Action for Childhood Arrivals (DACA) and 10.3 million undocumented immigrants in the United States (American Immigration Council, 2021). The immigrant population, especially undocumented immigrants, refugees, and migrants, have been identified as being under-immunized and are negatively impacted by access to

healthcare services and healthcare professionals. Moreover, decreased immigration rates have been reported among the immigrant population (Chang, 2019; Daniels et al., 2022).

The relevance of the intrapersonal level could be seen in a study that showed individuals had to be adequately motivated to seek out the vaccine through public vaccination sites (Betsch et al., 2018; Brewer et al., 2017). The intrapersonal level has factors that suggest vaccine intention similar to the HBM, especially surrounding relevant health threats, vaccine safety, and efficacy (Baldwin et al., 2023; Rural Health Information Hub, 2018). A study showed that the intrapersonal level included factors that reflected some of the contrusts of the HBM, such as perceived susceptibility, perceived severity, and benefits to vaccine uptake. The Health Belief Model (HBM) addresses the socio-ecological model's individual, intrapersonal, and community-level factors (Enyinnaya et al., 2024). However, the HBM models do not explain the multi-level complex interaction between the individual, physical and environmental, cultural, and social factors that impact vaccine hesitancy (Dankwa-Mullan et al., 2010). The intrapersonal level focuses on the perceived risk of disease; the Social Amplification of Risk Framework, Protection Motivation Theory, and Expected Utility Theory can show that barriers, perceptions of susceptibility to and severity of infection impact vaccine hesitancy (Dayton et al., 2022). Common behaviors that have been shown to drive vaccine hesitancy are attitude, motivation, individualism, perception, and cognitive bias (Khan et al., 2022). Due to the increasing level of misinformation perception during the COVID-19 pandemic, the perceived risk of diseases such as commodities, COVID-19 concerns, and history of vaccination will provide insight as to the association and degree of hesitancy towards the COVID-19 vaccine. It is therefore imperative to assess whether hesitancy towards the COVID-19 vaccine is common among older adults based on immigration status.

Interpersonal Level

This level focuses on the relationships between individuals' closest social circle (i.e., partners, family members, friends, and health professionals). Previous studies suggest that social ties/circles and marital status are major precursors for performing healthy behavior (Guan & So, 2016; Liu et al., 2023; Wang, Tee et al., 2021). The interpersonal level helps to understand how these relationships are closely related to an individual's health behavior and contribute to their experiences (McLeroy et al., 1988). The Social Contagion Theory shows that individual behavior and attitude can be contagious to people within their social network (Alabadi et al., 2023). The interpersonal level is one of the Social Ecological Models (SEM) that outlines various social factors that impact health decision-making (Dayton et al., 2022; Enyinnaya et al., 2024; Scarneo et al., 2019).

Rationale for Intrapersonal and Interpersonal Levels of SEM.

Intrapersonal factors shape individuals' vaccine hesitancy based on sociodemographic attributes, vaccine literacy, and beliefs about vaccination. In addition, interpersonal factors impact vaccine-making decisions due to social norms among family and social networks (Alabadi et al., 2023). Several studies have only focused on the intrapersonal and interpersonal factors as they relate to health outcomes based on participants' varied degrees of experience (Ma et al., 2022; Valaitis et al., 2018). Focusing on these levels of the SEM will not only determine factors associated with COVID-19 vaccine hesitancy but also show the variation of hesitancy that occurs among older adults based on their experiences.

Conceptual Framework

The conceptual framework below (figure 2) will incorporate the social and structural determinants of health into the SEM. In this study, there are three working hypotheses:

My first working hypothesis determined how the operationalized social and structural determinants of health predictors incorporated into the SEM level are associated with COVID-19 vaccine hesitancy among older adults in the United States. These operationalized determinants such as the StrDOH predictor (i.e., religiosity) incorporated at the institutional level, and the SDOH predictors such as broadband internet incorporated at the community level, social security income incorporated at the policy level, health insurance incorporated at the institutional level, marital status incorporated in the interpersonal level, and educational level incorporated at the intrapersonal level. This multiple-level interconnectedness will provide answers to their association with older adult decision-making regarding COVID-19 vaccine hesitancy in the United States.

My second working hypothesis determined how the intrapersonal of the SEM impacts COVID-19 vaccine hesitancy among older adults in the United States. For this study, I hypothesized that the socio-demographic factors (i.e., United States born and degree of education) and risk perception (i.e., presence of comorbidities, history of flu vaccination, and COVID-19 vaccine concern) might be associated with vaccine hesitancy.

My third working hypothesis determined how the interpersonal levels of the SEM impact COVID-19 vaccine hesitancy among older adults in the United States. For this study, I hypothesized that marital status and death due to COVID-19 infection from a family or friend may be associated with vaccine hesitancy.

Figure 2: Conceptual Framework
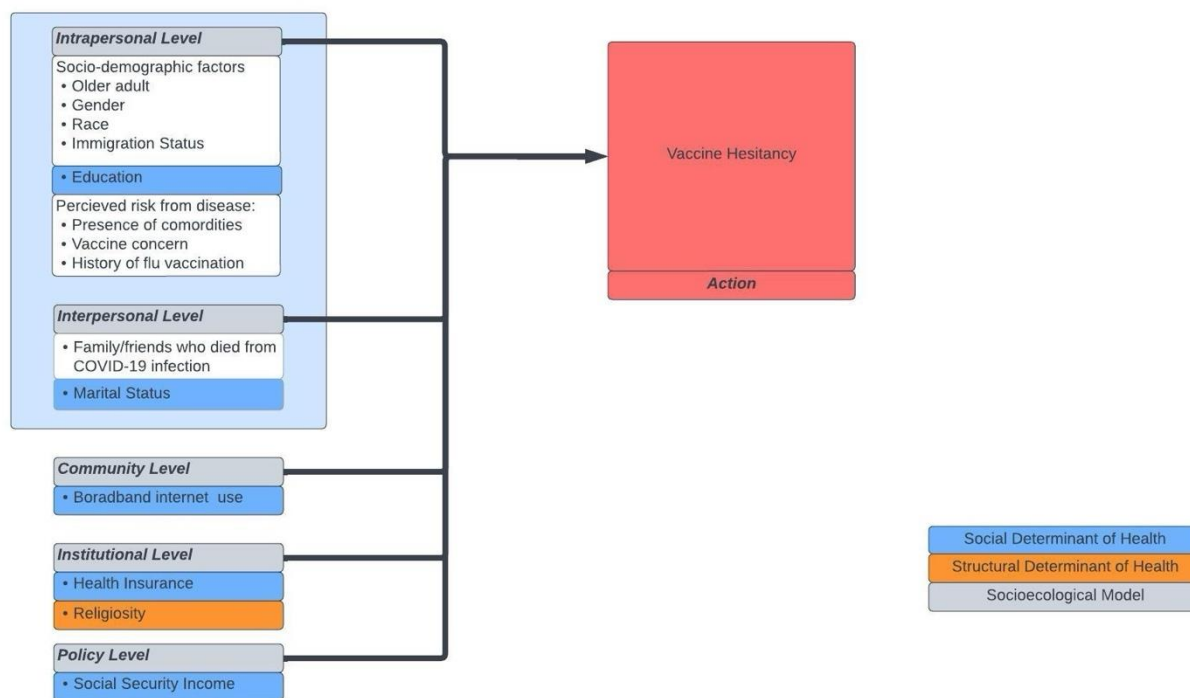
Gaps in Research Knowledge

Few studies have tried to investigate the complex relationship between COVID-19 vaccine reluctance and older adults. Some have used state-level data to assess the impact of health equity in COVID-19 vaccination among older adults with a focus on language, occupation, and housing (Wang, Xu, et al., 2021). Another study utilized state-level data to focus on the determinants of vaccine acceptability in older adults aged 50 years and older by examining human immunodeficiency virus (HIV) disease, demographic characteristics, and psychosocial factors (Davtyan et al., 2022). While other studies evaluated the association between COVID-19 vaccine intention and perception in older adults of an integrated health system within a specific period (i.e., June 2021-February 2021) (Cimone Durojaiye et al., 2022), another study focused on the association between rural-urban differences and disability and aging services and COVID-19

vaccination rates among older adults using county-level data (Sun & Rhubart, 2022). Another research study focused on the social and structural determinants of health to investigate attitudes and knowledge toward COVID-19 vaccine uptake among diverse racial and ethnic groups (Peña et al., 2023). However, vaccine hesitancy among adults 65 years and older persists.

Social and Structural Determinants of Health have been applied to several studies to understand health disparities and examine what predictors are responsible for health disparities in the United States (Dover & Belon, 2019; Majee et al., 2022). There are limited studies that assess the five domains of social determinants of health, certain dimensions of religiosity representing the structural determinants of health, and the combined impact of both determinants as it relates to COVID-19 vaccine hesitancy among older adults in the United States. This study may be key in providing insight as to how older adults' beliefs impact their behavior toward taking the COVID-19 vaccine and the reason for the increased related morbidity and mortality among older adults in the United States during the COVID-19 pandemic.

Chapter Summary

In summary, this chapter discussed existing literature on vaccine hesitancy, the older population, and social and structural determinants of health. The theoretical and conceptual framework for the study and how it applies to the hypothesis was also discussed in this chapter. The study design, methodology, and data analysis will be discussed in Chapter 3.

CHAPTER 3

METHODOLOGY

This chapter describes the research methodology and discusses the study design, data collection method, hypothesis, and analytical approach employed. This study used a quantitative approach to analyze secondary data to answer the research questions.

Data Source and Research Design

This research used a quantitative longitudinal study comprising multiple waves of data that allowed the assessment of changes over time. In 1990, the United States Congress directed the National Institute on Aging to create a new study to inform discussion at a national level about health and retirement issues among the growing population of older Americans. This new study, the Health and Retirement Study (HRS), was the first longitudinal survey of American older adults, and it had a complex panel structure and sample design launched in 1992. It includes information regarding behavior and choices (i.e., health behaviors, work, residence), events and transitions (widowhood, institutionalization), successful aging (i.e., public, psychological, and cognitive), and detailed health and economic information in the same survey. The aim was to establish an understanding of aging and provide scientific data for assessing national-level policy and social changes that may impact individuals. The Institute for Social Research performed the HRS at the University of Michigan (Health and Retirement Study, 2016; Sonnega et al., 2014).

The HRS participants represent all Americans aged 50 and older, and couples are generally followed until death. The survey participants were also community-dwelling persons at baseline but were retained in the study if they moved to long-term care facilities. The new sample is refreshed with younger cohorts every 6 years. The sample size ranges from 18,000 to 23,000 in any given wave (Health and Retirement Study, n.d.; Heisler et al., 2007; Sonnega et al., 2014).

Sampling Design

The HRS study sample population was conducted using a multi-stage area probability design of United States households that involves geographical stratification, oversampling, and clustering of certain demographic groups. The multistage area probability sample design consists of four stage selections: primary-stage selection, secondary-stage selection of area segments, third-stage selection, and fourth-stage selection. The primary stage selection details information regarding core samples, Black supplements, Hispanic supplements, and Florida oversampling; The secondary stage selection of area segments details information regarding second-stage sampling units (SSU) stratification, selection, and allocation; the third stage details the selection of housing units located geographical area; the fourth stage details respondents selection in which the interviewer made a list of all household members within each sampled housing unit (Heeringa & Connor, 1995).

Data Collection

The 2020 HRS study incorporated COVID-19-related questions, and the COVID-19 core interview data collection period was initially from March 2020 to June 2021 and repeated in 2022 (Health Retirement Study, 2023; Smith et al., 2023). The COVID-19 Project of the 2020 Health and Retirement Study (HRS) administered a 50% random sub-sample of households originally assigned to enhanced face-to-face interviewing (EFTF). This was conducted in two random half-groups. Interviews were conducted via the web or telephone due to social distancing and restrictions on social contact. Respondents who preferred in-person interviews were sent the self-administered leave-behind questionnaire (Health Retirement Study, 2023). The COVID-19 project was initially released in November 2020, updated in February 2021, and the 2020 HRS data collection is ongoing (Health Retirement Study, 2023; Smith et al., 2023). Information on

the questionnaire, data collection instruments, HRS COVID-19 data resources and release date, validation, and its application can be found at this link: https://hrs.isr.umich.edu/data-products/covid-19

Participants

In 1992, the creation of the HRS sample initially started with recruiting participants born in 1931-1941, then the Asset and Health Dynamics Among the Oldest Old (AHEAD) cohort born in 1890-1923. In 1998, two new cohorts were enrolled: the Children of the Depression (CODA) cohort born in 1924-1930 and the War Babies cohort born 1942-47. In 2004, a new cohort was added, the Early Baby Boomers cohort, which was born between 1948 and 1953. In 2010, the Mid Baby Boomers cohort born in 1954-1959 was added. The HRS employed a steady-state design in which samples were refreshed with younger cohorts every 6 years. The African-American and Hispanic household was oversampled with about twice the white participants, and mail surveys and core interviews were conducted in Spanish and English (Sonnega et al., 2014).

The majority of the baseline interviews were conducted face-to-face (FTF). Before 2004, telephone use was the primary mode of follow-up interview except for participants over 80 years who were offered face-to-face follow-up interviews. Since 2006, the HRS study has utilized a design in which half of the samples are assigned an FTF interview with biological and physical measures, a psychosocial questionnaire, and an enhanced FTF interview. The other half of the HRS sample completed the core interview utilizing the telephone (Health and Retirement Study, n.d.; Heisler et al., 2007; Sonnega et al., 2014).

Based on the study's research focus, the sample was restricted to HRS participants who represent older adults aged 65 years or older in the United States due to the following reasons: The National Institute on Aging (NIA) classifies older adults in the United States as people aged 65

years or older and selected age group represent the age for Medicare eligibility (National Council on Aging, 2021; National Institute of Health, 2022; U.S Department of Health and Human Services, 2022). The total sample size (N=2311) was selected based on the participants (i.e., 65 years and older who were eligible for Medicare coverage) who responded to the HRS COVID-19 questionnaire and a wide range of socio-demographic, health, and lifestyle characteristics to achieve the study goals. The HRS study provides the respondent-level and household sample weights derived from different probabilities of selection and differential non-response in each wave. The weights were not correlated with the dependent variable of interest to prevent bias, over-representation of data, and reduction in effective sample size.

Research Questions (RQ)

RQ1: Which specific social determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States?

RQ2: Which specific structural determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States?

RQ3: Which specific social and structural determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States?

RQ4A: Which specific factors in the intrapersonal level of the SEM have been associated with COVID-19 vaccine hesitancy among older adults?

RQ4B: Which specific factors in the interpersonal level of the SEM are associated with COVID-19 vaccine hesitancy among older adults?

Dependent Variable

The dependent variable of interest was vaccine hesitancy. The 2020 HRS COVID-19 core interview started before the COVID-19 vaccine was available in December 2020. At that time,

the participants responded to the operationalized survey question, *'It's possible there will be a vaccine for coronavirus in the next several months. How likely would you be to take a vaccine if it were available to you like a flu shot?'* The survey question was later updated to cover participants who did not take the vaccine when it became available. The participants who answered no to the question, *'Vaccines for the coronavirus have recently become available for some people. Have you received a vaccination shot for the coronavirus?'* were asked the updated survey item that operationalized vaccine hesitancy:

'How likely are you to take a coronavirus vaccine when it becomes available to you?'. The response categories remained the same very likely, somewhat likely, not very likely, not at all likely.

The original response categories were reverse-coded to not at all hesitant (coded as 1), a little hesitant (coded as 2), somewhat hesitant (coded as 3), and very hesitant (coded as 4).

Independent Variables

The independent variable was operationalized to reflect different domains in the social and structural determinants of health. As an independent variable, social determinants of health were operationalized using variables such as internet access, marital status, educational level, social security income, and medicare insurance coverage.

The variable 'marital status' was operationalized using the survey question 'marital status.' The response categories were 1=married, 2=separated/divorced, 3=widowed, 4=never married, 5=marital status unknown. The original response categories were coded married (coded=1), separated/divorced (coded=2), widowed (coded =3), and never married (coded=4).

The variable 'Internet access' was operationalized using the survey question 'Do you regularly use the Internet (World Wide Web) for sending and receiving e-mail or for any other

purpose, such as making purchases, searching for information, or making travel reservations?' The response categories were Yes (coded 1) and No (coded 2).

The variable 'education' was operationalized using the survey question 'Highest level of education?'. The responses were as follows: 1= No degree, 2= GED, 3= high school diploma,4= two-year college degrees, 5= four-year college degrees, 6= master degree, 7= professional degree, and 9= degree unknown . The original response categories were coded as high school diploma (coded 1), unknown degree (coded 2), college degree (coded 3), graduate degree (coded 4), and No degree (coded 5).

 The social security income variable was operationalized using the survey question 'Do you currently receive any income from Social Security?' the response categories were yes (coded 1), and No (coded 2).

The health insurance coverage variable was operationalized using the survey question 'Are you currently covered by Medicare health insurance?' the response categories were yes (coded 1), and No (coded 2).

As an independent variable representing structural determinant of health domains, the religiosity variable was operationalized using the survey question 'How often do you attend religious service?' and the original response categories were 'more than once a week= 1, once a week=2, two or three times a month=3, one or more times a year =4, not at all =5'. The original responses were coded as At least once a week (coded 1), at least once a month (coded 2), at least once a year (coded 3), and Not at all (coded 4).

Socioecological Model (SEM) Constructs

Some of the variables that were not categorized in the SDOH or StrDOH were imperative to determine if these events could trigger a behavior change in older adults. The variables operationalized are:

Intrapersonal Level

The variables were categorized as socio-demographic factors and perceived risk from disease. Variables such as older adults, gender, race, and immigration status are considered to be part of the sociodemographic factors variables of the intrapersonal level.

Socio-demographic Variables

- Age: the birthdate was categorized as 65-74 years (coded 1), 75-84 years (coded 2), and 85 years and older (coded as 3).

- Gender: The genders were coded as Female (coded 1) and Male (coded 2).

- Race: The races were coded as Black or African-American (coded 1), other (coded 2), and White/Caucasian (coded 3).

- Immigration status: The immigration status was coded as US-born (coded 1) and Immigrant (coded 2)

- Education level: The original response categories were coded as high school diploma (coded 1), unknown degree (coded 2), college degree (coded 3), graduate degree (coded 4), and No degree (coded 5).

Perceived Risk from Disease

- Co-morbidities: The variables 'high blood pressure, diabetes mellitus, chronic lung disease, and cancer were merged to create a new variable 'presence of comorbidities'. The response

category numbers 1-4 were reflected as the number of commodities (coded 1) and No

comorbidity (coded 2).

- Vaccine Concerns: the variable was operationalized using the survey question 'Overall, on a

  scale from 1 to 10, where one is the least concerned and ten is the most concerned, how

  concerned are you about the coronavirus pandemic?'The response categories were coded

  using a Likert scale to extremely concerned (coded 1), moderately concerned (coded 2),

  somewhat concerned (coded 3), slightly concerned (coded 4), and not at all concerned (coded

  5).

- History of flu Vaccination: The variable was operationalized using the survey question 'Have

  you had in the last two years the following medical tests or procedures? A flu shot?' The

  response was Yes (coded 1) and No (coded 2).

Interpersonal Level

- Death from COVID-19 infection: The variable was operationalized using the survey question

  'Has anyone you know died from COVID-19?' The response categories were yes (coded as

  1), and no (coded as 2).

- Marital status

The control variables for this study are age, gender, race, and immigration status.

Table 1 outlines the study variables and their measure.

Table 1

Study Variables and Measures

	Variable Name	Measure	Recoded Name
Dependent Variable	Vaccine intention	1= Very likely	1= Very Hesitant
	'How likely would you be to take a vaccine if it were	2= Somewhat likely	2= Somewhat Hesitant

	available to you like a flu shot?'	3=Not very likely	3= A little hesitant
		4=Not at all likely.	4= Not at all hesitant
Independent Variables	Religiosity scale How often Attend religious service	1= More than once a week	1=At least once a week
		2=Once a week	2=At least once a month
		3= Two or three times a month	3=At least once a year
		4= One or more times a year	4=Not at all
		5=Not at all	
	Marital status	1= married	1= Married
		2=annulled	2=Separated/divorced
		3=separated	3=Widowed
		4= divorced	4=Never Married
		5= widowed	
		6= other	
	Educational Level Highest level of education?	0=No degree	1=High school diploma.
		1=GED	2=Unknown degree.
		2=High school diploma	3= College degree
		3= two-year college degree	4=Graduate degree
		4= four-year college degree	5=No degree
		5=master degree	
		6= professional degree	
		9=degree unknown	
	Social Security Income	1=Yes	1=Yes
		2= No	2= No
	Medicare health coverage:	1=Yes	1=Yes

Are you currently covered by Medicare health insurance?	2= No	2= No
Regular use of web for email	1.Yes	1.Yes
Do you regularly use the Internet (World Wide Web) for sending and receiving e-mail or for any other purpose, such as making purchases, searching for information, or making travel reservations?	2. No	2. No
Intrapersonal Level: Socio-demographic factors**		
Education level	0=No degree 1=GED 2=High school diploma 3= two-year college degree 4= four-year college degree 5=master degree 6= professional degree 9=degree unknown	1=No grade 2= High school 3= Some college 4=College grade 5= Post college 6=None
Perceived risk from the Disease Presence of co-morbidities	High blood pressure, diabetes, chronic lung disease, cancer excluding skin	1=Presence of comorbidities 2=No comorbidities
History of flu Vaccination: Have you ever had pneumonia vaccination?/since we last talked to you, have	1=Yes 2= No	1=Yes 2= No

	you had a pneumonia vaccination?		
	COVID-19 concern: The variable was operationalized 'Have you been tested for the coronavirus'?	1=Yes 2= No	1=Yes 2= No
	Interpersonal level		
	Marital status	1= married 2=annulled 3=separated 4= divorced 5= widowed 6= other	1= Married 2=Separated/divorced 3=Widowed 4=Never Married
	Death from COVID-19:Has anyone you know died from COVID-19?	1=Yes 2= No	1=Yes 2= No
Controls	Older Adults**	Birthyear 1890-1995	1=65-74years 2=75-84years 3=85years and older
	Gender**	1=Male 2=Female	1=Female 2=Male
	Race**	1= White/Caucasian 2= Black/African American 3=Others (American Indian, Alaskan Native, Asian, Native Hawaiian, And Pacific Islander)	1= Black/African American 2=Others (American Indian, Alaskan Native, Asian, Native Hawaiian, And Pacific Islander) 3= White/Caucasian

Immigration status**	1=US born	1=US born
	2=Immigrant	2=Immigrant

**Socio-demographic variables incorporated into intrapersonal level

Data Analysis

The data analysis consisted of descriptive characteristics and multinomial multivariable logistic regression. The descriptive statistics were calculated to illustrate participants' characteristics such as mean, percentages, and frequencies. The COVID-19 vaccine hesitancy outcome was made an ordinal variable. The SPSS statistical software was used in the analysis and the statistical significance was evaluated at $p<.05$ level.

RQ1: Which specific social determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States?

Multinomial multivariable logistic regression was conducted to assess the association of the social determinants of health – internet access, marital status, social security income, education, and health insurance- and COVID-19 vaccine hesitancy among older adults.

RQ2: Which specific structural determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States?

Multinomial multivariable logistic regression was conducted to assess the association of the structural determinants of health – frequency of religious attendance- and COVID-19 vaccine hesitancy among older adults.

RQ3: Which specific social and structural determinants of health are associated with COVID-19 vaccine hesitancy among older adults in the United States?

Multinomial multivariable logistic regression was conducted to assess the association of the social and structural determinants of health – internet access, marital status, social security

income, education, health insurance, and frequency of religious attendance - and COVID-19 vaccine hesitancy among older adults.

RQ4A: Which specific factors in the intrapersonal level of the SEM are associated with COVID-19 vaccine hesitancy among older adults?

Multinomial multivariable logistic regression was conducted to assess the association of the intrapersonal level – socio-demographic variables such as older adults, gender, race, immigration status, educational level, and perceived risk of diseases such as the presence of comorbidities, history of flu vaccination, vaccine concern - and COVID-19 vaccine hesitancy among older adults.

RQ4B: Which specific factors in the interpersonal level of the SEM are associated with COVID-19 vaccine hesitancy among older adults?

Multinomial multivariable logistic regression was conducted to assess the association of the interpersonal level – marital status and family/friends who died from COVID-19 infection - and COVID-19 vaccine hesitancy among older adults.

Institutional Review Board and Ethical Consideration

Secondary data was utilized for this study and this study was approved by the Georgia Southern University Institutional Review Board under protocol H24167.

Summary of Chapter

The study methodology and data analytical plan were described in this chapter.

CHAPTER 4

RESULTS

This chapter presents the data analysis result showing the descriptive statistics and the regression model. The participants' characteristics were presented followed by the descriptive characteristics of the dependent variables and the multinomial multivariable regression model results.

Descriptive Studies

Table 2 outlines the participants' descriptive characteristics and the descriptive statistics of the dependent and independent variables.

Table 2

Descriptive Statistics of the Study Participants' Characteristics,2020-2022

Variables	**Frequency**	**Percentages**
Dependent Variable		
Vaccine Intention		
Not Hesitant	1142	49
Little Hesitant	590	26
Somewhat Hesitant	259	11
Very Hesitant	320	14
Independent Variables		
Older Adults		
65-74 years	1234	53
75-84years	777	34
85years and older	300	13
Immigration Status		
US-Born	1968	85
Immigrant	343	15

Gender		
Female	1405	61
Male	906	39
Ethnicity/Race		
Black	464	20
Other	198	9
White	1644	71
SDOH		
Educational Level		
High School	1080	47
Unknown Degree	30	1
College Degree	484	21
Graduate Degree	256	11
No Degree	461	20
Marital Status		
Married	1105	48
Separated/Divorced	433	19
Widowed	624	27
Never Married	139	6
Social Security Income		
Yes	2080	91
No	200	9
Broadband Internet Access		
Yes	1334	59
No	937	41

Medicare Health Insurance

Yes	2117	93
No	162	7

StrDOH

Frequency of religious attendance

At least Once a week	836	37
2/3times a week	206	9
At least one/more times a month	375	17
Not at all	837	37

Perceived Risk of the Disease

Comorbidities

Presence of comorbidities	454	20
Absence of comorbidities	1853	80

History of flu vaccination

Yes	1708	74
No	597	26

COVID-19 Concern

Extremely concerned	1276	56
Moderately concerned	484	21
Somewhat concerned	305	13
Slightly concerned	99	4
Not at all concerned	122	5

Anyone died of COVID-19

Yes	1502	32
No	3141	68

Abbreviations: SDOH, Social Determinants of Health, StrDOH, Structural Determinants of Health. *Note.* Total N=2,311

Descriptive Characteristics of the Older Adult Participants

The results (Table 2) show that more than half of the participants were female (60%), and the majority identified their race as white (71%), while a large percentage of the participants were born in the United States (85%). Fifty-three percent (53%) of the participants were within the 65-74 years age group, and thirty-four percent (34%) were within the 75-84 years age group, followed by 85 years and older age group with thirteen (13%) of the participants. The married participants were forty-eight percent (48%), and twenty-seven percent (27%) of the participants were widowed. Forty-six percent (46%) of the participants had at least a high school degree, and a majority of the participants (80%) had at least one form of comorbidities. Although seventy-four percent (74%) of the participants had a history of flu-shot vaccination, forty-nine (49%) were not hesitant to take the COVID-19 vaccine when available, and twenty-six percent (26%) were a little hesitant. More than half of the participants (59%) were extremely concerned about the COVID-19 infection, and sixty-eight percent (68%) of the participants were not aware anyone died of COVID-19 infection. The majority of the participants had medicare coverage (93%) and Social Security income (91%), with more than half having access to broadband internet (59%). Thirty-seven (37%) participants reported religious attendance at least once a week, the same for participants with no religious attendance.

Social Determinants of Health Associated with COVID-19 Vaccine Hesitancy Among Older Adults

Table 3 shows that when compared with participants who were 85 years and older, those in the age group 65-74years were more likely to be 'very hesitant' (Adjusted Odds Ratio AOR)=1.67,

Confidence Interval (CI)=1.07-2.60) about the COVID-19 vaccine, or 'somewhat hesitant' (AOR= 1.96, CI=1.15-3.34), rather than not being vaccine-hesitant. Compared to men, women had higher odds of being 'very hesitant' (AOR=1.90, CI=1.42-2.54) about the COVID-19 vaccine, 'somewhat hesitant' (AOR=1.98, CI=1.451-2.69), or 'little hesitant'(AOR=1.70, CI=1.36-2.12) rather than not being vaccine-hesitant. Compared to whites, African Americans were more likely to be 'very hesitant' (AOR=2.54, CI=1.84-3.50) about the COVID-19 vaccine, 'somewhat hesitant' (AOR=2.46, CI=1.74-3.47) or 'little hesitant' (AOR=1.93, CI=1.47-2.54) rather than not being vaccine-hesitant.

Compared to unmarried participants, separated/divorced participants had higher odds of being 'somewhat hesitant'(AOR=2.11, CI=1.11-4.22) about the COVID-19 vaccine rather than not being vaccine-hesitant. Compared to participants with no degree, high school participants were less likely to be a 'little hesitant' (AOR=.69, CI=.52-.93) about the COVID-19 vaccine, college degree participants had lower odds of being 'very hesitant' (AOR=.60, CI=.38-.93) about the COVID-19 vaccine, or being 'little hesitant' (AOR=.61, CI=.43-.86) about the COVID-19 vaccine and graduate participants were less likely to 'very hesitant' (AOR=.35, CI=.19-.65) about the COVID-19 vaccine, 'somewhat hesitant' (AOR=.39, CI=.21-.72), or a 'little hesitant (AOR=.50, CI=.33-.77) rather than being 'very hesitant'. However, there was no association between immigration status, SDOH predictors such as social security income, medicare coverage, broadband internet use, and COVID-19 vaccine hesitancy among older adults.

Table 3

Multinomial Multivariable Logistic Regression Model Showing the Association between the Social and Demographic Determinants of Health and COVID-19 Vaccine Hesitancy among Older Adults

| | Very hesitant | | | | Somewhat hesitant | | | | Little hesitant | | | |
| | 95% CI | | | | 95% CI | | | | 95% CI | | | |
	AOR	LL	UL	Sig	AOR	LL	UL	Sig	AOR	LL	UL	Sig
Marital Status												
Never Married	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Married	0.98	0.57	1.71	0.95	1.62	0.83	3.17	0.16	1.24	0.79	1.94	0.36
Separate/divorce	1.24	0.69	2.22	0.47	**2.11**	1.05	4.22	0.04	1.03	0.63	1.69	0.90
Widowed	1.28	0.72	2.26	0.41	1.44	0.71	2.91	0.32	1.04	0.65	1.68	0.87
Immigration Status												
Immigrant	(Ref. Category)				(Ref. Category)				(Ref. Category)			
US-born	1.09	0.73	1.63	0.66	1.25	0.79	1.97	0.34	1.20	0.86	1.67	0.29
Educational Level												
No degree	(Ref. Category)				(Ref. Category)				(Ref. Category)			
High school	0.84	0.59	1.19	0.32	0.71	0.48	1.06	0.09	**0.69**	0.52	0.93	0.02
Unknown degree	1.31	0.48	3.55	0.60	0.56	0.15	2.11	0.39	0.58	0.21	1.61	0.30
College	0.60	0.38	0.93	0.02	0.73	0.46	1.16	0.18	**0.61**	0.43	0.86	0.005
Graduate	**0.35**	0.19	0.65	0.001	**0.39**	0.21	0.72	0.003	**0.50**	0.33	0.77	0.001
Social Security Benefits												
No social security income	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Social security income	1.03	0.63	1.71	0.89	1.002	0.58	1.72	0.99	0.94	0.63	1.40	0.75

	AOR	LL	UL	Sig	AOR	LL	UL	Sig	AOR	LL	UL	Sig
Health Insurance												
No medicare insurance		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Presence of medicare insurance	0.91	0.53	1.55	0.73	1.43	0.76	2.70	0.27	1.28	0.80	2.05	0.30
Broadband internet use												
No internet use		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Internet use	0.79	0.58	1.06	0.12	1.13	0.81	1.58	0.46	1.02	0.80	1.30	0.90
Age												
85 years and older		(Ref. Category)				(Ref. Category)				(Ref. Category)		
65-74 years	**1.67**	1.07	2.60	0.03	**1.96**	1.15	3.34	0.02	1.26	0.89	1.80	0.19
75-84 years	0.90	0.57	1.40	0.63	1.28	0.75	2.19	0.36	1.10	0.78	1.55	0.59
Gender												
Male		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Female	**1.90**	1.42	2.54	<0.001	**1.98**	1.45	2.69	<0.001	**1.70**	1.36	2.12	<0.001
Race												
White		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Black	**2.54**	1.84	3.50	<0.001	**2.46**	1.74	3.47	<0.001	**1.93**	1.47	2.54	<0.001
Other	1.20	0.74	1.94	0.47	1.07	0.62	1.86	0.80	0.77	0.50	1.19	0.24

The reference outcome category is Not Hesitant

Note. AOR-Adjusted Odds Ratio; CI-Confidence Interval; Ref. Category-Reference Category; LL=lower limit; UL=upper limit; Sig-significant level at p ≤ .05

Structural Determinants of Health Associated with COVID-19 Vaccine Hesitancy Among Older Adults

Table 4 shows that when compared with participants who were 85 years and older, those in the age group 65-74years were more likely to be 'very hesitant' (AOR=1.52, CI=1.02-2.29) about the COVID-19 vaccine, or 'somewhat hesitant' (AOR= 2.23, CI=1.35-3.67), rather than not being vaccine-hesitant. Compared to men, women had higher odds of being 'very hesitant' (AOR=2.08, CI=1.58-2.74) about the COVID-19 vaccine, 'somewhat hesitant' (AOR=1.96, CI=1.46-2.65), or 'little hesitant'(AOR=1.63, CI=1.33-2.02) rather than not being vaccine-hesitant. Compared to whites, African Americans were more likely to be 'very hesitant' (AOR=2.86, CI=2.09-3.90) about the COVID-19 vaccine, 'somewhat hesitant' (AOR=2.35, CI=1.67-3.30) or 'little hesitant' (AOR=1.95, CI=1.49-2.54) rather than not being vaccine-hesitant. Compared to participants who reported no religious attendance, participants who reported religious attendance at least once a week had higher odds of being 'somewhat hesitant' (AOR=1.73, CI=1.24-2.40) about the COVID-19 vaccine, or a 'little hesitant' (AOR=1.30, CI=1.02-1.65), rather than not being vaccine-hesitant. However, there was no association between immigration status and COVID-19 vaccine hesitancy among older adults.

Table 4

Multinomial Multivariable Logistic Regression Model Showing the Association between the Structural and Demographic Determinants of Health and COVID-19 Vaccine Hesitancy among Older Adults

	Very hesitant				Somewhat hesitant				Little hesitant			
		95% CI				95% CI				95% CI		
	AOR	UL	LL	Sig	AOR	UL	LL	Sig	AOR	UL	LL	Sig
Religiosity												
Frequency of religious attendance		(Ref. Category)				(Ref. Category)				(Ref. Category)		
At least once a week	1.22	0.91	1.64	0.18	**1.73**	1.24	2.40	0.001	**1.30**	1.02	1.65	0.03
2/3 times a month	0.85	0.52	1.37	0.50	0.89	0.51	1.57	0.69	1.29	0.89	1.85	0.17
At least one/more times a month	0.76	0.51	1.13	0.17	1.13	0.74	1.73	0.56	1.00	0.74	1.35	0.98
Immigration Status												
Immigrant		(Ref. Category)				(Ref. Category)				(Ref. Category)		
US-born	0.99	0.67	1.45	0.95	1.12	0.72	1.74	0.61	1.10	0.80	1.52	0.55
Age												
85years and older		(Ref. Category)				(Ref. Category)				(Ref. Category)		
65-74 years	**1.52**	1.02	2.29	0.04	**2.23**	1.35	3.67	0.002	1.37	0.99	1.89	0.06
75-84 years	0.84	0.54	1.30	0.43	1.40	0.83	2.36	0.21	1.20	0.86	1.68	0.29
Gender												
Male		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Female	**2.08**	1.58	2.74	<0.001	**1.96**	1.46	2.65	<0.001	**1.64**	1.33	2.02	<0.001
Race												

	AOR	LL	UL	Sig	AOR	LL	UL	Sig	AOR	LL	UL	Sig
White	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Black	**2.86**	2.09	3.90	<0.001	**2.35**	1.67	3.30	<0.001	**1.95**	1.49	2.54	<0.001
Other	1.34	0.82	2.15	0.25	1.15	0.67	1.99	0.61	0.90	0.59	1.37	0.64

The reference outcome category is Not Hesitant

Note. AOR-Adjusted Odds Ratio; CI-Confidence Interval; Ref. Category-Reference Category; LL=lower limit; UL=upper limit; Sig-significant level at p ≤ .05

Social and Structural Determinants of Health Associated with COVID-19 Vaccine Hesitancy Among Older Adults

Table 5 shows that when compared with participants who were 85 years and older, those in the age group 65-74years were more likely to be 'very hesitant' (AOR=1.76, CI=1.12-2.77) about the COVID-19 vaccine or 'somewhat hesitant' (AOR= 2.04, CI=1.19-3.49), rather than not being vaccine-hesitant. Compared to men, women had higher odds of being 'very hesitant' (AOR=1.90, CI=1.42-2.55) about the COVID-19 vaccine, 'somewhat hesitant' (AOR=1.95, CI=1.42-2.67), or 'little hesitant'(AOR=1.69, CI=1.35-2.12) rather than not being vaccine-hesitant. Compared to whites, African Americans were more likely to be 'very hesitant' (AOR=2.54, CI=1.83-3.52) about the COVID-19 vaccine, 'somewhat hesitant' (AOR=2.36, CI=1.66-3.36) or 'little hesitant' (AOR=1.89, CI=1.42-2.50) rather than not being vaccine-hesitant. Compared to participants who reported no religious attendance, participants who reported religious attendance at least once a week had higher odds of being 'somewhat hesitant' (AOR=1.82, CI=1.30-2.56) about the COVID-19 vaccine rather than not being vaccine-hesitant. Compared to participants with no degree, high school participants were less likely to be a 'little hesitant' (AOR=.70, CI=.52-.95) about the COVID-19 vaccine, college degree participants had lower odds of being 'little hesitant' (AOR=.60, CI=.42-.85) and graduate participants were less likely to 'very hesitant' (AOR=.39, CI=.21-.72) about the COVID-19 vaccine, 'somewhat hesitant' (AOR=.38, CI=.20-.72), or a 'little hesitant (AOR=.49, CI=.32-.76) rather than being 'very hesitant'. Compared to unmarried participants, separated/divorced participants had higher odds of being 'somewhat hesitant'(AOR=2.32, CI=1.15-4.68) about the COVID-19 vaccine rather than not being vaccine-hesitant. However, there was no association between immigration status, social security income, medicare coverage, broadband internet use, and COVID-19 vaccine hesitancy among older adults.

Table 5

Multinomial Multivariable Logistic Regression Model Showing the Association between the Socio-Structural and Demographic Determinants of Health and COVID-19 Vaccine Hesitancy among Older Adults

	Very hesitant				Somewhat hesitant				Little hesitant			
		95% CI				95% CI				95% CI		
	AOR	UL	LL	Sig	AOR	UL	LL	Sig	AOR	UL	LL	Sig
Marital Status												
Never Married	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Married	0.99	0.57	1.72	0.96	1.52	0.77	3.00	0.22	1.20	0.76	1.89	0.43
Separate/divorce	1.34	0.74	2.40	0.34	**2.32**	1.15	4.68	0.02	1.06	0.65	1.75	0.81
Widowed	1.30	0.73	2.31	0.38	1.47	0.73	3.00	0.28	1.02	0.63	1.65	0.95
Immigration Status												
Immigrant	(Ref. Category)				(Ref. Category)				(Ref. Category)			
US-born	1.13	0.75	1.72	0.56	1.13	0.71	1.80	0.60	1.21	0.86	1.71	0.27
Educational Level												
No degree	(Ref. Category)				(Ref. Category)				(Ref. Category)			
High school	0.91	0.63	1.31	0.61	0.75	0.50	1.13	0.18	**0.70**	0.52	0.95	0.02
Unknown degree	1.44	0.53	3.92	0.48	0.62	0.16	2.33	0.48	0.48	0.16	1.40	0.18
College	0.65	0.41	1.02	0.06	0.73	0.45	1.17	0.19	**0.60**	0.42	0.85	0.005
Graduate	**0.39**	0.21	0.72	0.003	**0.38**	0.20	0.72	0.003	**0.49**	0.32	0.76	0.001

	OR	95% CI		p	OR	95% CI		p	OR	95% CI		p
Social security benefits												
No social security income	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Social security income	1.09	0.65	1.82	0.75	0.94	0.54	1.62	0.82	0.89	0.60	1.34	0.58
Health Insurance												
No medical health insurance	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Presence of health insurance	0.91	0.53	1.56	0.72	1.43	0.75	2.72	0.28	1.25	0.78	2.00	0.36
Broadband internet use												
No internet use	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Internet use	0.76	0.56	1.03	0.08	1.11	0.79	1.55	0.56	1.02	0.80	1.31	0.87
Religiosity												
Frequency of religious attendance	(Ref. Category)				(Ref. Category)				(Ref. Category)			
At least once a week	1.29	0.95	1.75	0.10	**1.82**	1.30	2.56	<0.001	1.27	0.99	1.63	0.06
2/3 times a month	0.77	0.47	1.28	0.32	0.84	0.47	1.50	0.55	1.25	0.86	1.82	0.23
At least one/more times a month	0.79	0.53	1.20	0.27	1.18	0.77	1.82	0.46	0.99	0.73	1.35	0.95
Age												
85years and older	(Ref. Category)				(Ref. Category)				(Ref. Category)			
65-74 years	**1.76**	1.12	2.77	0.02	**2.04**	1.19	3.49	0.01	1.34	0.93	1.93	0.11
75-84 years	0.89	0.57	1.40	0.62	1.26	0.73	2.15	0.41	1.12	0.79	1.59	0.53
Gender												
Male	(Ref. Category)				(Ref. Category)				(Ref. Category)			

	AOR	LL	UL	Sig	AOR	LL	UL	Sig	AOR	LL	UL	Sig
Female	**1.90**	1.42	2.55	<0.001	**1.95**	1.42	2.67	<0.001	**1.69**	1.35	2.12	<0.001
Race												
White		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Black	**2.54**	1.83	3.53	<0.001	**2.36**	1.66	3.36	<0.001	**1.89**	1.42	2.50	<0.001
Other	1.26	0.76	2.07	0.37	1.09	0.62	1.91	0.78	0.80	0.52	1.24	0.32

The reference outcome category is Not Hesitant

Note. AOR-Adjusted Odds Ratio; CI-Confidence Interval; Ref. Category-Reference Category; LL=lower limit; UL=upper limit; Sig-significant level at p ≤ .05

Intrapersonal Level of SEM Associated with COVID-19 Vaccine Hesitancy Among Older
Adults

Table 6 shows that when compared with participants who were 85 years and older, those in
the age group 65-74years were more likely to be 'somewhat hesitant' (AOR= 2.02, CI=1.20-
3.39) about the COVID-19 vaccine, rather than not being vaccine-hesitant. Compared to men,
women had higher odds of being 'very hesitant' (AOR=2.58, CI=1.90-3.50) about the COVID-
19 vaccine, 'somewhat hesitant' (AOR=2.23, CI=1.64-3.03), or 'little hesitant'(AOR=1.69,
CI=1.36-2.10) rather than not being vaccine-hesitant. Compared to whites, African Americans
were more likely to be 'very hesitant' (AOR=2.98, CI=2.87-4.25) about the COVID-19 vaccine,
'somewhat hesitant' (AOR=2.60, CI=1.81-3.73) or 'little hesitant' (AOR=2.06, CI=1.55-2.72)
rather than not being vaccine-hesitant. Compared to participants with no comorbidities,
participants with an increasing number of comorbidities had lower odds of being 'somewhat
hesitant'(AOR=.672, CI=.46-.98) about the COVID-19 vaccine rather than not being vaccine-
hesitant. Compared to participants with no history of flu vaccination, participants with a history
of flu vaccination were less likely to be 'very hesitant' (AOR=0.12, CI=.09-.16) about the
COVID-19 vaccine, 'somewhat hesitant' (AOR=.24, CI=.18-.34), or 'little hesitant'(AOR=.47,
CI=.36-.61) rather than not being vaccine-hesitant. Compared to participants with no degree,
high school participants were lower odds of being a 'little hesitant' (AOR=.71, CI=.53-.95) about
the COVID-19 vaccine, college degree participants had less likely to be 'very hesitant'
(AOR=.55, CI=.35-.89) about the COVID-19 vaccine, or being 'little hesitant' (AOR=.62,
CI=.45-.87) about the COVID-19 vaccine and graduate participants had lower odds of being
'very hesitant' (AOR=.34, CI=.18-.64) about the COVID-19 vaccine, 'somewhat hesitant'
(AOR=.54, CI=.31-.97), or a 'little hesitant (AOR=.55, CI=.37-.82) rather than not being
vaccine-hesitant. Compared to participants with no COVID-19 infection concerns, participants
extremely concerned about the COVID-19 infection were less likely to be a 'very hesitant'
(AOR=.24, CI=.14-.42) about the COVID-19 vaccine or 'somewhat hesitant (AOR=.38, CI=.20-
.69), participants moderately concerned about the COVID-19 infection had lower odds of being

'very hesitant' (AOR=.30, CI=.17-.55) about the COVID-19 vaccine and participants somewhat concerned about the COVID-19 infection were less likely to 'very hesitant' (AOR=.51, CI=.27-.93) about the COVID-19 vaccine, rather than being 'not hesitant.' However, there was no association between immigration status and COVID-19 vaccine hesitancy among older adults.

Table 6

Multinomial Multivariable Logistic Regression Model Showing the Association between Intrapersonal Level of SEM and COVID-19 Vaccine Hesitancy among Older Adults

	Very hesitant				Somewhat hesitant				Little hesitant			
	95% CI				95% CI				95% CI			
	AOR	UL	LL	Sig	AOR	UL	LL	Sig	AOR	UL	LL	Sig
Age												
85years and older	(Ref. Category)				(Ref. Category)				(Ref. Category)			
65-74 years	1.30	0.83	2.06	0.25	**2.02**	1.20	3.39	0.008	1.20	0.86	1.66	0.29
75-84 years	0.82	0.51	1.34	0.43	1.42	0.83	2.44	0.21	1.12	0.80	1.56	0.52
Gender												
Male	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Female	**2.58**	1.90	3.50	<0.001	**2.23**	1.64	3.03	<0.001	**1.69**	1.36	2.10	<0.001
Race												
White	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Black	**2.98**	2.09	4.25	<0.001	**2.60**	1.81	3.73	<0.001	**2.06**	1.55	2.72	<0.001
Other	1.10	0.64	1.88	0.74	1.11	0.63	1.93	0.73	0.88	0.58	1.34	0.55
Immigration Status												

Immigrant		(Ref. Category)				(Ref. Category)				(Ref. Category)		
US-born	1.25	0.81	1.91	0.31	1.39	0.88	2.19	0.16	1.347	0.97	1.88	0.08
Comorbidities												
No chronic disease		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Presence of chronic disease	0.76	0.53	1.08	0.13	**0.67**	0.46	0.98	0.04	0.765	0.58	1.003	0.05
History of flu vaccination												
No flu shot vaccination		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Flu shot vaccination	**0.12**	0.09	0.16	<0.001	**0.24**	0.18	0.34	<0.001	**0.47**	0.36	0.61	<0.001
Educational Level												
No degree		(Ref. Category)				(Ref. Category)				(Ref. Category)		
High school	0.76	0.52	1.10	0.14	0.75	0.51	1.11	0.15	**0.71**	0.53	0.95	0.02
Unknown degree	1.05	0.35	3.17	0.93	0.66	0.17	2.55	0.54	0.65	0.23	1.79	0.40
College	**0.55**	0.35	0.87	0.01	0.78	0.50	1.22	0.28	**0.62**	0.45	0.87	0.005
Graduate	**0.34**	0.18	0.64	0.001	**0.54**	0.31	0.97	0.04	**0.55**	0.37	0.82	0.003
COVID-19 concerns												
Not at all concern		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Extremely concerned	**0.24**	0.14	0.42	<0.001	**0.38**	0.20	0.69	0.002	0.82	0.47	1.42	0.48

	AOR	LL	UL	Sig	AOR	LL	UL	Sig	AOR	LL	UL	Sig
Moderately concerned	**0.30**	0.17	0.55	<0.001	0.53	0.27	1.01	0.05	1.07	0.60	1.89	0.82
Somewhat concerned	**0.51**	0.27	0.93	0.03	0.74	0.38	1.45	0.38	1.13	0.62	2.07	0.68
Slightly concerned	0.99	0.46	2.14	0.99	0.87	0.36	2.09	0.75	1.33	0.63	2.78	0.46

The reference outcome category is Not Hesitant

Note. AOR-Adjusted Odds Ratio; CI-Confidence Interval; Ref. Category-Reference Category; LL=lower limit; UL=upper limit; Sig-significant level at $p \le .05$

Interpersonal Level of SEM Associated with COVID-19 Vaccine Hesitancy Among Older
Adults

Table 7 shows that when compared with participants who were 85 years and older, those in
the age group 65-74years were more likely to be 'very hesitant' (AOR=1.64, CI=1.07-2.51)
about the COVID-19 vaccine or 'somewhat hesitant' (AOR= 2.04, CI=1.21-3.33), rather than not
being vaccine-hesitant. Compared to men, women had higher odds of being 'very hesitant'
(AOR=1.91, CI=1.44-2.53) about the COVID-19 vaccine, 'somewhat hesitant' (AOR=2.00,
CI=1.47-2.71), or 'little hesitant'(AOR=2.14, CI=1.63-2.81) rather than not being vaccine-
hesitant. Compared to whites, African Americans were more likely to be 'very hesitant'
(AOR=2.84, CI=2.807-3.90) about the COVID-19 vaccine, 'somewhat hesitant' (AOR=2.43,
CI=1.72-3.42) or 'little hesitant' (AOR=2.14, CI=1.63-2.81) rather than not being vaccine-
hesitant. Compared to unmarried participants, separated/divorced participants had higher odds of
being 'somewhat hesitant'(AOR=2.07, CI=1.04-4.13) about the COVID-19 vaccine rather than
not being vaccine-hesitant. Compared to participants with no awareness of anyone who died of
COVID-19 infection, participants who were aware of anyone who died of COVID-19 infection
were less likely to be a 'little hesitant' (AOR=.78 CI=.62-.99) about the COVID-19 vaccine,
rather than not being vaccine-hesitant. However, there was no association between immigration
status and COVID-19 vaccine hesitancy among older adults.

Table 7

Multinomial Multivariable Logistic Regression Model Showing the Association between Interpersonal Level of SEM and COVID-19 Vaccine Hesitancy among Older Adults

| | Very hesitant | | | | Somewhat hesitant | | | | Little hesitant | | | |
| | 95% CI | | | | 95% CI | | | | 95% CI | | | |
	AOR	UL	LL	Sig	AOR	UL	LL	Sig	AOR	UL	LL	Sig
Marital Status												
Never Married	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Married	0.93	0.55	1.59	0.80	1.61	0.83	3.13	0.16	1.20	0.77	1.87	0.42
Separate/divorce	1.26	0.72	2.21	0.42	**2.07**	1.04	4.13	0.04	1.01	0.62	1.64	0.97
Widowed	1.30	0.74	2.26	0.36	1.55	0.77	3.11	0.22	1.10	0.69	1.75	0.70
Awareness of COVID-19-related death												
No anyone died	(Ref. Category)				(Ref. Category)				(Ref. Category)			
Anyone died	0.90	0.68	1.20	0.48	1.15	0.85	1.56	0.36	**0.78**	0.62	0.99	0.04
Age												
85years and older	(Ref. Category)				(Ref. Category)				(Ref. Category)			
65-74 years	**1.64**	1.07	2.51	0.02	**2.04**	1.21	3.43	0.007	1.27	0.91	1.78	0.16
75-84 years	0.92	0.59	1.435	0.70	1.34	0.79	2.28	0.27	1.15	0.83	1.61	0.41

	AOR	LL	UL	Sig	AOR	LL	UL	Sig	AOR	LL	UL	Sig
Gender												
Male		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Female	**1.91**	1.44	2.53	<0.001	**2.00**	1.47	2.71	<0.001	**1.68**	1.35	2.09	<0.001
Race												
White		(Ref. Category)				(Ref. Category)				(Ref. Category)		
Black	**2.84**	2.07	3.90	<0.001	**2.43**	1.72	3.42	<0.001	**2.14**	1.63	2.81	<0.001
Other	1.32	0.82	2.12	0.25	1.16	0.68	1.98	0.60	0.90	0.59	1.36	0.61
Immigration Status												
Immigrant		(Ref. Category)				(Ref. Category)				(Ref. Category)		
US-born	0.95	0.65	1.38	0.79	1.23	0.79	1.90	0.36	1.11	0.81	1.52	0.52

The reference outcome category is Not Hesitant

Note. AOR-Adjusted Odds Ratio; CI-Confidence Interval; Ref. Category-Reference Category; LL=lower limit; UL=upper limit; Sig-significant level at p ≤ .05

CHAPTER 5

DISCUSSION AND CONCLUSIONS

This study aimed to assess certain social and structural determinants of health predictors with COVID-19 vaccine hesitancy among older adults in the United States. The study also focused on certain intrapersonal and interpersonal factors correlated with COVID-19 vaccine hesitancy among older adults in the United States. This chapter will discuss how these determinants impact the degree of reluctance among older adults in the United States.

Summary and Interpretation of Findings

The study showed that older adults, being female, separated/married, and having at least a high school degree or more were associated with COVID-19 vaccine hesitancy: this is consistent with the study hypothesis that certain factors of the social determinants of health and COVID-19 vaccine hesitancy. Moreover, the results were consistent with the study hypothesis that structural determinants of health, such as the frequency of religious attendance, were associated with COVID-19 vaccine hesitancy. One peculiarity about the results regarding the social and structural determinant of health was that older adults aged 65-74 years, female, African American, separated, and religiosity were more likely to be COVID-19 vaccine-hesitant. However, the educational level impacted their vaccine intention, making them less likely to take the COVID-19 vaccine when it is available. The result showed that the combined association of both determinants, such as frequency of religious attendance, marital status, and educational level, had a significant association with COVID-19 vaccine hesitancy and was consistent with the study hypothesis.

Regarding the intrapersonal level of SEM, the study reflected that older adults' sociodemographic factors and perceived risk of the disease are highly correlated with COVID-19

vaccine hesitancy. This was consistent with the hypothesis that the intrapersonal level was associated with COVID-19 vaccine hesitancy. The results show that being extremely concerned about the COVID-19 infection, an increased number of comorbidities, and a history of flu vaccination had lower odds of vaccine hesitancy. However, older adults aged 65-74 years, being female and African-American, had higher odds of vaccine hesitancy. Regarding the interpersonal level of the SEM, the study shows that marital status and awareness of COVID-19 death are correlated with vaccine intention, which is consistent with the study hypothesis that interpersonal levels were associated with COVID-19 vaccine hesitancy.

Social and Structural Determinants of Health Associated with COVID-19 Vaccine Hesitancy Among Older Adults

Although the result findings that older adults are hesitant to the COVID-19 vaccine conform to previous studies (Mathis & Rooks, 2022; Siu et al., 2022), it revealed that older adults aged 65-74 years had about a two-fold increase in the variation of COVID-19 vaccine hesitancy (i.e., very hesitant and somewhat hesitant). Past studies show that the reluctance toward COVID-19 vaccine hesitancy among older adults may be due to the increasing number of misinformation and distrust in the government and vaccine brands influencing vaccine intentions during the pandemic (Bhagianadh & Arora, 2021; Wu & Brennan-Ing, 2023).

This study also conforms to previous studies regarding increased vaccine hesitancy among women compared to men (Callaghan et al., 2021; Morales et al., 2022). However, the result shows that older female participants were about two times more likely to be hesitant about the COVID-19 vaccine, and past studies show that the fear of possible vaccine side effects may have been a contributing factor to their level of hesitancy (Zhang et al., 2022).

Although other studies showed African Americans were associated with vaccine hesitancy (Khubchandani et al., 2021), this study found that African Americans were almost 3 times more likely to be 'very hesitant' about the COVID-19 vaccine and 2 times more likely to be 'somewhat hesitant or a 'little hesitant'. Past studies suggest that vaccine hesitancy among African Americans may have been due to a preexisting history of reluctance towards vaccination, history of healthcare, and biomedical distrust, along with racism (Khubchandani et al., 2021).

Most studies have looked at different forms of religiosity (e.g., prayer frequency and the role of religiosity) and their association with vaccine hesitancy (Garcia & Federick, 2021; Kibongani Volet et al., 2022). When looking at the association between the StrDOH and COVID-19 vaccine hesitancy alone, older participants who reported religious attendance at least once a week had about a 2-fold increase of being 'somewhat hesitant' and were also a 'little hesitant' about the COVID-19 vaccine. The combined association of SDOH and StrDOH in the study showed that participants only had a 2-fold increase of being 'somewhat hesitant' about the COVID-19 vaccine thereby indicating a reduced severity of hesitancy. This level of association seen in the StrDOH may be related to institutional conflicts between religion and the refusal to validate governmental regulation such as social distancing, political affiliation, and science, especially when it comes to vaccination (Željko Pavić et al., 2023; Zhang et al., 2023).

The result findings show that older participants with a high school degree and above were less likely to be COVID-19 vaccine-hesitant, which was consistent with other studies (Nindrea et al., 2021; Yasmin et al., 2021). Furthermore, this study showed that older participants with a high school degree were associated with being a little hesitant, college degree holders were associated with being very hesitant or little hesitant, and graduate degree holders were associated with being very hesitant, somewhat hesitant, and a little hesitant about the COVID-19 vaccine.

This supports the idea that informed individuals are more knowledgeable about their health and have health literacy associated with the use of preventive health services (Coughlin et al., 2020; Nindrea et al., 2021).

With regards to marital status, this study found that being separated/divorced participants among older adults had two-fold higher odds of being 'somewhat hesitant' about the COVID-19 vaccine, while other studies found no association between marital status and COVID-19 vaccine hesitancy (Khubchandani et al., 2021). The level of impact of SDOH alone and the combined effect of both determinants (i.e., SDOH and StrDOH) as it relates to COVID-19 vaccine hesitancy was the same, and this shows the importance of social ties and social support and how their association impacts health behavior decisions (Umberson & Karas Montez, 2011).

On the contrary, there was no significant association between health insurance and COVID-19 vaccine hesitancy. This supports the evidence that health insurance coverage did not impact vaccine intention because the COVID-19 vaccination was freely administered regardless of immigration status (Tolbert et al., 2022). The study also showed no association between social security income and COVID-19 vaccine hesitancy. This may infer that although Social Security Income could improve health outcomes and well-being (Ayyagari, 2015), it does not impact vaccine decision-making in older adults. Furthermore, even though studies revealed that access to broadband internet impacted vaccine intention (Dubé et al., 2013; Duplaga, 2021), this study revealed no association toward COVID-19 vaccine hesitancy among older adults.

The Role of Intrapersonal Level and the Association with COVID-19 Vaccine Hesitancy Among Older Adults

Sociodemographic Factors: The study found that older adults were associated with vaccine hesitancy, which is consistent with other studies (Mathis & Rooks, 2022; Siu et al., 2022).

However, this study showed that the degree of hesitancy of those aged 65-74 years was only 'somewhat.' This might be due to misinformation, denial that the pandemic is a real threat, and religious beliefs (Anas et al., 2023). This study also shows that female participants had about a 3-fold increase in being 'very hesitant,' about a 2-fold increase in being 'somewhat hesitant', and a 'little hesitant' about the COVID-19 vaccine. This varying degree of hesitancy may be due to beliefs, preexisting vaccine hesitancy, and risk-avoiding behaviors of women (Morales et al., 2022; Tolstrup Wester et al., 2022). Concerning race, this study shows African-Americans had about a 3-fold increase of being 'very hesitant' or 'somewhat hesitant' and about a 2-fold increase of being 'little hesitant. The high level of hesitancy might be due to a history of biomedical-related distrust, racism, lack of trust in government, and misinformation (Laurencin, 2021; Morales et al., 2022).

Perceived Risk Behavior: Although this study found that chronic disease was associated with COVID-19 vaccine hesitancy, consistent with other studies (Khanna et al., 2023), the degree of vaccine reluctance was 'somewhat.' This indecisiveness among older adults may be due to reviewing the benefits of vaccination based on past recommended vaccinations that may have strengthened their immune system and the misconception about the COVID-19 vaccine (Chia & Hartanto, 2021; Smith, 2017). Comparing their educational level, older adults with a graduate degree had significant associations and the degrees of reluctance to the COVID-19 vaccine (i.e., very hesitant, somewhat hesitant, and a little hesitant), followed by those with college degrees and the least high school. These variations in hesitancy may be related to differences in knowledge regarding potential side effects, effectiveness, benefits, and risks (Beusekom, 2022). The study results found that participants who were extremely concerned about COVID-19 had a significant association with being 'very hesitant' and less 'somewhat hesitant' about the COVID-

19 vaccine. While the participants who were moderately and somewhat concerned were associated with being 'very hesitant about the COVID-19 vaccine. This might be because older adults felt more vulnerable to the coronavirus disease due to their immunocompromised nature. In summary, this study shows that the sociodemographic factors and perceived behavior of the older adult participants at the intrapersonal level have a significant impact on COVID-19 vaccine hesitancy.

The Role of Interpersonal Level and the Association with COVID-19 Vaccine Hesitancy Among Older Adults

At the interpersonal level, this study showed a greater degree of hesitancy among older adults aged 65-74 years; they had about 2 fold increase of being 'very hesitant' and 'somewhat' to the COVID-19 vaccine. The high level of hesitancy might be that participants with high social or interpersonal contacts fear they have a higher risk of COVID-19 transmission (Adu et al., 2022). The female participants had about a 2 fold increase in the degree of hesitancy about the COVID-19 vaccine, and this might be because older females had the least interpersonal contact and risk-avoiding behavior (Adu et al., 2022; Morales et al., 2022).

The study showed that separated/divorced participants had a 2 fold increase in being 'somewhat hesitant' about COVID-19, and this may be due to separated individuals having few social networks, leading to less valuable information that could positively impact vaccination rates (Liu et al., 2023). The result found that participants who knew anyone had died from COVID-19 had lower odds of having COVID-19 vaccine hesitancy. This may likely be due to their social connectedness, which has been shown to impact vaccine decision-making (Kalra et al., 2023).

Public and Community Health Implications

There is a need for public health stakeholders to restrategize and develop interventions that can address vaccine hesitancy in the community. Based on the study findings, it appears that despite past public health interventions, there is still a growing concern regarding vaccines, especially within certain racial and age groups. This study's findings are important to public health workers, policymakers, and researchers due to the potential of older adults transferring such beliefs regarding vaccines to the younger generation. Addressing these concerns may encourage community members to take currently available preventive vaccines such as flu vaccine and any other vaccine that may be available in the future. The study findings draw attention to the potential benefits that may occur when public health stakeholders partner with faith-based organizations to increase awareness of the benefits of vaccination and dispel any existing misinformation.

Community Health Recommendations of this Study

Public health practitioners can address barriers to vaccination, such as mistrust, misinformation, and inequity within the African-American, Hispanic, or other minority communities by training respected and influential community members to become pro-vaccine ambassadors who can deliver culturally and linguistically appropriate health messages that promote vaccination. Also, there is a need to explore how targeted support groups for certain demographics such as women, older adults, divorced or separated persons, and African-Americans can be used as platforms to increase health literacy and address concerns regarding vaccination.

Public health stakeholders, including policymakers, should create strategies that focus on improving the relationship between faith-based organizations and health authorities so that

religious leaders can encourage their members to get vaccinated. The government and pharmaceutical agencies can partner with faith-based organizations to discuss strategies to implement policies that increase vaccination awareness and create community resources that encourage vaccine uptake. Public health stakeholders can also partner with religious organizations, especially those populated with marginalized races, to organize community outreaches and create resources to educate members. There is a need for public health researchers to conduct more explorative qualitative or mixed methods studies that will provide more context on the existing barriers and what type of public health interventions may work. Policymakers should implement policies that will reduce disparities in access to the social determinants of health and ensure that policies targeted at the structural level promote equity.

Strengths and Limitations

The main strength of this study was the large nationally representative study sample that included a wide range of lifestyle, health-related factors, and socio-demographic factors among older adults in the United States. Compared to previous studies, this research study offers the opportunity to examine religiosity as a structural determinant of health and its association with COVID-19 vaccine hesitancy among older adults in the United States. This study also provided an opportunity to examine the different domains of the SDOH, religiosity as a StrDOH, and its association with COVID-19 vaccine hesitancy among older adults in the United States. The study assesses certain intrapersonal and interpersonal factors of the SEM and their association with older adults' vaccine-making due to their increased risk of COVID-19-related complications, morbidity, and mortality. However, one of the limitations was the smaller sample size of the 2020 COVID-19 HRS core survey compared to total samples of HRS, which could have allowed for a more robust sample. Also, the use of secondary data limited the availability of

variables that could be used to assess data analysis; for example, other dimensions of religiosity, such as religious affiliation, would have been considered. Another potential limitation of this research study is that there could be potential confounders that could have affected the results due to their association with both outcome variables of interest (ie., vaccine hesitancy) and the predictors such as age, race, gender, marital status, and education.

Conclusion

In summary, the study findings showed that social and structural determinants of health are associated with vaccine hesitancy among the elderly in the United States. Addressing these factors may reduce the disparities in vaccine uptake reported among this age group. There is a need to conduct more research on the other causes of vaccine hesitancy not covered in this study. Further research on the facilitators and barriers of vaccine hesitancy using a qualitative approach is essential to provide more context from the demographic of interest.

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