

https://dspace.org/

Demographic, psychosocial, and motivational factors associated with SARSCoV2 vaccine hesitancy among undergraduate students at a university in Johannesburg, South Africa, 2021

Morrison, Alice Ruth

2025
University of the Witwatersrand, Johannesburg
https://hdl.handle.net/10539/49720
Morrison, Alice Ruth. (2025). Demographic, psychosocial, and motivational factors associated with SARSCoV2 vaccine hesitancy among undergraduate students at a university in Johannesburg, South Africa, 2021 [Master's dissertation, University of the Witwatersrand, Johannesburg]. WIReDSpace. https://hdl.handle.net/10539/49720

Downloaded from a DSpace repository. https://dspace.org/



UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

FACULTY OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH

Demographic, psychosocial, and motivational factors associated with SARSCoV2 vaccine hesitancy among undergraduate students at a university in Johannesburg, South Africa, 2021.

SUBMITTED BY:
ALICE RUTH MORRISON
STUDENT NUMBER: 698308

SUPERVISORS:
PROF SUSAN GOLDSTEIN
DR ATIYA MOSAM

IN PARTIAL FULFILLMENT OF THE AWARD OF
MASTER OF PUBLIC HEALTH

DATE:
JULY 2025

DECLARATION

I, **Alice Ruth Morrison**, declare that this research report is my own work. It is being submitted for the degree of Master of Public Health in the field of Social and Behaviour Change Communication at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.



_____

24 July 2025

_____

DEDICATION

For my mother, who passed away from motor neuron disease during this Master's, and my father, who passed away during my previous Master's. Their belief in me and their deep value for education—as a means of understanding and a foundation for action—have carried me through this degree, even in their absence.

ACKNOWLEDGEMENTS

I am grateful to my supervisors, Prof. Susan Goldstein and Dr. Atiya Mosam, for their guidance and patience. I would also like to thank Prof. Nicola Christofides for her support.

To my friends—Alex, Carrie, Donna, Imke, Liandra, Suzanne, and Suzi—thank you for your kindness and encouragement. Your support during a difficult period in my life meant more than I can express. Your enthusiasm and belief in me made completing this thesis possible.

To Bobby and Kippy Keal, I am deeply grateful for your ongoing generosity and care. Thank you to Ant Lovell for our many long walks, where you allowed me to talk through my ideas and motivated me to continue writing.

Finally, I would like to thank my ever-loyal dogs, Spodge and Pippa, for keeping me company throughout my MPH and during the many late nights of reading and writing it entailed.

ABSTRACT

Background

This study examines COVID-19[1] vaccine hesitancy (VH) among young adults in South Africa, focusing on undergraduate students aged 18–35 years at the University of the Witwatersrand between December 2021 and February 2022. Young adults exhibited higher COVID-19 VH rates than other age groups, yet limited studies have focused on the factors shaping VH among young adults in South Africa. This study investigates the prevalence, reported reasons for, and socio-demographic factors associated with COVID-19 VH, as well as the applicability of the World Health Organization's Behavioural and Social Drivers (BeSD) of Vaccination framework in this context. The BeSD framework conceptualises vaccine-related behaviours through four key drivers: 'Thinking & Feeling,' 'Social Processes,' 'Motivation,' and 'Practical Issues.'

Methods

A cross-sectional study surveyed 24,573 undergraduate students using an online self-administered questionnaire distributed via the university's email Listserv. Data were collected between December 2021 and February 2022 using an adapted BeSD questionnaire. A total of 526 eligible responses were analysed. Descriptive statistics determined VH prevalence and socio-demographic characteristics. Exploratory factor analysis (EFA) identified latent constructs within the BeSD framework, while binary logistic regression assessed predictive and protective factors associated with COVID-19 VH.

Results

The study found 23.38% of respondents were COVID-19 VH, while 76.62% were vaccine accepting. The most frequently cited reasons for VH included concerns about vaccine safety, development, and necessity. Being aged 21–35 years and prior COVID-19 infection were predictive of VH, while prior adult vaccination, on-campus residence, and having no religious affiliation were protective factors. EFA revealed that the BeSD drivers did not function as independent constructs in this study population. Instead, four latent constructs—'COVID-19 Vaccine Confidence,' 'COVID-19 Infection Concerns,' 'Social Norms,' and 'Negative Information about Vaccines'— were identified and showed that vaccine confidence, disease risk perceptions, and social norms were protective against VH. These findings suggest vaccination behaviours arise from an interrelated set of factors rather than distinct drivers.

Conclusion

This study provides insights into the prevalence, reasons for, and socio-demographic factors influencing COVID-19 VH in young adults in a tertiary education setting. The findings highlight the importance of vaccine confidence, social norms, and risk perceptions in shaping vaccine decisions. By applying the BeSD framework, this study enhances understanding of VH among young adults. The findings suggest that the BeSD framework provides a useful foundation for understanding VH, but its application may require further

[1] For simplicity of understanding, SARS-CoV-2 will be referred to as COVID-19 throughout this text

testing or adaptation to capture the interrelated nature of the BeSD drivers and their influence on vaccination behaviour. These insights have implications for public health strategies, particularly in higher education settings, where addressing safety concerns, emphasising disease risks, and strengthening pro-vaccine social norms could further reduce VH among young adults in South Africa and similar contexts.

TABLE OF CONTENTS

DECLARATION ..... *i*

DEDICATION ..... *ii*

ACKNOWLEDGEMENTS ..... *iii*

ABSTRACT ..... *iv*

LIST OF FIGURES ..... *ix*

LIST OF TABLES ..... *ix*

LIST OF ABBREVIATIONS ..... *x*

CHAPTER 1: INTRODUCTION *1*

1.1 Introduction to the Study **1**

1.2 Background to the Study **1**

1.2.1 Vaccine Hesitancy – A global threat 1

1.2.2 South Africa's COVID-19 Vaccination Campaign 3

1.2.3 COVID-19 Vaccine Hesitancy Prevalence in South Africa 3

1.3 Problem Statement **4**

1.4 Justification **5**

1.5 Research Question, Aim, and Objective **6**

1.5.1 Research Question 6

1.5.2 Research Aim 6

1.5.3 Research Objectives 6

1.6 Chapter Conclusion **7**

CHAPTER 2: THEORETICAL FRAMEWORK AND LITERATURE REVIEW *8*

2.1 Theoretical Framework **8**

2.1.1 The Vaccine Hesitancy Continuum 8

2.1.2 The C Models 9

2.1.3 Behavioural and Social Drivers of COVID-19 Vaccination Model 9

2.1.4 Conclusion to the Theoretical Framework 11

2.2 Literature Review **12**

2.2.1 Introduction – Vaccine Hesitancy: A Dynamic and Growing Field of Study 12

2.2.2 From Global Patterns to Local Insights: Reactive Vaccine Hesitancy in RSA 12

2.2.3 Socio-demographic and Health Factors Associated with Vaccine Hesitancy 13

2.2.4 Applying the BeSD Framework to Vaccine Hesitancy Research 15

2.2.5 Conclusion to the Literature Review 18

2.3 Chapter Conclusion **18**

CHAPTER 3: METHODOLOGY *20*

3.1 Study Design **20**

3.2 Study Setting **20**

3.3 Study Population and Study Sample **20**

3.3.1. Study Population 20

3.3.2. Study Sample 21

3.4 Data Collection **21**

3.4.1 Data Collection Tool 21
3.4.2 Data Collection Process 22
3.5 Data Management **23**
3.6 Data Analysis **23**
3.7 Ethical Considerations **28**
3.9 Chapter Conclusion **28**
CHAPTER 4: RESULTS ***29***
4.1 Socio-demographic and Health-related Characteristics **29**
4.2 COVID-19 Vaccine Hesitancy as a Continuum and a Binary Categorical Variable **32**
4.3 Reported Reasons for COVID-19 Vaccine Hesitancy **33**
4.4 Socio-demographic and Health Characteristics Associated with COVID-19 Vaccine Hesitancy among WITS Undergraduate Students **34**
4.5 Association between Behavioural and Social Drivers of Vaccination Model and COVID-19 Vaccine Hesitancy **37**
4.5.1. Results of the Exploratory Factor Analysis 38
4.5.2 Binary Logistic Regression Model Results 39
4.6 Chapter Conclusion **43**
CHAPTER 5: DISCUSSION ***44***
5.1 COVID-19 Vaccine Hesitancy Prevalence among WITS Undergraduate Students **44**
5.1.1 Prevalence of COVID-19 VH and VA among WITS Undergraduate Students 44
5.1.2 Comparison to National and Global COVID-19 Vaccine Hesitancy Prevalence Trends 45
5.2 Reported Reasons for COVID-19 Vaccine Hesitancy among WITS Undergraduate Students **45**
5.2.1 Cognitive and Emotional Reasons (Thinking & Feeling) 45
5.2.2 Social Processes Influencing VH (Social Processes) 46
5.2.3 Practical Barriers to Vaccine Uptake (Practical Issues) 47
5.3 Socio-demographic and Health Factors Associated with COVID-19 Vaccine Hesitancy among WITS Undergraduate Students. **48**
5.3.1 Age 48
5.3.2 Religion 48
5.3.3 Location 49
5.3.4 Health-Related Factors 50
5.3.5 University Policies and COVID-19 Vaccination Beliefs 51
5.4 Operationalising and Testing the BeSD of COVID-19 Vaccination **51**
5.4.1 Disrupting the BeSD of COVID-19 Vaccination Drivers – Evidence from Latent Factors 52
5.4.2 Implications for the BeSD of Vaccination 55
5.5 Limitations of this Research **58**
5.6 Chapter Conclusion **58**
CHAPTER 6: CONCLUSION ***60***
6.1 Summary of Findings **60**
6.2 Contributions **61**
6.3 Recommendations **62**
6.3.1 Recommendations for Future Research 62

6.3.2 Practical Recommendations.....64

6.4 Chapter Conclusion.....**66**

REFERENCES.....***68***

APPENDICES.....***83***

Appendix A: Plagiarism Declaration and Turnitin Report.....**83**

Appendix B: Ethical Clearance Certificate.....**86**

Appendix C: Study Invitation and Information Sheet.....**87**

Appendix D: Adapted BeSD Questionnaire - including informed consent.....**88**

Appendix E: Supplementary Results – BeSD Items.....**93**

LIST OF FIGURES

CHAPTER 2

Figure 2.1: The Vaccine Hesitancy Continuum……. 9
Figure 2.2: The BeSD of COVID-19 Vaccination Framework …… 10

LIST OF TABLES

CHAPTER 3

Table 3.1: Initial Eigenvalues and Factor Retention Based on Kaiser's Criterion …… 25

Table 3.2: Data Measurement and Analysis Plan and Process ……..26

CHAPTER 4

Table 4.1: Socio-demographic and Health Characteristics of Respondents…… 30

Table 4.2: Health Related Characteristics and Beliefs of Respondents…….. 32

Table 4.3: COVID-19 Vaccine Hesitancy and Vaccine Acceptance…… 33

Table 4.4: Reasons for COVID-19 VH Given by COVID-19 VH Respondents…… 34

Table 4.5: Comparison of Socio-Demographic Factors Between Vaccine Hesitant and Vaccine Accepting Respondents with Associated P-values…… 35

Table 4.6: Covid Related Experiences and Beliefs and their Association with Vaccine Hesitancy…… 37

Table 4.7: Constructs Identified Through Exploratory Factor Analysis…… 38

Table 4.8: Exploratory Factor Loadings…… 38

Table 4.9: Newly Identified Constructs of Vaccine Hesitancy…… 39

Table 4.10: Logistic Regression Model 1 - Socio-demographic and Health Characteristics of COVID-19 Vaccine Hesitancy …….. 40

Table 4.11: Logistic Regression Model 2 – Factor Analysis Constructs …….. 41

Table 4.12: Logistic Regression Model 3 – Fully Controlled Model of Constructs and Characteristics ….. 42

APPENDICES

Table D: Adapted BeSD Questionnaire …… 88

Table E: BeSD Item Responses by COVID-19 Vaccine Hesitant and Vaccine Accepting Groups …… 94

LIST OF ABBREVIATIONS

BeSD – Behavioural and Social Drivers of Vaccination Model

COVID-19 – Coronavirus Disease 2019

EFA – Exploratory Factor Analysis

HPV – Human Papillomavirus

HSRC – Human Sciences Research Council

IPF – Iterated Principal Factor

IVM – Increasing Vaccination Model

MMR – Measles, Mumps, and Rubella

NIDS-CRAM - National Income Dynamics Study – Coronavirus Rapid Mobile Survey

PCF – Principal Component Factor

RSA – The Republic of South Africa

SAGE – Strategic Advisory Group of Experts

SARS-CoV-2 – Severe Acute Respiratory Syndrome Coronavirus 2

UJ-HSRC – University of Johannesburg – Human Sciences Research Council

UNICEF – United Nations International Children's Emergency Fund

VA – Vaccine acceptance

VH – Vaccine hesitancy

VHC – Vaccine Hesitancy Continuum

VPD – Vaccine-preventable diseases

WHO – The World Health Organization

WITS – The University of the Witwatersrand

CHAPTER 1: INTRODUCTION

1.1 Introduction to the Study

This thesis explores the sociodemographic, psychological, social, and practical factors associated with vaccine hesitancy (VH), specifically COVID-19 (Corona Virus Disease 2019) VH, in young adults aged 18 -35 years in South Africa (RSA) during the COVID-19 pandemic. COVID-19 is caused by the novel coronavirus SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2). The dynamic nature of COVID-19 VH during the pandemic means this research provides a point-in-time snapshot of its prevalence and associated factors. Despite this, the study contributes to the growing body of research aimed at understanding and addressing VH. When this study was conceived, research on adulthood VH in RSA was limited. While the field has since grown, the core inquiry of this study - exploring VH among young adults in RSA - remains relevant.

By focusing on RSA's young adult demographic, specifically undergraduate university students, this research seeks to develop an understanding of the VH factors unique to this group, as COVID-19 VH rates remained high among young adults throughout RSA's SARS-CoV-2 vaccination campaign (1–4). This study utilises the World Health Organization's (WHO) Behavioural and Social Drivers of COVID-19 Vaccination Model (BeSD) and its associated research tool, developed during the pandemic, to explore the factors associated with COVID-19 VH (5,6).

1.2 Background to the Study

1.2.1 Vaccine Hesitancy – A global threat

Vaccination is a cornerstone of public health, reducing morbidity and mortality through disease prevention (7–12). Achieving herd immunity for infectious vaccine-preventable diseases (VPD) typically requires 80-90% vaccination coverage in a population (8). VH undermines vaccination efforts globally, increasing the risk of VPD outbreaks (8). VH is defined as a "*motivational state of being conflicted about, or opposed to, getting vaccinated*", which results in a "*delay in acceptance or refusal of vaccination despite availability of vaccination services*" (11,13–15). It is a complex phenomenon that is shaped by context and varies depending on time, place, and vaccine (7,11). Although VH is not a new phenomenon, in recent years, it has emerged as a growing public health concern, with the WHO recognising VH as one of the top ten threats to global health in 2019 (7,9,21–23,11,13,14,16–20). The threat of VH to global health is exacerbated by its socially contagious nature, amplified by global population growth, digital interconnectivity, and health inequities (14,16–18,23–27).

Globally, the success of childhood vaccination programmes has demonstrated broad public vaccine acceptance (VA) and confidence (10). This has contributed to the eradication of smallpox and control of

VPDs such as polio, measles, rubella, and diphtheria (28). Ironically, these successes have reduced modern exposure to VPDs and, thus, lowered VPD risk perceptions, increased vaccination complacency, and diminished confidence in vaccine safety among certain individuals and groups (8–10,16,22,23,28,29). This has given rise to debates regarding the necessity and need for vaccines—debates rooted in social and political contexts rather than scientific concerns (30). These trends highlight the importance of understanding VH, especially as emerging infectious diseases like COVID-19 are expected to become more frequent in the era of climate change (31).

The COVID-19 pandemic highlighted the urgency of addressing VH (32). COVID-19, first identified in December 2019 in China, spread rapidly around the world, prompting the WHO to declare a global pandemic on 11 March 2020 (33,34). RSA reported its first confirmed case on 5 March 2020, initiating the country's pandemic response (35). Initially, non-pharmaceutical interventions - handwashing, social distancing, and mask-wearing - were the only protective measures against the virus (36,37). By early 2021, several vaccines received emergency approval, launching the start of the world's largest and fastest vaccination campaign (38–41). However, as global vaccination efforts began, VH emerged as a barrier to achieving high vaccination coverage. Thus, the urgency to understand and address VH rose sharply (42,43).

Wiyeh et al. (2018) distinguish between two types of VH: baseline and reactive (17). Baseline VH represents a constant level of long-standing scepticism towards vaccines within any given population. This scepticism is often rooted in deeply held internal beliefs or distrust in health systems. It leads to consistent refusal of some or all vaccines (17,23,44). Reactive VH is triggered by external events, such as the introduction of new vaccines or vaccine controversies, that influence perceptions of vaccine safety, efficacy, or necessity (17). Unlike baseline VH, it tends to emerge rapidly and dissipate slowly (17). Baseline VH is more complex to address as it stems from deeply held beliefs, while reactive VH, driven by external events, is more responsive to education and support interventions (17). During the pandemic, reactive VH surged globally and in RSA, driven by concerns over the rapid development and deployment of COVID-19 vaccines, misinformation, and vaccine safety fears (24,45,46). Although COVID-19 reactive VH declined over time as vaccines became widely available and coverage increased, its sudden growth and widespread presence among populations that do not usually exhibit baseline VH was particularly striking, highlighting its potential to undermine public health efforts during the pandemic.

During the COVID-19 pandemic, VH posed a significant threat to containing the virus. The factors driving VH—individual beliefs, social influences, misinformation, and declining trust in institutions—remained largely unchanged from non-pandemic times. What differed was the scale and expansion of the phenomenon around the world, including RSA. Understanding VH and its drivers is essential for mitigating

its impact on public health. In RSA, vaccine rollout efforts highlighted the need to address reactive VH, especially among young adults – a demographic that emerged as particularly VH during the pandemic.

1.2.2 South Africa's COVID-19 Vaccination Campaign

By late 2020, RSA had recorded over one million COVID-19 cases and more than 28,000 deaths, underscoring the urgent need for its vaccination campaign to begin (47). In February 2021, RSA's COVID-19 vaccination rollout started with the 'Sisonke Study', a Phase 3b clinical trial of the Johnson & Johnson (J&J) vaccine among healthcare workers (48). In May 2021, due to the limited availability of vaccines in the Global South, a phased national rollout was implemented, prioritising individuals based on age, occupation, and comorbidities (49). The government aimed to vaccinate 40 million people to reach 67% vaccine coverage – this fell on the lower end of the spectrum of vaccine coverage needed to achieve herd immunity for a highly infectious virus (49–52). Initial models had proposed that a vaccine coverage of 60-70% would be sufficient to decrease the spread of COVID-19 within a given population (53–55). However, as more transmissible variants emerged, revised models suggested that a vaccine coverage of 80 – 95% would be needed to reach herd immunity (55,56).

Despite the initial "vaccine enthusiasm" exhibited among healthcare workers, the rollout of the vaccination campaign to the general population faced several challenges to achieving high uptake, including VH (48). By August 2021, slow vaccine uptake led the government to open vaccinations earlier than planned for adults aged 18 to 34(49,57). Uptake remained low, with 50% of all adults and only 37% of 18 to 34-year-olds having received one dose by June 2022 (1). By December 2023, just 35% of RSA's total population had completed a primary COVID-19 vaccination series (2,58). Thus, RSA's COVID-19 vaccination coverage fell short of herd immunity thresholds and lagged behind global vaccination rates (2). Researchers anticipated low uptake among young adults due to the high COVID-19 VH that this demographic exhibited before and during the vaccination campaign (59–64). Bergh et al. argue that targeting younger adults later in the vaccination campaign contributed to their higher VH levels and lower vaccine uptake (2).

1.2.3 COVID-19 Vaccine Hesitancy Prevalence in South Africa

COVID-19 VH in RSA increased as the pandemic progressed and vaccinations began; it then diminished as vaccine availability increased (19,37,71–74,52,62,65–70). The prevalence of COVID-19 VH in RSA before vaccine rollout was higher than many other countries (75,76). Between June 2020 and November 2021, various surveys reported VH prevalence rates ranging from 18% to 48% of the adult population (19,52,69,72,75,77,60,62–68). These surveys offer snapshots of COVID-19 VH prevalence in RSA, with variations reflecting differences in timing, methods, and sample populations rather than just fluctuations in VH. Additionally, they identified that certain socio-demographic factors, including age, gender, education

level, race, geographic location, and income level, were associated with COVID-19 VH (19,52,60,62,64,65,75,78).

Representative surveys, including The National Income Dynamics Study – Coronavirus Rapid Mobile Survey (NIDS-CRAM) and the UJ-HSRC COVID-19 Democracy Survey, consistently found that young adults aged 18 to 34 exhibited higher levels of COVID-19 VH than other age groups, mirroring trends observed internationally (3,19,72,74,79–82,42,52,59,60,62–65). For example, between January and June/July 2021, the UJ-HSRC COVID-19 Democracy survey found VH increased among 18 to 24-year-olds from 37% to 45% (61–64). By comparison, only 14% of respondents over 60 were VH (61,63). Additionally, the June/July survey found VH to be 45% among those identifying as learners or students, with half of these stating they would not have the vaccine (61,63,64). Similarly, Muthoni et al. reported a staggeringly high prevalence of COVID-19 VH (79.2%) among young adults aged 18–35 years in Soweto between April and June 2022, while George et al. noted that in November/December 2021 COVID-19 vaccine uptake was lowest among University of KwaZulu Natal staff and students aged 35 years and younger (3,4). This suggests that distinct factors could drive VH among young adults. While multiple VH studies conducted during the pandemic identified young adults as particularly vulnerable to VH, few specifically examined the factors driving VH in this group. The pandemic underscored the importance of broadening the field's knowledge of these factors, as better understanding could help facilitate health communication and intervention strategies to diminish or prevent VH among young adults in the future.

1.3 Problem Statement

Before the COVID-19 pandemic, research on VH and vaccination behaviour in RSA was limited, particularly among young adults. While the pandemic led to increased research on adulthood VH in RSA, research focusing on VH among young adults remains sparse (3,59,83). Research conducted during the pandemic revealed significantly higher COVID-19 VH levels among young adults aged 18 to 34 compared to other age groups (30,52,59,61–64,80,82). This demographic faced similar VH drivers as other groups - vaccine safety and efficacy concerns, needle phobia, mistrust in the government and health authorities, exposure to misinformation and conspiracy theories, and peer influences – but also demonstrated unique factors, such as lower perceived risk of severe infection, expectations of mild symptoms, and a preference for traditional or alternative medicines (2,4,71,72,74,81,82,84–86,36,52,59,60,62–65). These findings suggest young adults assess vaccination risks and benefits through age-related developmental and socio-demographic factors. Conversely, VA among younger adults stems from a desire to protect loved ones from infection and confidence in vaccine efficacy and safety (2,59). These insights highlight the complex interplay of social processes and individual risk-benefit calculations in shaping vaccine behaviour among young adults.

Globally, young adults were identified as a target demographic for COVID-19 vaccination due to their sociability and mobility, which increased their likelihood of contracting and transmitting the virus (86–91). Furthermore, with a median age of 28 in 2021, the density and dispersal of young adults across RSA's population highlighted the importance of this demographic for RSA to achieve COVID-19 herd immunity (92). However, before the vaccine rollout, researchers warned that high COVID-19 VH level young adults could impede RSA's pandemic response by limiting vaccination uptake and coverage (59–61,63,64). These predictions were confirmed by low and slow vaccine uptake among young adults during RSA's campaign (71). Similar trends in other countries further demonstrated the challenge of achieving vaccination coverage among this demographic (93–96).

When this study was conceptualised, research in RSA on young adults' vaccination behaviours was underdeveloped. Initially, the study aimed to assess COVID-19 VH and its associated socio-demographic, psychological, social, motivational, and practical factors among young adults before the vaccine became available to this demographic. However, vaccines became available to young adults earlier than anticipated. As such, data collection commenced once vaccines were available to adults aged 18 and older in RSA. This allowed for the examination of COVID-19 VH prevalence and its associated factors among young adults during vaccine availability. Although RSA is no longer actively vaccinating against COVID-19, the core research problem of this study persists: during the COVID-19 pandemic, young adults in RSA exhibited higher levels of COVID-19 VH compared to the general population. These appear to have been driven by unique risk-benefit calculations influenced by age-related, socio-demographic, psychological, social, motivational, and practical factors. This posed challenges for public health interventions and highlighted the need for targeted research. Despite this, research focusing on the factors associated with and drivers of COVID-19 VH among young adults in RSA remains limited.

1.4 Justification

In RSA, despite evidence of higher COVID-19 VH levels in young adults aged 18 to 35 compared to the general population, research focusing on vaccination behaviour and VH among this demographic remains limited (52,59,64). Understanding the sociodemographic, psychological, social, motivational, and practical factors associated with VH among young adults is crucial for improving public health strategies, particularly in RSA, where this demographic plays a fundamental role in disease transmission and herd immunity due to their population size, mobility, social behaviours, and unique risk perceptions (86–92). Understanding the drivers of COVID-19 VH can inform public health strategies for future outbreaks, new interventions, or similar populations.

Undergraduate students from the University of the Witwatersrand (WITS) serve as the study population. As a distinct subset of young adults, they provide an accessible, diverse, and well-defined group for this

research. The heterogeneity of the university population allows for a wide range of perspectives, attitudes, and beliefs to be captured, providing insights into COVID-19 VH among university undergraduates of WITS specifically and young adults more broadly.

This study is guided by the WHO's BeSD of COVID-19 Vaccination framework, which posits that VH or VA, is influenced by four key drivers: what people think and feel about vaccines (emotional and cognitive barriers) social processes (peer, family, and societal influences), motivation to vaccinate (intention and readiness), and practical issues (logistical barriers) (5,6,15,97). At the time of this study's conceptualisation and data collection, the BeSD model was newly introduced and, while evidence-based, had not yet been widely validated (5,6). By applying this framework to young adults in an RSA university context, this study provides an opportunity to explore the practical applicability of the BeSD model among this population and context.

In summary, this study is justified firstly by its focus on an under-researched yet critical demographic and its potential to inform targeted public health communication and strategies to address VH in contexts and populations, such as the university setting and RSA more generally, where young adults play a significant role in public health outcomes.

1.5 Research Question, Aim, and Objective

1.5.1 Research Question

What is the extent of COVID-19 vaccine hesitancy among University of the Witwatersrand undergraduate students between December 2021 and February 2022?

1.5.2 Research Aim

This study aims to establish the prevalence of COVID-19 vaccine hesitancy and the demographic, psychosocial, and motivational factors associated with COVID-19 VH in the University of the Witwatersrand undergraduate student population between December 2021 and February 2022.

1.5.3 Research Objectives

The study has four objectives:

1. To establish the prevalence of COVID-19 VH in the WITS undergraduate student population in December 2021 and February 2022.
2. To identify the reported reasons for COVID-19 VH among WITS undergraduate students exhibiting VH between December 2021 and February 2022.
3. To examine the socio-demographic and health factors associated with COVID-19 VH in the WITS undergraduate student population between December 2021 and February 2022.

4. To determine whether the BeSD model's drivers can be operationalised as constructs and to evaluate their association with COVID-19 vaccine hesitancy among WITS undergraduate students between December 2021 and February 2022.

1.6 Chapter Conclusion

This chapter has outlined the study's background and context, emphasising the challenges of COVID-19 VH in RSA, particularly among young adults. It introduced the problem statement, rationale, and research objectives that underpin this study. The next chapter examines the theoretical framework and critically reviews the literature, drawing on global and RSA-specific perspectives on VH.

CHAPTER 2: THEORETICAL FRAMEWORK AND LITERATURE REVIEW

This chapter outlines the theoretical framework underpinning the study and situates it within the existing body of literature. It begins by introducing the key theoretical models that guide the research, including the WHO's BeSD framework and the Vaccine Hesitancy Continuum (VHC). The chapter then moves to a critical review of relevant literature, examining global and RSA-specific studies on VH. By integrating insights from established and emerging research, the review aims to contextualise this study within the wider and rapidly evolving field of VH research while addressing its specific focus on young adults in RSA.

2.1 Theoretical Framework

VH is a complex dynamic phenomenon influenced by factors at multiple levels of the socio-ecological framework—individual, interpersonal, community, and institutional (8,21). These factors are shaped by person, time, place, and vaccine type, as well as socio-demographic, political, and cultural contexts (7,10,21,29). This complexity necessitates analytical models that can account for the interplay between internal beliefs and external contextual factors, including personal motivations, societal pressures, vaccine safety concerns, misinformation, distrust in institutions, and barriers to vaccination services (10,11,20,21,98–102).

Several models have been developed to understand VH, vaccination behaviour, and guide interventions. Early frameworks predominantly focused on individual-level beliefs and motivations, while more recent models adopt a broader socio-ecological perspective, acknowledging the influence of community, institutional, and systemic factors. This section focuses on four models developed or promoted by the WHO's Strategic Advisory Group of Experts (SAGE) on Immunization and its Working Group on Vaccine Hesitancy: the VHC, the 3C Model, the 5C Model, and the BeSD model. While the BeSD Model and VHC form the theoretical framework of this research, the C Models are included for their constructs, which offer insights into the psychological antecedents to vaccination.

2.1.1 The Vaccine Hesitancy Continuum

The VHC (see Figure 2.1, p. 9) visually represents attitudes towards vaccination, ranging from VA through VH to refusing specific or all vaccines (7,10,11). Individuals may shift position on the continuum depending on the vaccine, geographical location, or timing (7,10,11,103). Importantly, even individuals who are "hesitant but likely to accept vaccination" are classified as VH as their ambivalence may delay or affect vaccine uptake (1,8,57). This distinguishes them from VA individuals, who demonstrate an active intent to vaccinate (10,16). By illustrating VH attitudes along a continuum, the model shows that VH is not a static or homogenous category but reflects varying degrees of vaccination indecision or concern. For example, research conducted in RSA during the COVID-19 pandemic demonstrated the dynamic nature of VH, as

COVID-19 VH prevalence shifted over time and in different contexts (37,62–64). However, while the VHC captures the fluidity of vaccination attitudes, it does not identify the factors influencing positions on the continuum or shifts towards VA or vaccine refusal. Therefore, additional frameworks are needed to explore the motivations and drivers behind these attitudes and changes.

Figure 2.1: The Vaccine Hesitancy Continuum						
Vaccine Accepting		**Vaccine Hesitant**				
Accept all vaccines	Active intention for vaccination	Hesitant but likely to accept	Delaying uptake of vaccine	Hesitant but unlikely to accept	Those who refuse a specific vaccine	Those who refuse all vaccines

2.1.2 The C Models

The 3C Model, developed by the WHO's SAGE on Immunization in 2014, identifies three psychological constructs influencing vaccination behaviour: 'Confidence' (trust in vaccines and systems), 'Complacency' (perceived low disease risk), and 'Convenience' (practical barriers) (7,104). In 2018, Betsch et al. expanded this framework into the 5C Model, adding two constructs - 'Risk Calculation' (weighing vaccination risks and benefits) and 'Collective Responsibility' (social motivations for herd immunity) - while redefining 'Convenience' as 'Constraints' to encompass both practical and psychological barriers (105,106). Both models have been widely applied across diverse populations and vaccine types, with the 5C Model offering greater nuance in understanding motivations for vaccination behaviour (24,29,113–116,105–112). However, these models have faced criticism for their limited recognition of the broader social and environmental influences on vaccination attitudes, making them less suitable for fully addressing this study's objectives.

2.1.3 Behavioural and Social Drivers of COVID-19 Vaccination Model

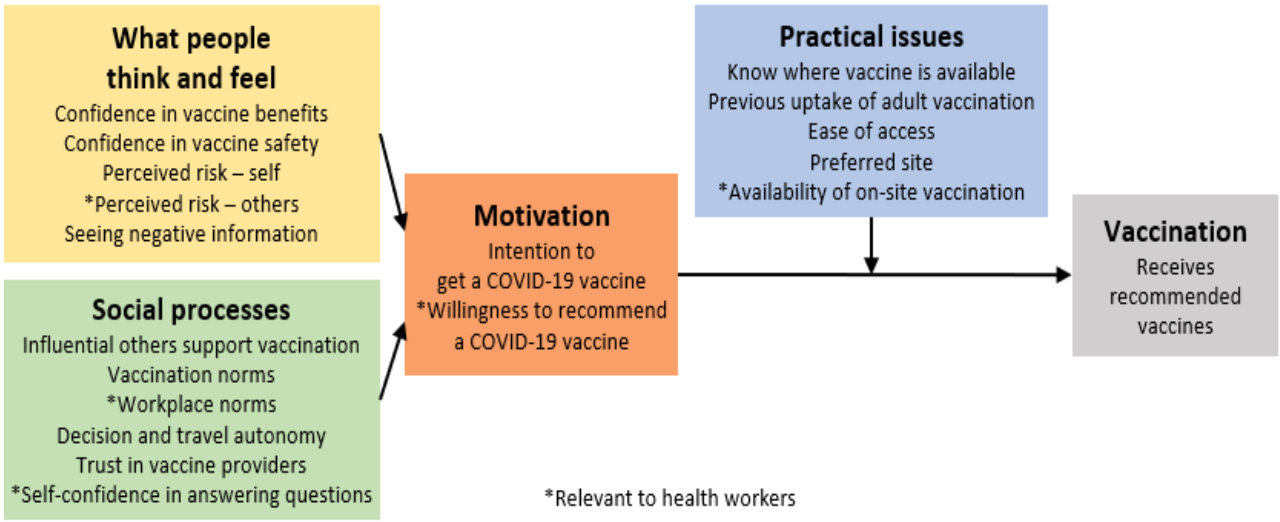
In October 2018, the WHO established the BeSD Working Group to develop a comprehensive framework utilising a socio-ecological perspective for understanding vaccination behaviour across diverse contexts (15). Unlike earlier models, the BeSD framework moves beyond cognitive beliefs to explore broader modifiable drivers of vaccination behaviour, including social, emotional, environmental, and practical factors (15).

The model was initially developed for researching childhood vaccination uptake but was adapted during the COVID-19 pandemic to research COVID-19 VH and support vaccine uptake (5,6,15,97). The WHO's *Data for Action* guide, released in 2021, introduced tools and guidelines for implementing the model (5,6). While the model and tools were still being validated at that time, their release during a global pandemic provided a unique opportunity for real-world testing (5,6). This offered this study an evidence-based framework for exploring VH. Validation was completed in 2022; however, this study uses the 2021 BeSD framework, guide, and tools, as these were available during this research's design and data collection phase (15,97).

The BeSD model builds on Brewer et al.'s Increasing Vaccination Model (IVM), which integrates three behavioural approaches to vaccination uptake: 'Thinking & Feeling', which addresses perceptions of risk and benefits; 'Social Processes', which focus on the influence of norms and trusted individuals; and 'Direct Behaviour Change', which includes practical interventions to improve vaccine accessibility (8). The BeSD model refines these behavioural approaches into four primary drivers of vaccination behaviour:

- What people think and feel about vaccines: This driver assesses cognitive and emotional responses to vaccines by examining confidence in vaccine safety and benefits, perceived risks, and exposure to negative information (5,6,15,97). It aims to understand whether individuals feel confident and motivated to get vaccinated and to identify any emotional or cognitive barriers they may encounter (5,6,15,97).
- Social processes: This driver assesses the social influences that drive or inhibit vaccination and includes social norms, influences from trusted individuals, and trust in healthcare providers (5,6,15,97). The driver offers insight into the role of social influence and social support in vaccination behaviour (5,6,15,97).
- Individual motivation and hesitancy: This driver assesses readiness and hesitancy to get vaccinated, including intention to vaccinate through willingness to seek vaccination and hesitancy through the factors or concerns that could create ambivalence or reluctance to vaccinate (5,6,15,97). It aims to gauge willingness to vaccinate and to identify what might make people hesitant (5,6,15,97).
- Practical issues: This driver examines the practical aspects of accessing vaccinations and vaccination services, including availability and affordability, service quality, and ease of access to vaccination sites (5,6,15,97). Its goal is to identify logistical challenges that might deter individuals from seeking vaccination services (5,6,15,97).

Figure 2.2: The BeSD of COVID-19 Vaccination Framework



Source: taken from the WHO and UNICEF's 'Data for Action' 2021 (6).

Together, these drivers form a holistic framework for examining vaccination-related beliefs and experiences that can be modified to improve vaccine uptake (5,6,15,97). Figure 2.2 illustrates how 'Thinking & Feeling' and 'Social Processes' can positively or negatively shape 'Motivation' to vaccinate, while 'Practical Issues' further shape whether this motivation turns into action. Together, these drivers determine whether an individual decides to get vaccinated or not.

The BeSD model aligns with this study's objectives by providing a holistic framework for understanding the socio-demographic, psychological, social, and practical factors influencing VH in RSA's young adult population. Its application facilitates the exploration of these factors while contributing to testing a model adapted for researching vaccination behaviour during the pandemic. Since the release of the BeSD of COVID-19 Vaccination Model in 2021, the model and its tools have been applied across diverse contexts - including RSA, China, India, Eastern and Southern Africa, the United States, and Latin America - and populations, including healthcare workers, rural and urban communities, healthy individuals, and individuals with chronic conditions (72,80,117–120). In 2021, the HSRC's VaxScene Study applied the model to assess predictors of COVID-19 VH in RSA communities (72). The study affirmed the model's ability to identify VH determinants in RSA, reinforcing its relevance locally and across similar Global South contexts (72).

2.1.4 Conclusion to the Theoretical Framework

The models reviewed in this section provide valuable insights into VH and vaccination behaviour. The VHC and BeSD offer this research two complementary approaches to understanding VH. They form the theoretical framework for the study. The VHC highlights the fluidity of vaccination attitudes, illustrating how individuals may shift between VA, VH, and refusal. However, it does not offer a means to explore the underlying factors or dynamics influencing vaccination attitudes and behaviours. This limitation can be addressed through the use of the BeSD framework, which provides a means of systematically examining the psychological, social, motivational, and practical drivers of vaccination decisions. By integrating these models, this study has a robust theoretical framework to explore COVID-19 VH and the modifiable factors influencing COVID-19 VH among young adults in RSA during the COVID-19 pandemic.

Additionally, the release of the BeSD model and its tools shortly before this study's conceptualisation provided a timely opportunity to apply an evidence-based, though initially unvalidated, framework and survey instrument to this under-researched demographic in RSA. With the VHC and BeSD framework as guiding models, the literature review critically examines existing VH literature to illustrate how these theoretical constructs have manifested globally and in RSA. This empirical grounding highlights the broader social and demographic factors influencing VH, particularly COVID-19 VH, reinforcing the relevance of the study's focus on young adults.

2.2 Literature Review

2.2.1 Introduction – Vaccine Hesitancy: A Dynamic and Growing Field of Study

The COVID-19 pandemic intensified global research efforts into VH, particularly COVID-19 VH, leading to a rapidly expanding field of knowledge. Interest in VH was rising pre-pandemic, but the crisis accelerated research into the socio-demographic, psychological, and systemic barriers to vaccine uptake. However, this growth in research has also exposed inconsistencies and gaps, particularly in context-specific studies.

This literature review begins by examining historical examples of reactive VH, exploring how specific events have shaped public perceptions of vaccines and highlighted the socially contagious nature of VH. Reviewing global patterns of reactive VH provides a foundation for exploring these dynamics in RSA. It then focuses on the socio-demographic factors associated with VH, identifying the populations most likely to exhibit VH and the underlying factors driving these disparities. Finally, the review applies the BeSD framework to systematically analyse the psychological, social, motivational, and practical drivers associated with VH. Given the limited research addressing COVID-19 VH among young adults in RSA, this review draws on broader studies of adult populations to contextualise findings relevant to this demographic. It aims to integrate emerging insights with established knowledge, offering a coherent foundation for this study while exploring the unique dynamics of COVID-19 VH in the South African context through the lens of the BeSD framework.

2.2.2 From Global Patterns to Local Insights: Reactive Vaccine Hesitancy in RSA

The surge in VH during the COVID-19 pandemic echoes previous outbreaks of reactive VH, where misinformation, political manipulation, and public distrust undermined vaccination campaigns. However, during the pandemic, the global scale of the crisis and pervasive uncertainty amplified the scale and influence of these dynamics. Historical examples of reactive VH outbreaks, such as the 1998 measles, mumps, and rubella (MMR) vaccine-autism controversy and the 2003/2004 northern Nigerian polio vaccine boycott, illustrate how a confluence of factors can erode public trust and reduce vaccine uptake. The MMR controversy led to a decline in vaccine confidence, reduced uptake, and outbreaks of measles and mumps (121,122), while the Nigerian polio boycott, driven by misinformation and political manipulation, led to the resurgence of wild polio in regions previously declared polio-free (123,124). These examples illustrate the inherently social nature of reactive VH, which emerges in response to specific events, is shaped by contextual vulnerabilities, and spreads through misinformation and distrust amplified by social networks and communication channels (21).

In RSA, VH has traditionally not been a prominent concern, with pre-pandemic vaccine challenges focusing more on systemic and logistical barriers to vaccine access rather than VH itself (17,36,131–135,52,77,125–130). High rates of early childhood vaccination suggest relatively low baseline levels of VH; however, the

introduction of the human papillomavirus (HPV) vaccine in 2014 prompted an outbreak of reactive VH and marked the start of an upward trend in baseline VH (16,17,137–141,19,36,52,77,125–127,136). This upward trend was reflected in an increased number of publications examining the phenomenon (9,100,101,134,140,142). During the COVID-19 pandemic, RSA experienced an outbreak of reactive VH consistent with global trends. Surveys, such as the NIDS-CRAM survey, UJ-HSRC COVID-19 Democracy Survey, and IPSOS, demonstrated fluctuating levels of COVID-19 VH across different socio-demographic groups and found that VH spiked and then declined as the vaccination campaign progressed (41,52,75,143–145,60,62–64,66–69). This pattern illustrates reactive VH's responsiveness to external factors such as vaccine availability.

2.2.3 Socio-demographic and Health Factors Associated with Vaccine Hesitancy

VH has been closely associated with various socio-demographic factors across different contexts, highlighting shared global patterns and unique local dynamics. Globally, VH rates were higher among individuals with lower education levels, rural residents, and those facing economic hardship (24,45,146,147). Specific groups, including females, young adults, and racial minorities, also demonstrated heightened VH (24,45,46,146,148). Identifying socio-demographic factors associated with VH is key to understanding VH trends. While RSA shares many global influences, such as misinformation and social norms, its unique socio-political history, economic inequality, and healthcare disparities warrant a focused local analysis. This section examines these patterns with an emphasis on RSA.

RSA-specific research indicated that women were generally more VA than men during the COVID-19 pandemic (52,65,149). Globally, however, women were often found to be more VH than men (30,150–154). However, this could be mediated by education level and infection risk perceptions (152). Pre-pandemic research in RSA found that family and peer norms often influenced women's vaccination decisions, while men prioritised personal benefits (155). These findings suggest that gendered social norms and decision-making processes shape vaccination behaviours in RSA.

Age was a key socio-demographic factor in COVID-19 VH globally and in RSA, with studies consistently finding higher VH among young adults than older adults (36,52,81,82,154,59,60,62–65,72,74). Engelbrecht et al. found that individuals 34 years or younger were 2.9 times more likely to be unvaccinated than those aged 35 or older (70). Several studies have found that religious beliefs, including affiliation with specific religious groups or adherence to certain doctrines, have been identified as contributing to VH in RSA and globally (64,74,156–160). However, findings from the NIDS-CRAM Wave 4 study suggest a more complex picture, with the highest levels of VH found among Hindus, non-religious people, and those with African traditional beliefs, suggesting VH can span across religious and non-religious groups (52,60).

Global studies have highlighted heightened VH among racial minorities, often linked to systemic inequities and historical injustices (154). However, in RSA, greater COVID-19 VH was exhibited by White and Coloured individuals than Black individuals (19,62–65,70,73,74,79). While these groups are demographic minorities in terms of population density, White South Africans have not faced the same historical injustices and systemic marginalisation as racial minorities in other global contexts. This distinction highlights the importance of considering RSA's unique socio-political history when examining VH patterns within this context.

The Western and Northern Cape provinces reported the highest COVID-19 VH levels, while Limpopo exhibited the lowest (52,64). Geographic disparities were evident, with rural populations generally displaying lower VH than urban ones despite facing greater logistical barriers to vaccine access (52,62,63,72,74,79,149). This contrasts with pre-pandemic findings in RSA and global COVID-19 VH trends, where rural households were often found to have greater VH than urban households, often due to structural barriers to vaccine access (153,154,161–163).

In RSA, COVID-19 VH was higher among the unemployed and lower-income individuals and those living in informal areas, reflecting broader global trends (19,72,81,154). The relationship between education and VH was more nuanced. While many global and RSA studies linked lower education levels with higher VH, the UJ-HSRC survey and the Vax-Scene study found greater VH among highly educated individuals in RSA (62,63,165,64,65,72,74,78,79,154,164). Pre-pandemic research in RSA also found inconsistent relationships: Wong et al. reported higher influenza VH among individuals with higher income and education levels, whereas Katz et al. and Botha et al. observed higher HPV VA in wealthier households (163,166,167).

Personal experiences with COVID-19 and health factors were found to intersect with socio-demographic factors to shape COVID-19 vaccine attitudes (74,81,154). In RSA, those who lost a loved one to COVID-19 were more likely to be VA, while those who had experienced mild COVID-19 infections, personally or within their social circles, showed higher VH compared to no infection exposure or exposure to severe cases (74,81). Globally, many studies reported no significant differences in VH between those who had contracted COVID-19 and those who had not (154). Global and RSA research typically finds that comorbidities and chronic illnesses are associated with lower VH; however, pregnancy and mental health conditions, such as anxiety or depression, have been linked to higher VH (73,81,154,168). Additionally, a history of adulthood vaccination correlated with lower VH globally and in RSA (70,72,74).

COVID-19 Vaccine Hesitancy within University Populations

Although limited research focuses on COVID-19 VH among young adults in RSA, studies conducted with university populations offer valuable insights. As undergraduate students fall within the young adult demographic, examining VH within this context helps illuminate patterns that may apply to the broader population. VA rates varied across RSA universities during the pandemic. At the University of the Witwatersrand, 83.3% of staff and students indicated vaccine intent, 89.5% of healthcare staff and students indicated vaccine intent, and 16.1% of dental students at the University of the Western Cape expressed VH (165,169,170). A study conducted at the University of Venda found that while most students (70%) were VA, they did not support mandatory COVID-19 vaccinations (171). By December 2021, when data collection for this research began, several universities had announced mandatory vaccination policies for staff and students for 2022 – this included the University of the Witwatersrand, where the Student Representative Council opposed the measure (172). Support for mandatory vaccination by the general population was not high in early 2022 (173).

Notably, 78% of nursing students at the University of KwaZulu-Natal did not understand how vaccines work despite broadly supporting vaccination (174). Safety concerns consistently emerged as a primary factor driving VH across studies, alongside fear of side effects, social influences, religious beliefs, and reservations about the rapid development and approval of vaccines (165,169–171,174,175). Internationally, similar patterns were observed at universities in diverse contexts, including the United States, Ethiopia, and Vietnam (176–178). These studies highlighted vaccine safety concerns, lack of transparency around vaccine development, and fears of side effects as recurring factors contributing to VH in student populations.

2.2.4 Applying the BeSD Framework to Vaccine Hesitancy Research

This section applies the BeSD framework to examine emerging and persistent factors associated with VH globally and in RSA, both before and during the pandemic. While not all the factors discussed were identified in studies that explicitly applied the BeSD model, categorising them within its 'Thinking & Feeling,' 'Social Processes,' and 'Practical Issues' drivers provides a structured lens for understanding their influence on vaccine 'Motivation' and hesitancy. Building on the socio-demographic factors explored in the previous section, this approach offers a cohesive perspective on how internal cognitive and emotional processes interact with external social and structural influences to shape vaccination behaviour.

Thoughts and Feelings associated with Vaccine Hesitancy

This driver explores cognitive and emotional responses to vaccination, focusing on confidence, perceived risks, and exposure to misinformation. Globally and in RSA, concerns about vaccine safety, efficacy, and potential side effects have consistently emerged as prominent barriers to vaccine uptake (20,21,164,165,168,173,179–184,42,185,60,72,74,81,104,146,148). The rapid development and approval of

vaccines during the COVID-19 pandemic, for example, amplified doubts and fears, reflecting a broader lack of confidence in the vaccine approval process and the institutions guiding this (24,45,46,72). In RSA and abroad, VH has been associated with exposure to misinformation, conspiracy theories, and fake news—particularly through social media— as it exacerbates vaccine safety concerns and creates doubts about the purpose of vaccination (3,20,183–187,21,52,62,104,146,148,179,182). Pre-pandemic research in RSA highlighted that gaps in communication and public health literacy could increase VH by creating misunderstandings about the necessity of vaccination for healthy individuals (131). The pandemic intensified such issues (59).

Emotional responses play a significant role in VH, particularly if vaccination campaigns trigger social reactance (188–190). In this context, reactance refers to a psychological response in which individuals resist or reject vaccination, perceiving it as a threat to their freedom or autonomy. Studies indicate that those who prioritise personal liberty or align with anti-establishment sentiments are more likely to exhibit VH, whereas those who defer to authority or value collective responsibility demonstrate greater VA (24,147,191–193).

During the pandemic, younger adults in RSA were particularly affected by complacency, driven by a perceived low vulnerability to COVID-19, vaccine safety concerns, and a preference for infection over vaccination, which reduced their motivation to vaccinate (3,36,59,181,194). Vaccination fatigue – resulting from prolonged pandemic conditions and inconsistent messaging from authorities - further reduced confidence and willingness to vaccinate. Additionally, anxiety about the vaccination process itself, including concerns about pain and a fear of needles, emerged as another psychological barrier discouraging uptake (59,70,180,195). These cognitive and emotional factors show how individual perceptions of risk can shape vaccine-related decisions.

Social Processes Associated with Vaccine Hesitancy

Trust—or the lack thereof—in healthcare systems, governments, information sources, and pharmaceutical companies consistently emerges across VH literature as a critical determinant of vaccine behaviour (8,21,104,185,191–193,196,197). Recent research highlights that trust functions as a multi-level construct, encompassing trust in the product (vaccine), the provider (healthcare professionals), and the policymaker (government and public health researchers) (198). Larson asserts that public trust forms a “chain” linking individuals to those responsible for vaccine development and distribution (21). When this chain is broken by misinformation, political manipulation, or systemic inequities, distrust in these authorities and institutions increases, leading to vaccine scepticism and VH (21,24,184,45,46,72,104,146,148,179,183). Conversely, the absence of distrust is associated with VA (199). Historical inequities, political conflict, and systemic racism can further exacerbate distrust, with marginalised populations exhibiting heightened VH

due to eroded trust in health systems and authorities (24,45,46,72,146,148,198). RSA mirrors global patterns with distrust of healthcare systems, healthcare providers, government institutions, and pharmaceutical companies being associated with VH (51,62,155,163,164,167,179,187,200–202,63,64,70,72,74,80,131,139). For example, Gittings et al. illustrate this dynamic, showing that inconsistent and conflicting messaging during the pandemic heightened young adults' mistrust of health authorities, contributing to increased VH (59). These dynamics highlight the role of generalised trust, shaped by systemic factors and historical legacies, in influencing vaccination behaviours across communities.

The importance of trust in mediating vaccination behaviour often extends beyond individual-institutional relationships and permeates social networks. Before and during the pandemic, social norms and social networks have been found to strongly influence vaccination behaviour both globally and in RSA (8,21,191,192,196,197,203,204). Research shows that in the absence of trusted official information, individuals often turn to social networks for vaccination advice (198) VH tends to be higher among individuals who are exposed to negative vaccination attitudes expressed by trusted individuals such as peers, family members, healthcare workers, and community, political, or religious leaders (3,59,181,205,72,80,103,164,165,169,179,180). These dynamics can be amplified by social affiliations, as VH and vaccine refusal can become markers of political identity or group belonging, reinforcing social divisions (21,206). Conversely, greater exposure to supportive vaccination sentiments in one's social network is associated with VA (21). Research in RSA shows that community engagement initiatives supporting vaccination can build trust and decrease VH (71,72,164,195). Additionally, research has found that vaccination uptake can be influenced by altruistic motivations, with the desire to protect loved ones from COVID-19 reducing VH among young adults (59). These social processes illustrate how trust and social connections drive both VA and VA, reflecting the broader influence of community dynamics on individual vaccination decisions.

Motivation / hesitancy to vaccinate

COVID-19 pandemic research utilising the BeSD model has shown that the 'Motivation' driver is shaped by an interplay between 'Thinking & Feeling', 'Social Processes', and 'Practical Issues' or considerations (117–120,207,208). 'Thoughts & Feelings', such as confidence in vaccine safety and efficacy, enhance vaccination motivation, while concerns about risks, safety concerns, misinformation, and low perceived vulnerability to COVID-19 reduce it and heighten VH (72,80,117–120,208). Similarly, 'Social Processes', including trust in healthcare providers and support from family, friends, and community leaders, bolster vaccination motivation and counter VH, whereas distrust of health workers, insufficient communication from trusted sources, and low social support for vaccination diminish motivation, increasing VH (72,80,117,119,207–209). Socio-demographic factors were also found to shape the motivation/hesitancy dynamic. For example,

Bon et al. found that age moderated the 'Thinking & Feeling' driver and shaped how social norms influenced vaccination motivation in Eastern and Southern Africa (119). Research also highlights that 'Practical Issues' such as accessibility, infrastructure, service quality, information availability, and logistical barriers consistently impact motivation by determining whether vaccination intention leads to vaccine uptake (72,117–120,207,208).

Practical Barriers Associated with Vaccine Hesitancy

'Practical Issues' shape vaccine VH by influencing whether vaccination intention leads to uptake. Globally, accessibility, infrastructure, service quality, information availability, and logistical challenges hinder vaccination efforts (72,117–120,207,208). The severity of these issues varies by local context and socio-economic conditions. In RSA, practical barriers to vaccine uptake reflect systemic healthcare challenges. Before the pandemic, common vaccination barriers included staffing shortages, cold chain failures, logistical inefficiencies, vaccine stockouts and geographic and socio-economic access disparities (17,125,210,211,126,128–131,135,155,202). These issues persisted during the pandemic, particularly in low-income and rural areas, with limited transport infrastructure, high transportation costs, inconvenient vaccination hours, and long queues reducing vaccine uptake by decreasing access or motivation (51,72,80,81,149,195). Inadequate vaccine supplies and outreach efforts negatively impacted access and uptake (72,212). RSA's digital vaccination registration system also reinforced systemic inequities, creating an additional uptake barrier for low-income individuals, older adults, and those with limited digital literacy or digital access (2,72,181,194). These barriers highlight the critical role of logistical planning and support in vaccination efforts. Without accessible infrastructure and services, even those motivated to vaccinate may struggle to access vaccinations.

2.2.5 Conclusion to the Literature Review

This literature review has highlighted the complex and multi-faceted nature of VH, which is shaped by global and local patterns, socio-demographic disparities, and broader psychological, social, and practical drivers. The examination of historical and contemporary examples underscores the dynamic and socially embedded nature of VH. Applying the BeSD framework to relevant literature has provided a structured approach to analysing the interplay between internal beliefs and external influences on VH. Additionally, by synthesising insights from global research and RSA-specific studies, this review has established a strong foundation for understanding the factors contributing to COVID-19 VH among young adults in RSA.

2.3 Chapter Conclusion

This chapter has outlined the theoretical and empirical foundation for understanding VH during the COVID-19 pandemic, with a focus on young adults in RSA. Integrating the VHC and BeSD model offers this study a structured approach to analysing the internal and external factors influencing vaccination behaviour. The

literature review highlighted the dynamic, socially embedded nature of VH, drawing on global and RSA-specific studies to identify key factors shaping COVID-19 VH. This chapter has contextualised the study within the broader field of VH research but also identifies gaps and opportunities for further exploration, particularly in relation to young adults, a demographic that exhibited heightened COVID-19 VH. Building on this foundation, the next chapter outlines the research design, methodology, and data collection processes used to investigate the prevalence and determinants of COVID-19 VH among undergraduate students at the University of the Witwatersrand.

CHAPTER 3: METHODOLOGY

This chapter outlines the method used to answer this study's objectives. It presents the study design, setting, population, sampling methods, and data collection and analysis. Finally, the study's ethical considerations are discussed.

3.1 Study Design

This research employed a cross-sectional study design with an inferential analysis component. This research design was selected as it is traditionally used for population-based surveys or studies to establish the prevalence of a health issue and its associated exposures within a defined population at a particular point in time (213). In addition to providing descriptive insights, the inferential component allows for statistical testing to examine relationships between variables, which supports identifying factors associated with COVID-19 VH in the sample. In cross-sectional studies, the study population and sample are defined by their membership to a specific population rather than by their outcome or exposure status. In this research, the study population's exposure status - factors associated with COVID-19 VH – and outcome status – COVID-19 VH - were untested before data collection (213). Instead, these were identified through responses gathered during the survey (see Appendix C). The study population included all members of the University of the Witwatersrand (WITS) undergraduate student community (see section 2.4).

3.2 Study Setting

The study was conducted at WITS, a university based in Johannesburg, in the province of Gauteng, South Africa, between 13 December 2021 and 28 February 2022. As COVID-19 lockdowns had forced most teaching and learning to occur online, and the university had facilitated off-campus internet access, eligible respondents were invited to access and complete the questionnaire online.

3.3 Study Population and Study Sample

3.3.1. Study Population

The population under investigation in this study was young adults aged 18 to 35 years old in RSA who were undergraduate students at WITS. This study population was selected as most undergraduate students are young adults. There were 24,573 undergraduate students registered to study at WITS in 2021 (214). Additionally, the population was accessible to the researcher through their shared affiliation with WITS, which facilitated the researcher accessing potential respondents through the university's email Listserv system. At the start of data collection, all individuals within RSA aged 18 years and older had recently become eligible for COVID-19 vaccination.

3.3.2. Study Sample

The entire study population was invited to participate in the survey; thus, the study population and the sample were the same. All undergraduate students at WITS were sent emails inviting those who fitted the following inclusion criteria to participate in the research:

- Registered as an undergraduate student at WITS in the years 2021/2022.
- Hold a WITS email address and have access to the internet through a computer or smartphone.
- Between 18 and 35 years old at the time of completing the survey.

During data cleaning, individuals who completed the questionnaire but did not meet the inclusion criteria were excluded from the dataset.

Online surveys are known to have a response rate as low as ten percent and to have response rates that are six to 15 percent lower than other survey methods (215). While low response rates can limit the validity and generalisability of the data, inviting the entire study population to participate can mitigate the issues associated with a low response rate. A minimum sample of 379 respondents was needed from the population of 24,573 individuals to support representativity (Assumed VH level = 30%, Confidence Level = 95%, Margin of Error = 5%) (216). This accounted for 1.54% of the WITS undergraduate student population. Thus, reaching a level of representativity in the sample could be achieved by inviting the whole study population to participate.

3.4 Data Collection

3.4.1 Data Collection Tool

The research instrument used in this study was an adaption of the WHO and UNICEF's Behavioural and Social Drivers (BeSD) of COVID-19 Vaccination tool (see Appendix C). It was developed to gauge the prevalence of and factors associated with COVID-19 VH within a population by exploring the individual and social processes that impact vaccine uptake. The BeSD examines this through four drivers, which are made up of different constructs:

- What people think and feel about vaccines.
- Social processes that support or inhibit vaccination.
- Individual motivation/hesitancy to obtain a vaccine.
- Practical issues regarding seeking or receiving a COVID-19 vaccination.

The adapted research instrument consisted of 45 questions, with variables measured at nominal and ordinal levels. The self-administered questionnaire was constructed in English, as this is the medium of instruction at WITS University. It primarily comprised Likert-scale response items, which were used to measure outcome and exposure variables, while additional items captured socio-demographic

characteristics to provide contextual insights. Most variables were categorical. The first section of the questionnaire focused on socio-demographic and health-related characteristics, while the second section examined the four drivers of the BeSD framework.

The socio-demographic section of the questionnaire was adapted to the South African context and study population. The outcome variable of COVID-19 VH / COVID-19 VA was measured through a single item (see Appendix C, question A.19.a). The exposure variables in this study were the drivers of the BeSD model (see Figure 2.2), each consisting of several thematically similar items. In addition to being grouped within drivers, individual items could also function as standalone exposure variables (see Appendix D for all BeSD items included in the study). To account for potential confounding effects, the questionnaire also measured socio-demographic and health-related variables, which were incorporated into the analysis as potential confounders and effect modifiers (see Table 3.2, pg 26). These were accounted for in the analysis phase of the study in the logistic regression model.

3.4.2 Data Collection Process

Once approval for the study was obtained from the WITS Ethics Committee (see Appendix B), the researcher secured permission from WITS University to conduct the study using its undergraduate student population and email-based Listserv system. The approval was granted at the end of the 2021 academic year, when most students were on holiday and unlikely to check their email accounts. As such, the initial invitation email sent in 2021 was followed by a reminder email sent via each Faculty in early 2022. Research shows that reminders support increased response rates (215,217,218).

The emails invited all eligible undergraduate students to participate in the study (see Appendix C). The email included a brief overview of the study, information regarding informed consent, and a link to the online questionnaire, which was hosted on REDCap.

Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at the University of the Witwatersrand (219,220). REDCap is a secure, web-based software platform designed to support data capture for research studies, providing: an intuitive interface for validated data capture; audit trails for tracking data manipulation and export procedures; automated export procedures for seamless data downloads to common statistical packages; and procedures for data integration and interoperability with external sources (219,220).

Respondents could access the structured, self-administered questionnaire via a computer or smartphone. An informed consent question preceded access to the questionnaire. The survey collected anonymous primary quantitative data.

3.5 Data Management

Once data collection concluded, the data were downloaded from REDCap onto the researcher's password-protected computer. The dataset was then exported as a Microsoft Excel file and cleaned to prepare it for statistical analysis. In cleaning the data, missing data, errors, and outliers were identified, and variables were labelled. A copy of the cleaned data set was stored on the researcher's OneDrive for safekeeping. The data were then imported into STATA™ 18, a statistical analysis programme.

3.6 Data Analysis

Each variable was examined individually to establish its distribution, shape, measure of central tendency, and variability. This step assisted in identifying data errors, describing the dataset, and assessing assumptions before statistical tests were run. The first step in the analysis was to conduct a frequency analysis to describe the data set by establishing the baseline characteristics of the study population. The data were summarised as counts and percentages for categorical variables, such as "COVID-19 Vaccine Hesitant (VH) / COVID-19 Vaccine Accepting (VA)", and mean (standard deviation) for continuous variables, for example "Age" (see Table 4.1, p.30 and Table 4.2, p.32). Medians and interquartile ranges were used to summarise variables that were not normally distributed, such as "Age". The following section provides a detailed description of the analytical process used to answer each research objective. A summary of this process, including the variables analysed and the statistical tests conducted, is presented in Table 3.2 (p. 26).

Objective 1: *To establish the prevalence of COVID-19 vaccine hesitancy in the WITS University undergraduate student population in 2021*.

- The ordinal categorical variable "COVID-19 Continuum of VH" (vaccinated, will have, probably will, delay uptake, probably refuse, refusing) is presented as a frequency and a percentage of the study population (see Table 4.3, p.33).
- The binary categorical variable "COVID-19 VH / COVID-19 VA" is presented as a frequency and a percentage of the study population (see Table 4.3, p.33). This variable was created by recoding responses to the "COVID-19 Continuum of VH" into two binary responses: COVID-19 VH (probably will, delay uptake, probably refuse, refusing) and COVID-19 VA (vaccinated, will have).

Objective 2: *To identify the reported reasons for COVID-19 vaccine hesitancy among WITS undergraduate students exhibiting vaccine hesitancy in 2021.*

COVID-19 VH respondents (those who selected "probably will", "delaying uptake", "probably refuse", or "refusing" on the VH continuum) were provided with a series of statements offering reasons for VH. These

statements were drawn from the literature. Respondents could select more than one statement (see Table 4.4, p.34). A summary table presenting the categorical variable of “Reasons for VH” by the ordinal categorical variable “COVID-19 Continuum of VH” was developed. Data is presented as frequencies and percentages.

Objective 3: *To examine the socio-demographic and health factors associated with COVID-19 vaccine hesitancy in the WITS undergraduate student population in 2021.*

Summary tables of socio-demographic and health characteristics by the binary categorical variable “COVID-19 VH / COVID-19 VA” were developed (see Table 4.5, p.35 and Table 4.6, p.37). Some exposure variables were re-coded as response rates for some answer options were low. For example, “Year of Study” was re-coded from six options to four: year of study 4, 5, and 6 were re-coded and grouped into one answer option as they only accounted for 10.08% of responses. Similarly, the continuous variable 'Age' was recoded into two categories: 18–20 years and 21–35 years. Given the right-skewed distribution of age, categorisation was a statistically appropriate approach for bivariate and multivariable analysis. This grouping also reflects typical undergraduate progression, where most students start university at 18 and turn 19 in their first year, while final-year undergraduates, assuming no academic delays, are typically 21–22 years old. This classification supported clearer comparisons between younger and older students while maintaining statistical rigour.

Bivariate tests of association were run to determine whether there was an association between the outcome variable - COVID-19 VH / VA - and sociodemographic characteristics such as age, year of study, gender, and health characteristics such as co-morbidities, previous adulthood vaccination behaviour, and COVID-19 infection. A Wilcoxon Rank Sum Exact Test was used to examine the continuous variable “Age” as the data for this variable was not normally distributed. The association between categorical variables, such as “Faculty of study” and “Gender”, and the outcome variable were examined using either Pearson’s Chi-Square Test or Fisher’s Exact Test. The latter was selected when a small number of observations were recorded in a cell. “Faculty” and VH, or “Gender” and VH. Analysis was performed through STATA™. A confidence interval of 95% was used, and a P value of ≤ 0.05 was considered statistically significant.

Objective 4: *To determine whether the BeSD model’s drivers can be operationalised as constructs and to evaluate their association with COVID-19 vaccine hesitancy among WITS undergraduate students between December 2021 and February 2022.*

The association between the binary outcome variable of “COVID-19 VH / COVID-19 VA” was analysed in relation to the BeSD of Vaccination model. The BeSD drivers comprise 20 items, each of which can operate as a stand-alone measure, distributed across the four theoretical drivers:

- Thinking & Feeling: Ten items covering what people think and feel about vaccines, including COVID-19 infection concerns, vaccine safety and efficacy confidence, and exposure to negative information about vaccines.
- Social Processes: Six items addressing social influences that support or inhibit vaccination, such as family, friend, and religious norms, as well as trust in healthcare workers and government.
- Motivation/hesitancy for Uptake: Two items capturing individual intent to vaccinate and vaccine hesitancy (using the VHC).
- Practical Issues: Two items assessing accessibility and logistical barriers to seeking or receiving a COVID-19 vaccination.

An exploratory factor analysis (EFA) was conducted to assess the latent structure of the BeSD items and evaluate construct validity. The analysis aimed to determine whether the BeSD items loaded distinctly onto latent constructs aligned with the model's four drivers or if a different underlying factor structure emerged. Two extraction methods, Principal Component Factor (PCF) and Iterated Principal Factor (IPF), were used to identify latent constructs within the BeSD items. Varimax rotation with Horst's method was applied to enhance interpretability and to ensure that factors remained uncorrelated.

Four factors were identified. Using Kaiser's Criterion, factors with eigenvalues greater than one were initially retained, resulting in three main factors (221). However, a fourth factor, with an eigenvalue below one, was also retained to preserve the two items that had loaded exclusively onto this factor. The exclusion of this factor would have led to the loss of the two items, which were theoretically and practically significant to the BeSD framework (See Table 3.1).

Table: 3.1 Initial Eigenvalues and Factor Retention Based on Kaiser's Criterion

Factor	Eigenvalue	Variance Explained (%)	Retention Decision
1	6.62	33.08%	Retained
2	1.13	5.65%	Retained
3	1.06	5.31%	Retained
4	0.66	3.09%	Retained for theoretical reasons

Items that loaded onto multiple factors were assigned to the factor with the highest loading to avoid redundancy. Latent construct development involved summing the scores of statistically significant items that had loaded onto each factor, thereby resulting in composite scores. The internal consistency of each factor was evaluated using Cronbach's alpha. Factors with an $\alpha \geq 0.7$ were considered reliable and retained for analysis (222). However, in line with exploratory research practices, factors with lower alpha levels were retained if they demonstrated interpretability, conceptual coherence, and relevance to VH or VA (222) (see Table 4.7. p.38). Although lower alpha levels indicate reduced internal consistency, they were retained if they provided meaningful insights, particularly when dealing with overlapping constructs or emergent

factors that do not align with the original theoretical model. To ensure construct validity, items that were cross-loaded onto more than one factor were retained only on the factor where they had the highest loading (see Table 4.8, p.38). This was done to minimise overlap and ensure statistical rigour.

Following the EFA, three binary logistic regression models were constructed to assess the association between COVID-19 VH and the latent constructs (see Table 4.9, p. 39), socio-demographic characteristics, and health variables. Model 1 included socio-demographic and health variables significantly associated with COVID-19 VH (see Table 4.10, p.40). Model 2 included the latent constructs derived from the EFA (see Table 4.11, p.41). Model 3 represents the fully adjusted model, combining significant socio-demographic and health variables with the latent constructs from the EFA (see Table 4.12, p.42). Potential confounders were controlled for in all models. Analysis was performed using STATA™, a confidence interval of 95% was used, and a P-value of ≤ 0.05 was considered statistically significant.

The measurement and analysis plan and process for each objective is summarised in Table 3.2 below:

Table 3.2: Data Measurement and Analysis Plan and Process	
Objective 1: To establish the prevalence of COVID-19 VH in the WITS University undergraduate student population between December 2021 and February 2022.	
1.1 Outcome variable	**Outcome variable = Vaccine Hesitancy** VH was measured in two ways using two categorical variable both obtained through responses to one survey item (B1a): Ordinal Variable: Continuum of COVID-19 VH (vaccinated, will have, probably will, delay uptake, probably refuse, refusing) (5) Binary variable: COVID-19 VH / VA. This was developed from the VH continuum: vaccinated + will have = vaccine accepting; probably will + delay uptake + probably refuse + refusing = VH)
1.2 Measurement	COVID-19 VH was measured using a question with close-ended response categories which measures the continuum of VH. As outlined above, the results of this were used to create a new binary categorical variable of COVID-19 VH / VA
1.3 Tests used	Descriptive analysis: frequency and percentages
Objective 2: To establish the reported reasons for COVID-19 VH among WITS undergraduate students evidencing VH between December 2021 and February 2022.	
2.1 Outcome Variable	**Outcome variable = Vaccine Hesitancy (excluding VA students)** Only those students that fell within the VH range of the VH continuum were used to answer this objective. Ordinal Variable: Continuum of COVID-19 VH (probably will, delay uptake, probably refuse, refusing) (5) Categorical variable: COVID-19 VH. This will be developed from the VH continuum: probably will + delay uptake + probably refuse + refusing = VH (VA students were excluded)
2.2 Exposure variables: Reasons for hesitancy	The exposure variables that were used to measure the reported factors for VH among VH WITS undergraduate students are presented below. Categorical (nominal): Fear of needles, I think vaccines are dangerous, I think the Covid-19 vaccine isn't properly tested, I think the Covid-19 vaccine doesn't work, I think the Covid-19 vaccine is a money-making scam, I am healthy so doesn't need the Covid-19 vaccine, I am concerned about time or financial costs, I am concern about side effects, I am concerned it will hurt, I think the Covid-19 vaccine makes people sick, I think the Covid-19 vaccine is used to control people, I think the Covid-19 vaccine is used to limit population growth, Other
2.3 Measurement	Outcome variable: same as Objective 1, however, VA students were excluded Exposure variable: A series of statements were provided offering reasons for VH. More than one statement could be selected. If "other" was selected a written response could be provided.
2.3 Tests used	Descriptive analysis – frequency and percentages

Objective 3: To examine the socio-demographic and health factors that are associated with COVID-19 VH in WITS undergraduate students between December 2021 and February 2022.	
3.1 Outcome Variable	The binary variable of COVID-19 VH / VA was used
3.2 Exposure variables: Socio-demographic and health characteristics	The exposure variables that were used to measure socio-demographic factors are presented below. They are organised by variable type. Quantitative continuous: Age Categorical (nominal): Age group; Gender; Race; Religion Language; Province of family home; Term-time residence; Faculty of study; Primary residence (rural, peri-urban, urban); Comorbidities; Previous adulthood vaccination behaviour; COVID-19 infection – respondent; COVID-19 infection – friends or family; COVID-19 death of friend or family; Responsibility for ensuring students are vaccinated Categorical (ordinal): Year of study; Socio-economic status -using hunger as a proxy; Severity of COVID-19 infection; Safety attending lectures with unvaccinated; In-person lectures with unvaccinated; Mandatory vaccinations for WITS
3.3 Measurement	Outcome variable: same as Objective 1 Exposure variables: A series of questions with close-ended response categories was asked to establish each of the listed exposure variables.
3.4 Tests used	Descriptive analysis – frequency and percentages Pearson's Chi-squared Test Fisher's Exact Test Wilcoxon Rank Sum Exact test
Objective 4: To determine whether the BeSD model's drivers can be operationalised as constructs and to evaluate their association with COVID-19 vaccine hesitancy or acceptance among WITS undergraduate students between December 2021 and February 2022	
4.1 Outcome Variable	The binary variable of "COVID-19 VH / VA" was used.
4.2 Exposure Variable: BeSD Drivers	Exposure variables were the 4 BeSD model drivers. These are listed below and composed of the sub-variables listed beneath them (53) **1.What people think and feel about the COVID-19 vaccine:** Categorical (ordinal): Perceived risk of COVID-19 to self; Perceived risk of COVID-19 to others; Trust in vaccine; Confidence in vaccine benefits; Confidence in protecting others; Confidence in vaccine safety; Concern about vaccine harm; Negative information **2.Social processes impacting hesitancy and uptake:** Categorical (nominal): Decision autonomy; Family norms; Friend norms; Religious leaders Categorical (ordinal): Confidence in health care providers administering vaccines, Confidence in government **3.Motivation for uptake** Categorical (ordinal): Intention for uptake; Extent of vaccination intention; Willingness to recommend vaccination to others **4.Practical issues impacting uptake** Categorical (nominal): Previous adulthood vaccination behaviour Categorical (ordinal): Ease of access to vaccination site
4.3 Measurement	Outcome variable: As stated in Objective 1 Exposure variables was measured using questions with close-response categories **1.What people think and feel about the COVID-19 vaccine.** Eight items will be used to measure this driver **2.Social processes impacting hesitancy and uptake.** Six items were used to measure this driver **3.Motivation for uptake.** Three items were used to measure this driver **4.Practical issues impacting uptake.** Two items were used to measure this driver The items under each driver can act as stand-alone measures. However, each driver was measured by summing the scores of the statistically significant items that fell under it. Cronbach's alpha was calculated to assess the internal consistency of all sub-scales.
4.3 Tests used	Pearson's Chi-squared Exploratory Factor Analysis Binary Logistic Regression

3.7 Ethical Considerations

Informed consent, confidentiality, beneficence, and non-maleficence are the four principles that guide ethical research (223). These principles were adhered to throughout this study to ensure that the research process respected the rights of the respondents. To support non-maleficence, no data collection was conducted until ethical clearance for the study had been granted by WITS University's Human Research Ethics Committee (Medical) – Clearance Certificate No. M210832 (see Appendix B). To support informed consent, potential respondents were sent an email detailing the study's purpose, the researcher's name and field of study, the length of time the questionnaire would take to complete, and the link to the online survey. They were informed that participation in the study is entirely voluntary, that their participation or lack thereof will not impact their academic outcomes, and that their participation and responses would remain confidential. All questionnaires required online consent before a respondent could proceed with the questionnaire. Participants were not coerced into beginning or completing the questionnaire once they had started.

Confidentiality was supported through the structure of the questionnaire, which recorded no identifying information. During the data collection phase, the researcher could view which student email addresses had completed the survey on REDCap. However, email addresses were not linked to responses. When the data were downloaded for analysis, the email addresses were not included in the dataset. REDCap assigned unique identifiers to each respondent. While it was anticipated that no individual benefits would be derived through participation in the study, beneficence was supported as the data generated through this research provides valuable information regarding student attitudes towards novel vaccinations, specifically the COVID-19 vaccine. No monetary or other compensation was offered to any respondents.

3.9 Chapter Conclusion

This chapter provided a discussion and an overview of the study design, sampling technique, data collection, and statistical analyses conducted during this study to answer the study's three research objectives. The results of this process are discussed in the next chapter.

CHAPTER 4: RESULTS

This chapter presents the study's results. It begins by providing an overview of the sample's demographic and health-related characteristics. Then, it presents the findings for the four objectives of this research.

4.1 Socio-demographic and Health-related Characteristics

In total, 24,573 WITS University undergraduate students received an email link inviting them to complete the study's questionnaire. 540 questionnaires were submitted via REDCAP. Of these, 526 respondents matched the inclusion criteria, giving a response rate of 2.14%. Table 4.1 (p. 30) provides an overview of the demographic characteristics of the research sample (n=526). Inclusion criteria required respondents to be between 18 and 35 years old. The mean age of respondents was 22.73 years, with over 50% falling within the 18–20 age range. Given the right-skewed distribution of age and the typical undergraduate trajectory—where most students start university at 18 and complete their degree by 21–22—age was grouped into two categories (18–20 years and 21–35 years) for analytical purposes 58.98% of the respondents were female, 37.90% were male, and the remaining 3.42% preferred not to disclose their gender. English was the most dominant home language (43.16%), followed by isiZulu (15.97%) and Sesotho Sa Leboa (7.42%). The least spoken home language was isiNdeble (0.76%). The majority of respondents identified as black (59.32%), followed by white (20.72%), Indian (11.03%), and Coloured (4.75%). 4.18% preferred not to state their race or chose to describe themselves as "Other". 16.73% of respondents identified as non-religious. Of the 83.27% who identified as religious, 62.55% were Christian, 6.65% were Muslim, and 5.89% held Traditional African Beliefs.

As research from South Africa and other contexts has shown food insecurity to be a reliable indicator of material deprivation and social vulnerability, it was used in this study as a proxy for socioeconomic status (224–230). This was decided because the sample was drawn from a population of students. Often, students have yet to enter the job market formally. Thus, employment status and income level would not accurately gauge the respondents' socioeconomic status. Food insecurity was described in the questionnaire as 'not knowing where your next meal is coming from, or eating less food than you need'. Most students (70.67%) reported having never experienced food insecurity in the 12 months before participating in this study. 15.62% of respondents reported experiencing hunger a couple of times during the 12 months that preceded their participation in this study. 7.24% reported hunger a couple of times a month, while 4.57% of respondents reported going hungry every week.

The majority of respondents' family homes, where they resided out-of-term-time, were located in Gauteng (65.27%), followed by KwaZulu Natal (11.07%), and Limpopo (9.35%). 1.72% of respondents were international students. These households were mainly located in urban areas (65.59%), followed by peri-

urban (18.25%), and rural areas (16.16%). During term time, most respondents (81.71%) resided off campus. The closure of university campuses and shift to online learning during RSA's COVID-19 lockdowns would have likely increased the number of students living off-campus.

There are five faculties at WITS. 29.09% of respondents were registered in the Faculty of Science, 20.72% in the Faculty of Humanities, 19.2% in the Faculty of Commerce Law, and Management, 15.78% in the Faculty of Health Sciences, and 15.21% were registered in the Faculty of Engineering and Built Environment. Finally, respondents were asked to provide their year of study. The majority were in their first year (38.59%). Second and third-year students comprised 25.29% and 26.05% of respondents, respectively. Fourth to sixth-year students accounted for 10.07% of respondents.

Table 4.1: Socio-demographic and Health Characteristics of Respondents

Characteristic	**n (%)**
Mean Age (n=526)	20.73 SD: 2.75, CI 20.50 – 20.97 Min 18 max 35
Participant's Age (n=526)	
18 - 20 years	305 (57.98%)
21 – 35 years	221 (40.02%)
Gender (n=525)	
Female	308 (58.67%)
Male	199 (37.90%)
Not disclosed	18 (3.43%)
Home Language (n=526)	
Afrikaans	22 (4.18%)
English	227 (43.16%)
isiNdebele	4 (0.76%)
isiXhosa	26 (4.94%)
isiZulu	84 (15.97%)
Sesotho	29 (5.51%)
Sesotho sa Leboa	39 (7.42%)
Setswana	32 (6.08%)
siSwati	10 (1.90%)
Tshivenda	19 (3.61%)
Tsonga	16 (3.04%)
Other	18 (3.42%)
Race (n=526)	
Black	312 (59.32%)
Coloured	25 (4.75%)
Indian	58 (11.03%)
White	109 (20.72%)
Other	22 (4.18%)
Religion (n=526)	
African Traditional Beliefs	31 (5.89%)
Christianity	329 (62.55%)
Hinduism	19 (3.61%)
Islam	35 (6.65%)
Judaism	12 (2.28%)
Other religion	12 (2.28%)
No religion	88 (16.73%)
Home Province (n=524)	
Eastern Cape	18 (3.44%)
Free State	5 (0.95%)
Gauteng	342 (65.27%)
KwaZulu Natal	58 (11.07%)
Limpopo	49 (9.35%)
Mpumalanga	24 (4.58%)
North West	11 (2.10%)
Northern Cape	1 (0.19%)

Western Cape	7 (1.34%)
International Student	9 (1.72%)
Location of Family Home (n=526)	
Urban	345 (65.59%)
Rural	85 (16.16%)
Peri-urban	96 (18.25%)
Term Time Accommodation (n=525)	
On-campus	96 (18.29%)
Off-campus	429 (81.71%)
Food Insecurity in last year (n=525)	
Severe (hunger daily / weekly)	24 (4.57%)
Moderate (hunger monthly)	48 (9.14%)
Mild (hunger during the year)	82 (15.62%)
Never hungry	371 (70.67%)
Year of Study (n=526)	
1st year	203 (38.59%)
2nd year	133 (25.29%)
3rd year	137 (26.05%)
4th year	41 (7.79%)
5th year	10 (1.90%)
6th year	2 (0.38%)
Faculty of Study (n=526)	
Commerce, Law, & Management	101 (19.20%)
Engineering & Built Environment	80 (15.21%)
Health Sciences	83 (15.78%)
Humanities	109 (20.72%)
Science	153 (29.09%)

Respondents were asked questions regarding their health and exposure to health risks; these can be seen in Table 4.2. 11.26% of respondents reported having a chronic health condition, these included mental health conditions (depression, anxiety, anorexia, attention deficit hyperactivity disorder), autoimmune conditions (lupus, rheumatoid arthritis), cardiac conditions, epilepsy, allergies, gastrointestinal conditions, vascular conditions, musculoskeletal conditions, among others). Most respondents (56.08%) reported never having a vaccination during their adulthood before the COVID-19 vaccine rollout. The questionnaire explored both personal and social exposure to COVID-19. 31.62% of respondents had been infected with the virus; 98.34% of these were treated at home, while 3.66% required hospitalisation. 77.71% of respondents had a family member or friend who had been infected with COVID-19, while 41.44% of respondents knew a family member or friend who had died from the virus.

Respondents were also asked to explore their beliefs about COVID-19 and attending university. Most respondents believed unvaccinated people should not be allowed to attend in-person lectures (n=275, 52.48%) and that it would not be safe for them to attend lectures with unvaccinated people (n=278, 52.95%). 58.29% of respondents supported mandatory COVID-19 vaccination for all WITS University staff and students. Respondents were also asked to select who they felt was responsible for ensuring WITS students were vaccinated against COVID-19. Respondents were able to select more than one answer for this item. Most respondents selected each individual student (81.52%), followed by the university itself (52.57%), the government (32%), and parents of students (20%).

Table 4.2 Health Related Characteristics and Beliefs of Respondents	
Characteristic or belief	**n (%)**
Vaccination as an adult (n=526)	
Yes	231 (43.92%)
No	295 (56.08%)
Chronic Illness (n=524)	
Yes	59 (11.26%)
No	454 (86.64%)
Prefer not to say	11 (2.10%)
Currently or previously infected with COVID-19 (n=525)	
Yes	166 (31.62%)
No	359 (68.38%)
Severity of Infection (n=164)	
Treated at home	158 (98.34%)
Treated in hospital	6 (3.66%)
Friends or family currently or previously infected with COVID-19 (n=525)	
Yes	408 (77.71%)
No	117 (22.29%)
Family or friends died from COVID-19 (n=526)	
Yes	218 (41.44%)
No	308 (58.56%)
Unvaccinated should be allowed to attend lectures (n=525)	
Yes	249 (47.52%)
No	275 (52.48%)
Safe to attend lectures with unvaccinated people (n=525)	
Yes	247 (47.05%)
No	278 (52.95%)
Supports mandatory COVID-19 vaccinations for WITS students and staff (n=525)	
Yes	306 (58.29%)
No	219 (41.71%)
Responsibility for ensuring WITS students are vaccinated – more than one could be selected (n=525)	
WITS University	276 (52.57%)
The Government	162 (32.00%)
Each individual Student	428 (81.52%)
Parents of Students	105 (20.00%)
Other person / institution	12 (2.29%)

4.2 COVID-19 Vaccine Hesitancy as a Continuum and a Binary Categorical Variable

At the time of the survey, the majority of respondents, 381 (72.43%), had received a COVID-19 vaccination or indicated that they planned to be vaccinated in the future (n=22, 4.18%). These individuals constitute the 403 (76.62%) respondents considered “vaccine accepting” (VA). The remaining 123 (23.38%) respondents were classified as “vaccine hesitant” (VH). They displayed varying degrees of hesitancy: 15 (2.85%) described themselves as “probably going to have the vaccine”, 42 (7.99%) as “delaying having the vaccine”, 27 (5.1%) as “probably not having the vaccine”, and 39 (7.42%) stated that they “definitely would not be having the vaccine”. The COVID-19 vaccine became available to people aged 18 to 34 years old in RSA on 20 August 2021. Respondents were asked if they had intended to have the COVID-19 vaccination before this date when the vaccination campaign had not yet opened to their demographic group. The percentage of respondents reporting they had the intention for COVID-19 vaccine uptake before its availability was 64.45% (low intention (13.50%), moderate intention (12.93%), high intention (32.51%)). The remaining 35.5% reported having had no intention of having the vaccine before it became available. The above data are available in Table 4.3 (p.33).

Table 4.3: COVID-19 Vaccine Hesitancy and Vaccine Acceptance	
COVID-19 Vaccine Intention and Uptake	n(%)
Intention for Covid-19 vaccine uptake at the time of the survey – COVID-19 VH Continuum (n=526)	
I have already had the COVID-19 vaccine (VA)	381 (72.43%)
I definitely will have the COVID-19 vaccine (VA)	22 (4.18%)
I probably will have the COVID-19 vaccine (VH)	15 (2.85%)
I am delaying having the COVID-19 vaccine (VH)	42 (7.99%)
I probably will not have the Covid-19 vaccine (VH)	27 (5.10%)
I definitely will not have the COVID-19 vaccine (VH)	39 (7.42%)
Covid-19 VH Binary (n=526)	
COVID-19 Vaccine Accepting	403 (76.62%)
COVID-19 Vaccine Hesitant	123 (23.38%)
Reported intention for Covid-19 vaccine uptake prior to its availability to respondent's age group in RSA (n=526)	
Already vaccinated in RSA (high)	27 (5.13%)
Already vaccinated outside RSA (high)	2 (0.38%)
Very much (high)	171 (32.51%)
Moderately (moderate)	68 (12.93%)
A little (low)	71 (13.50%)
Not at all (none)	187 (35.55%)

4.3 Reported Reasons for COVID-19 Vaccine Hesitancy

Table 4.4 (p.34) provides an overview of the reasons COVID-19 VH respondents selected as reasons for their VH. Of the 123 respondents who indicated a level of COVID-19 VH, the majority (n=77; 62.60%) linked their hesitancy to concerns about side effects. This was followed by concerns that the vaccines had not been adequately tested (n=65, 52.85%), the belief that COVID-19 vaccines did not work (n=44, 35.77%), and the belief that healthy individuals didn't require COVID-19 vaccination (n=40, 32.52%). Concerns about side effects was the primary response given by VH respondents across each level of the VH continuum – probably will be vaccinated (66.67%), delaying vaccine (59.52%), probably won't be (70.37%), refusing vaccine (58.97%). This was followed by concerns that the vaccines had not been adequately tested - probably will be vaccinated (26.67%), delaying vaccine (57.14%), probably won't be (55.56%), refusing vaccine (53.85%).

Respondents (n=33, 26.80%) who selected "other" as a reason for their COVID-19 VH were invited to elaborate on their choice. 12 (9.76%) respondents stated that they believed natural immunity, acquired through previous infection with COVID-19, would provide enough protection from COVID-19, with some stating they believed prior infection offered superior protection from the virus compared to vaccination. Four (3.25%) respondents were concerned that mutations in the COVID-19 virus might lead to a need for additional booster vaccinations in the future, which contributed to their hesitancy about receiving a COVID-19 vaccine. Nine (7.32%) respondents stated that they were hesitant to have the vaccine as they felt coerced or forced into having it. Religion (4.88%) was also raised as an "Other" factor preventing vaccine uptake among individual respondents.

Table 4.4: Reasons for COVID-19 VH Given by COVID-19 VH Respondents (respondents could select more than one option (n=123))

Reasons Given Influencing COVID-19 Hesitancy	All VH n(%)	Probably will n(%)	Delaying n(%)	Probably won't n(%)	Refusing n(%)
Concern about side effects	77 (62.60)	10 (66.67)	25 (59.52)	19 (70.37)	23 (58.97)
Covid-19 vaccine isn't properly tested	65 (52.85)	4 (26.67)	25 (59.52)	15 (55.56)	21 (53.85)
Covid-19 vaccine doesn't work	44 (35.77)	3 (20.00)	12 (28.57)	8 (29.63)	21 (53.85)
Covid-19 vaccine is unnecessary for healthy people	40 (32.52)	1 (6.67)	6 (14.29)	12 (44.44)	21 (53.85)
Covid-19 vaccine makes people sick	35 (28.46)	3 (20.00)	9 (21.43)	7 (25.93)	16 (41.03)
Other	33 (26.83)	3 (20.00)	6 (14.28)	8 (29.69)	16 (41.03)
C-19 vax used to limit population growth	25 (20.33)	0 (0.00)	10 (23.81)	4 (14.81)	11 (28.21)
Covid-19 vaccine is a money-making scam	24 (19.51)	2 (13.33)	5 (11.91)	4 (14.81)	13 (33.33)
Covid-19 vaccine is used to control people	23 (18.70)	2 (13.33)	6 (11.91)	5 (18.52)	10 (25.64)
Fear of needles	14 (11.38)	4 (26.67)	7 (16.67)	3 (11.11)	0 (0.00)
All vaccines are dangerous	13 (10.57)	0 (0.00)	5 (11.91)	0 (0.00)	8 (20.51)
Concerned COVID-19 vaccination will hurt	6 (4.88)	2 (13.33)	2 (4.76)	0 (0.00)	2 (5.13)
Concerned about time or financial costs associated with Covid-19 vaccination	3 (2.44)	0 (0.00)	2 (4.76)	0 (0.00)	1 (2.56)

4.4 Socio-demographic and Health Characteristics Associated with COVID-19 Vaccine Hesitancy among WITS Undergraduate Students

Table 4.5 (p.35) presents the findings of bivariate tests of association that were conducted to test the association between socio-demographic factors and the binary categorical outcome variable of "COVID-19 VH / COVID-19 VA". Several factors were found to be significantly associated with the binary categorical variable of "COVID-19 VH / COVID-19 VA":

- **Mean Age** (p = <0.001): Among VH individuals (n = 123), the mean age was 21.52 years (SD = 3.26; 95% CI: 20.96–22.08), ranging from 18 to 35 years. VA individuals (n = 403) had a slightly lower mean age of 20.49 years (SD = 2.58; 95% CI: 20.24–20.74) with the same age range.
- **Age Group** (p = 0.010): 47.97% of VH respondents were aged 18–20 years and 52.03% aged 21–35 years, compared to 61.04% and 38.96% in the VA group, respectively.
- **Gender** (p=0.057): This result approached but did not reach statistical significance. Among VH respondents, 54.47% were female, 44.72% were male, and 0.81% preferred not to disclose their gender. In contrast, among VA respondents, 59.95% were female, 35.82% were male, and 4.23% preferred not to disclose their gender.
- **Religion** (p = 0.004): Christianity was the most reported religion in both VH and VA groups, with a higher proportion among VH respondents (72.36%) compared to VA respondents (59.55%). In the VH group, the next most reported affiliation was to 'Other religions not listed' (8.94%) and African Traditional Beliefs (8.13%). By contrast, a greater proportion of VA respondents reported no religious affiliation (19.11%). Additionally, 7.44% of VA respondents identified as Muslim, compared to 4.07% in the VH group.
- **Home Province** (p = 0.005): Over half of VH respondents were from Gauteng (53.66%), with notable proportions from Limpopo (17.07%) and KwaZulu-Natal (11.38%). In contrast, 68.83% of VA

respondents were from Gauteng, 10.97% were from KwaZulu-Natal, and fewer were from Limpopo (6.98%).

- **Location of Family Home** (p = 0.003): Among VH respondents, 52.85% had urban family homes, 26.02% were from peri-urban areas, and 21.14% were from rural areas. Among VA respondents, a larger proportion were from urban areas (69.48%), with lower percentages from peri-urban (15.88%) and rural (14.64%) locations.
- **Term-time Accommodation Location** (p = 0.024): Among VH respondents, 11.38% lived on campus and 88.62% off campus. For VA respondents, 20.40% lived on campus and 79.60% off campus, showing a slightly higher proportion of VA students living on campus.
- **Received other vaccinations as an adult** (excluding COVID-19) (p = 0.001): Of the VH respondents, 30.89% reported receiving other adult vaccinations, while 69.11% had not. In the VA group, a higher proportion (47.89%) had received other adult vaccinations, with 52.11% indicating they had not.
- **Having a chronic illness** (p = 0.044): Among VH respondents, 9.76% reported having a chronic illness, 83.37% reported none, and 4.88% preferred not to disclose. In the VA group, 11.72% reported a chronic illness, 87.03% reported none, and 1.25% preferred not to disclose.

Table 4.5: Comparison of Socio-Demographic Factors Between Vaccine Hesitant and Vaccine Accepting Respondents with Associated P-values

	n(%)	Vaccine Hesitant n(%)	Vaccine Accepting n(%)	P-value
Mean Age (n=526)	20.73 (SD: 2.75) CI 20.496 – 20.97 Min 18 Max 35	21.52 (SD 3.16) CI 20.96 – 22.08 Min 18 Max 35 (n=123)	20.49 (SD2.58) CI 20.24 – 20.74 Min 18 Max 35 (n=403)	**<0.001**
Respondent's Age Group (n=526)				**0.010**
18 - 20 years	305 (57.98%)	59 (47.97%)	246 (61.04%)	
21 – 35 years	221 (40.02%)	64 (52.03%)	157 (38.96%)	
Gender (n=525)				0.057*
Female	308 (58.67%)	67 (54.47%)	241 (59.95%)	
Male	199 (37.90%)	55 (44.72%)	144 (35.82%)	
Not disclosed	18 (3.43%)	1 (0.81%)	17 (4.23%)	
Home Language (n=526)				0.096*
Afrikaans	22 (4.18%)	4 (3.25%)	18 (4.47%)	
English	227(43.16%)	42 (43.15%)	185 (45.91%)	
isiZulu	84 (15.97%)	23 (18.70%)	61 (15.76%)	
Other South African language	175 (33.27%)	47 (38.21%)	128 (31.76%)	
Other language	18 (3.42%)	7 (5.69%)	11 (2.73%)	
Race (n=526)				0.063*
Black	312 (59.32%)	81 (65.85%)	231 (57.32%)	
Coloured	25 (4.75%)	4 (3.25%)	21 (5.21%)	
Indian	58 (11.03%)	9 (7.32%)	49 (12.16%)	
White	109 (20.72%)	20 (16.26%)	89 (22.08%)	
Other	22 (4.18%)	9 (7.32%)	13 (3.23%)	
Religion (n=526)				**0.004***
African Traditional Beliefs	31 (5.89%)	10 (8.13%)	21 (5.21%)	
Christianity	329 (62.55%)	89 (72.36%)	240 (59.55%)	
Hinduism	19 (3.61%)	3 (2.44%)	16 (3.97%)	
Islam	35 (6.65%)	5 (4.07%)	30 (7.44%)	
Judaism	12 (2.28%)	0 (0%)	12 (2.98%)	
Other religion	12 (2.28%)	11 (8.94%)	7 (1.74%)	
No religion	88 (16.73%)	5 (4.07%)	77 (19.11%)	

Home Province (n=524)				**0.005***
Eastern Cape	18 (3.44%)	3 (2.44%)	15 (3.74%)	
Free State	5 (0.95%)	0 (0%)	5 (1.25%)	
Gauteng	342 (65.27%)	66 (53.66%)	276 (68.83%)	
KwaZulu Natal	58 (11.07%)	14 (11.38%)	44 (10.97%)	
Limpopo	49 (9.35%)	21 (17.07%)	28 (6.98%)	
Mpumalanga	24 (4.58%)	9 (7.32%)	15 (3.74%)	
North West	11 (2.10%)	5 (4.07%)	6 (1.50%)	
Northern Cape	1 (0.19%)	0 (0%)	1 (0.25%)	
Western Cape	7 (1.34%)	3 (2.44%)	4 (1%)	
International Student	9 (1.72%)	2 (1.63%)	7 (1.75%)	
Location of Family Home (n=526)				**0.003**
Urban	345 (65.59%)	65 (52.85%)	280 (69.48%)	
Rural	85 (16.16%)	26 (21.14%)	59 (14.64%)	
Peri-urban	96 (18.25%)	32 (26.02%)	64 (15.88%)	
Term Time Accommodation (n=525)				**0.024**
On-campus	96 (18.29%)	14 (11.38%)	82 (20.40%)	
Off-campus	429 (81.71%)	109 (88.62%)	320 (79.60%)	
Food Insecurity in last year				0.843*
Severe (hunger daily / weekly)	24 (4.57%)	6 (4.88%)	18 (4.48%)	
Moderate (hunger monthly)	48 (9.14%)	11 (8.94%)	37 (9.20%)	
Mild (hunger during the year)	82 (15.62%)	22 (17.89%)	60 (14.93%)	
Never hungry	371 (70.67%)	84 (68.29%)	287 (71.39%)	
Year of Study				0.145
1st year	203 (38.59%)	41 (33.33%)	162 (40.20%)	
2nd year	133 (25.29%)	27 (21.95%)	106 (26.30%)	
3rd year	137 (26.05%)	41 (33.33%)	96 (23.82%)	
4th – 6th year	53 (10.08%)	14 (11.38%)	39 (9.68%)	
Faculty of Study (n=526)				0.189
Commerce, Law, & Management	101 (19.20%)	30 (24.39%)	71 (17.62%)	
Engineering & Built Environment	80 (15.21%)	21 (17.07%)	59 (14.64%)	
Health Sciences	83 (15.78%)	17 (13.82%)	66 (16.38%)	
Humanities	109 (20.72%)	28 (22.76%)	81 (20.10%)	
Science	153 (29.09%)	27 (21.95%)	126 (31.27%)	
Vaccination as an adult (n=526)				**0.001**
Yes	231 (43.92%)	38 (30.89%)	193 (47.89%)	
No	295 (56.08%)	85 (69.11%)	210 (52.11%)	
Chronic Illness (n=524)				**0.044**
Yes	59 (11.26%)	12 (9.76%)	47 (11.72%)	
No	454 (86.64%)	105 (85.37%)	349 (87.03%)	
Prefer not to say	11 (2.10%)	6 (4.88%)	5 (1.25%)	

* Indicates that a Fisher's Exact test was conducted

Table 4.6 (p.37) presents COVID-19-related experiences and beliefs in relation to the binary outcome of "COVID-19 Vaccine Hesitancy (VH) / Vaccine Acceptance (VA)." The only experience significantly associated with the binary outcome was prior or current infection with COVID-19 ($p = 0.047$). Among vaccine-hesitant respondents, 39.02% reported previous infection compared to 29.35% of vaccine-accepting respondents. The majority of both groups, however, reported no prior infection (60.98% of VH and 70.65% of VA).

Beliefs about COVID-19 risks and prevention at the university showed strong associations:

- **Allowing unvaccinated individuals to attend lectures** ($p < 0.001$): 92.62% of VH respondents supported this, compared to 40.30% of VA respondents.
- **Feeling safe attending lectures with unvaccinated individuals** ($p < 0.001$): 92.68% of VH respondents felt safe, while 66.92% of VA respondents did not.

- **Mandatory vaccination for students and staff** ($p < 0.001$): 95.93% of VH respondents opposed mandatory vaccination, whereas 74.88% of VA respondents supported it.

The findings highlight notable differences in beliefs regarding vaccination policies and safety concerns between the VH and VA respondents.

Table 4.6: Covid Related Experiences and Beliefs and their Association with Vaccine Hesitancy

	All n(%)	Vaccine Hesitant n(%)	Vaccine Accepting n(%)	P Value
Infected with Covid (n=525)				**0.047**
Yes	166 (31.62%)	48 (39.02%)	118 (29.35%)	
No	359 (68.38%)	75 (60.98%)	284 (70.65%)	
Severity of infection (n=164)				1.000
Treated at home	158 (98.34%)	45 (95.74%)	113 (96.58%)	
Treated at hospital	6 (3.66%)	2 (4.26%)	4 (3.42%)	
Family / Friends infected (n=525)				0.174
Yes	408 (77.71%)	90 (73.17%)	318 (79.10%)	
No	117 (22.29%)	33 (26.83 %)	84 (20.90%)	
Family or friends died from Covid (n=526)				0.174
Yes	218 (41.44%)	44 (35.77%)	174 (43.18%)	
No	308 (58.56%)	79 (64.23%)	229 (56.82%)	
Unvaccinated should be allowed to attend lectures (n=525)				**<0.001**
Yes	275 (52.48%)	113 (92.62%)	162 (40.30%)	
No	249 (47.52%)	9 (7.38%)	240 (59.70%)	
Safe to attend lectures with unvaccinated people (n=525)				**<0.001**
Yes	278 (52.95%)	114 (92.68%)	133 (33.08%)	
No	247 (47.05%)	9 (7.32%)	269 (66.92%)	
Mandatory COVID-19 vaccinations for WITS students and staff (n=525)				**<0.001**
Yes	306 (58.29%)	5 (4.07%)	301 (74.88%)	
No	219 (41.71%)	188 (95.93%)	101 (25.12%)	

The socio-demographic and health variables identified as holding significant associations with the binary categorical variable of "COVID-19 VH / COVID-19 VA" were later used to develop a binary logistic regression model, which allowed for the directionality of the association to be established. The results of this can be viewed in section 4.5.2.

4.5 Association between Behavioural and Social Drivers of Vaccination Model and COVID-19 Vaccine Hesitancy

This section presents the results of the EFA and subsequent binary logistic regression models conducted to address Objective 4. The EFA aimed to determine whether the 20 items of the BeSD model grouped into latent constructs aligned with the BeSD models' theoretical drivers or if alternative factor structures emerged (to view the BeSD items see Table 4.8 or Appendix D). After the EFA, three binary logistic regression models were constructed to assess the association between COVID-19 VH and latent constructs, alongside socio-demographic and health variables. A supplementary item-level analysis of the BeSD responses was also constructed to contextualise the EFA results further. The supplementary findings,

detailed in Appendix D, provide insight into the individual item responses and their divergence between VH and VA respondents.

4.5.1. Results of the Exploratory Factor Analysis

The EFA with varimax rotation resulted in the retention of four factors, collectively accounting for 63.13% of the total variation in the dataset. The item loadings did not align discretely with the original BeSD drivers. Instead, overlapping constructs emerged. Factor 1, comprising nine items related to trust, willingness to recommend vaccination, and confidence in vaccine safety and efficacy, was labelled 'COVID-19 Vaccine Confidence.' It contained items from three drivers. Factor 2 contained two items reflecting concerns about infection and the risk of transmission and was labelled 'COVID-19 Infection Concerns.' It contained items from one driver. Factor 3 reflected the influence of family and friends on vaccination behaviour and was labelled 'Social Norms.' It contained items from one driver. Factor 4 included two items reflecting exposure to negative vaccine information and was labelled 'Negative Information about Vaccines'. It contained items from one driver. The properties of the four factors are summarised in Table 4.7 while detailed item-level loadings are presented in Table 4.8. Items that cross-loaded onto multiple factors were retained on the factor where they demonstrated the highest loading.

Table: 4.7 Constructs Identified Through Exploratory Factor Analysis

Factor	Construct Name	Items in Scale	Eigenvalue	Variance Explained (%)	Reliability (Cronbach's α)	Factor Loading Range
1	COVID-19 Vaccine Confidence	9	6.62	33.08%	0.9391	0.49–0.88
2	COVID-19 Infection Concerns	2	1.13	5.65%	0.6947	0.65–0.70
3	Social Norms	2	1.06	5.31%	0.5832	0.52–0.74
4	Negative Information About Vaccines	2	0.66	3.09%	0.5992	0.49–0.92

Table 4.8: Exploratory Factor Loadings

BeSD Driver	Variable	Factors				Uniqueness
		1	2	3	4	
Thinking & Feeling	Vaccine hesitancy continuum					0.9375
Thinking & Feeling	Concerned about infecting family/friends (concerns)		**0.6554**			0.5280
Thinking & Feeling	Trust COVID-19 vaccine (confidence)	**0.8695**				0.1602
Thinking & Feeling	Concerned about getting COVID-19 (concerns)		**0.6967**			0.4885
Thinking & Feeling	Importance of COVID-19 vaccine for your health (confidence)	**0.7385**	0.4421			0.2245
Thinking & Feeling	COVID-19 vaccine will protect others (confidence)	**0.7507**	0.3334			0.2752
Thinking & Feeling	COVID-19 vaccine safety (confidence)	**0.8795**				0.1549
Thinking & Feeling	Concerned about COVID-19 vaccine side effects (confidence)	**0.7454**				0.3808
Thinking & Feeling	Seen negative Information on any vaccines				**0.4889**	0.7538
Thinking & Feeling	Seen negative information on COVID-19 vaccines				**0.9193**	0.1209
Motivation	Intention for COVID-19 vaccine uptake (confidence)	**0.7153**		0.3097		0.3649

Motivation	Willingness to recommend COVID-19 vaccination to others (confidence)	**0.7918**	0.3179		0.2036
Social Processes	COVID-19 vaccination decision autonomy				0.9687
Social Processes	Family Norms – will close family/friends want you to get vaccinated			**0.7424**	0.3971
Social Processes	Friend Norms – will friends be vaccinated			**0.5187**	0.7035
Social Processes	Religious Norms – religious leaders want you to get vaccinated				0.9282
Social Processes	Trust in Healthcare Workers	**0.7620**			0.3864
Social Processes	Trust in Government	**0.4852**			0.7296
Practical Issues	COVID-19 vaccine is accessible (accessibility)				0.9080
Practical Issues	Other adulthood vaccination (accessibility)				0.9096

Comparison of mean construct scores between COVID-19 VH and VA groups revealed significant differences ($p \leq 0.05$) across all four constructs. These are summarised in Table 4.9. The largest differences were observed in 'COVID-19 Vaccine Confidence' and 'Social Norms', where individuals reported lower levels of confidence in vaccines and higher susceptibility to negative social influences compared to VA respondents. Statistically significant but smaller differences were observed in 'Negative Information about Vaccines' and 'COVID-19 Infection Concerns', suggesting that, while relevant, they may have a less substantive impact on VH.

Table 4.9: Newly Identified Constructs of Vaccine Hesitancy

Construct	Total	COVID-19 Vaccine Hesitant	COVID-19 Vaccine Accepting	P value
COVID-19 Vaccine Confidence (n=519)		n= 122	n = 397	**<0.001**
Mean	20.19	30.57	17.00	
Standard deviation	8.07	4.73	5.92	
COVID-19 Infection Concerns (n=526)		n =123	n =403	**<0.001**
Mean	4.51	5.61	4.17	
Standard deviation	1.88	1.87	1.75	
Social Norms (n=525)		n = 123	n =402	**<0.001**
Mean	3.22	4.07	2.96	
Standard deviation	1.41	1.26	1.35	
Negative Information about Vaccines (n=526)		n =123	n =303	**0.039**
Mean	2.39	2.29	2.43	
Standard deviation	0.67	0.52	0.71	

4.5.2 Binary Logistic Regression Model Results

Following the EFA, three binary logistic regression models were developed to assess the relationship between socio-demographic characteristics, latent constructs, and COVID-19 VH. The results are presented below.

Model 1 – Socio-demographic and Health Characteristics

A binary logistic regression was conducted to assess the relationship between socio-demographic variables and COVID-19 VH. Variables that had been significantly associated ($P \leq 0.05$) with the binary categorical variable of COVID-19 VH / VA were included. These were age group, religion, term-time accommodation, family home location (urban or rural), chronic illness, prior adulthood vaccination, and COVID-19 infection status. Although 'home province' was significant in the bivariate analysis, it was excluded from the final model due to small sample sizes across several provinces. Including this variable could have reduced the

stability and interpretability of the estimates. Instead, family home location and term-time accommodation were prioritised as they more directly reflect the participants' living environments and access to vaccination services. Additionally, gender and having a family member or friend die from COVID-19 were included as it was theoretically important and a potential confounder. A P-value of 0.00 was observed, meaning the model was significant.

Table 4.10 presents the results of the logistic regression. Six characteristics were identified as significantly associated with COVID-19 VH. Of these, two characteristics increased the risk of VH, and four characteristics protected against it.

Risk Association with COVID-19 VH:

- Age: Older respondents in the 21 – 35 age group had higher odds of being VH (OR=1.7, P=0.025, CI=1.07 – 2.69) than those in the 18 – 20 age group.
- Adulthood vaccinations: Respondents who reported not having had any vaccinations as adults had higher odds of VH (OR=1.83, P=0.015, CI=1.13 -2.98) than those vaccinated as adults.

Protective Association with SARS-CoV2 VH:

- Religion: Respondents who identified themselves as having no religion had lower odds of VH (OR=0.32, P=0.035 CI=0.11 – 0.92) than religious students.
- Term-time accommodation: Respondents who resided in on-campus accommodation during term time had significantly lower odds of being VH (OR=0.36, P=0.002 CI=0.19 – 0.698) than students who lived off-campus during term time.
- Location of family home: Respondents whose family home was in an urban area had lower odds of VH (OR=0.54, P=0.030, CI=0.31 – 0.94) than students whose family homes were in rural or peri-urban areas.
- Covid-infection: Respondents who had never been infected with COVID-19 had lower odds of VH (OR=0.59, P=0.027 CI=0.37 – 0.94) than those infected with COVID-19.

Table 4.10: Logistic Regression Model 1 - Socio-demographic and Health Characteristics of COVID-19 Vaccine Hesitancy (n=481)

Variable of Interest	Odds ratio	P value	95 % Confidence Interval
Age			
21 – 35 years	1.698	**0.025**	1.07 – 2.69
Gender			
Male	1.17	0.505	0.74 – 1.86
Religion			
Christian	0.85	0.703	0.36 – 1.996
Hindu	0.61	0.531	0.13 – 2.87
Islam	0.31	0.100	0.08 – 1.25
Judaism	1*	-	-
No religion	0.31	**0.035**	0.11 – 0.92
Other religion	0.83	0.829	0.16 – 4.33
Term-time Accommodation			
On-campus	0.36	**0.002**	0.19 – 0.698
Location of family home			

Rural	0.83	0.602	0.42 – 1.66
Urban	0.54	**0.030**	0.31 – 0.94
Chronic Illness			
No chronic illness	1.27	0.538	0.595 – 2.70
Vaccination as an adult			
No other vaccinations as an adult	1.83	**0.015**	1.13 – 2.98
Infected with Covid			
Never infected	0.59	**0.027**	0.37 – 0.94
Family or Friend died from Covid			
No deaths	1.22	0.417	0.76-1.95

* none of the respondents selecting Judaism were VH.

Model 2 – Variables of interest

A second binary logistic regression model was run with only the latent constructs identified through the EFA. As seen in Table 4.11, three of the constructs had statistically significant negative associations with VH, meaning they were protective against VH.

- COVID-19 Vaccine Confidence (OR=0.014, P=0.00 CI=0.003 – 0.057): Respondents who had displayed more confidence in the COVID-19 vaccine had significantly lower odds of VH than those who lacked confidence.
- COVID-19 Infection Concerns (OR=0.36, P=0.00 CI=0.21-0.61): Respondents who had displayed greater concerns regarding contracting COVID-19 and/or infecting friends or family members with COVID-19 had significantly lower odds of VH than those who were less concerned about contracting COVID-19 or infecting others with the virus.
- Social Norms (OR=0.28, P=0.00, CI=0.15-0.51): Respondents who thought their friends and family supported COVID-19 vaccination had significantly lower odds of VH.

The fourth construct, Negative Information about Vaccines, was not significantly associated with COVID-19 VH.

Table 4.11: Logistic Regression Model 2 – Factor Analysis Constructs (n=526)

Variable of Interest	Odds ratio	P value	95 % Confidence Interval
COVID-19 Vaccine Confidence	0.014	**0.00**	0.003 – 0.057
COVID-19 Infection Concerns (self and others)	0.36	**0.00**	0.21 – 0.61
Social Norms	0.28	**0.00**	0.15 – 0.51
Negative Information about Vaccines	1.42	0.23	0.797 – 2.53

Model 3 – Fully Controlled Model

A third fully adjusted logistic regression model was run, which contained significant sociodemographic characteristics, significant health characteristics, and significant constructs. This contained 493 observations and was statistically significant (P=<0.001). Gender was included in the model because it was theoretically important, as the literature reviewed had indicated gender differences in VH. The results, shown in Table 4.12 (p.42), three constructs and two socio-demographic factors were protective against VH, while one socio-demographic factor increased the risk of VH.

Protective association with COVID-19 VH:

- Construct: COVID-19 Vaccine Confidence (OR=0.01, P=<0.001 CI=0.003-0.06)

- Construct: COVID-19 Infection Concerns (self and others) (OR=0.40, P=0.002 CI=0.22-0.72)
- Construct: Social Norms (OR=0.29, P=<0.001 CI0.15-0.56)
- Socio-demographic characteristic: Term-time Accommodation (OR=0.37, P=0.009 CI=0.17-0.78)
- Socio-demographic characteristic: No Religion (OR=0.25, P=0.034 CI0.07-0.897)

Risk association with COVID-19 VH:

- Socio-demographic characteristic: Age Group (OR=2.09, P=0.012 CI1.17-3.72) – Respondents aged 21 – 35 years old had greater odds of being COVID-19 VH.

Table 4.12: Logistic Regression Model 3 – Fully Controlled Model of Constructs and Characteristics

Variable of Interest	Odds ratio	P value	95 % Confidence Interval
COVID-19 Vaccine Confidence			
	0.01	**<0.001**	0.003 – 0.06
COVID-19 Infection Concerns			
(self and others)	0.40	**0.002**	0.22 – 0.72
Social Norms			
	0.29	**<0.001**	0.15 – 0.56
Age Group			
21 – 35 years	2.09	**0.012**	1.17 – 3.72
Gender			
Male	1.15	0.635	0.64 – 2.09
Term-time accommodation			
On-campus	0.37	**0.009**	0.17 – 0.78
Family Home			
Rural	0.71	0.404	0.31 – 1.595
Urban	0.84	0.620	0.41 – 1.69
Religion			
No religion	0.25	**0.034**	0.07 – 0.897
Other Vaccination as Adult			
No other vaccination as an adult	1.19	0.580	0.64 – 2.22
Infected with Covid			
Never infected	0.70	0.255	0.37 – 1.27

Conclusion to the Logistic Regression Results

The results of the binary logistic regression models (Models 1–3) illustrate how socio-demographic factors and latent constructs contribute to or mediate COVID-19 VH. Overall, the progression from Model 1 and Model 2 to Model 3 revealed that while certain socio-demographic and latent constructs (retained their significance and strength, other socio-demographic factors lost their association in the fully controlled model.

'Age group' (21–35 years) consistently showed a risk association with COVID-19 VH, with an OR of 1.83 (p=0.015) in Model 1, increasing to 2.09 (p=0.012) in Model 3. 'Term-time accommodation' ('on-campus') remained protective with an OR changing slightly from 0.36 (p=0.002) in Model 1 to 0.37 (p=0.009) in Model 3. 'Religion' ('no religion') also showed a consistent protective effect, with its OR decreasing from 0.32 (p=0.035) in Model 1 to 0.25 (p=0.034) in Model 3, indicating a stronger independent association. Conversely, 'Family home location', which was significant in Model 1 (OR=0.54, p=0.03), lost significance in Model 3 (OR=0.71, p=0.404), suggesting its contribution was reduced after adjusting for additional variables.

The latent constructs identified in Model 2 demonstrated strong protective effects against COVID-19 VH. 'COVID-19 Vaccine Confidence' emerged as the most influential construct, with an OR of 0.014 (p=<0.001) in Model 2, which persisted in the fully controlled model (Model 3; OR=0.01, p=<0.001). 'COVID-19 Infection Concerns' ('self and others') also retained its strength as a protective factor, showing significant associations in both Model 2 (OR=0.36, p=<0.001) and Model 3 (OR=0.40, p=0.002), with minimal changes in OR. Similarly, 'Social Norms' demonstrated consistent protective effects, with an OR of 0.28 (p=<0.001) in Model 2 and 0.29 (p=<0.001) in Model 3, reflecting stability across models. Conversely, the construct 'Negative Information about Vaccines' was not significantly associated with COVID-19 VH in Model 2 and, therefore, was not carried forward to Model 3.

4.6 Chapter Conclusion

This chapter presented the results of the analyses conducted to answer the four objectives of this study. The results evidenced that 23.38% of respondents were COVID-19 VH, and that certain socio-demographic and health characteristics are significantly associated with COVID-19 VH. Furthermore, the factor analysis found that the items making up the BeSD drivers do not load as discrete constructs in this study population. Finally, the binary logistic regression models offered insight into the relationship between socio-demographic and health characteristics, as well as the constructs developed through the factor analysis, to identify what factors and constructs are protective against COVID-19 VH and which increase its likelihood.

CHAPTER 5: DISCUSSION

This chapter examines the study's findings in relation to its research objectives and existing literature. It positions the prevalence of COVID-19 VH among undergraduate students at the University of the Witwatersrand within the broader context of VH and the BeSD model. The findings provide a point-in-time snapshot of VH and VA, capturing shifts in vaccination intention before and after vaccine availability. By situating these results within national and global trends and drawing on supplementary findings (Appendix E), the chapter highlights patterns distinct to this study population and reflective of broader societal trends.

The discussion is structured according to the study's objectives. It first interprets the prevalence of COVID-19 VH, comparing it to national and global trends. This is followed by an examination of the reasons given for VH by COVID-19 VH respondents, drawing on both closed- and open-ended responses categorised within the BeSD framework. The chapter then explores the socio-demographic and health-related factors associated with VH, reflecting on the findings to highlight key patterns and divergences from existing research. Finally, the discussion evaluates the operationalisation of the BeSD framework, examining how its drivers function and relate in this study context and population. The chapter concludes with a reflection on the research's limitations.

5.1 COVID-19 Vaccine Hesitancy Prevalence among WITS Undergraduate Students

5.1.1 Prevalence of COVID-19 VH and VA among WITS Undergraduate Students

At the time of the survey, 23.38% of respondents were classified as COVID-19 VH, while 76.62% were VA. These findings represent a point-in-time snapshot of VH within the WITS undergraduate population during the data collection (December 2021 – February 2022). Despite widespread vaccine availability, a notable minority of respondents remained VH, mirroring broader trends of low vaccine uptake among young adults in RSA (51,52).

Respondents were also asked to reflect on their intention to vaccinate before COVID-19 vaccine availability for their demographic group. 61.98% of all respondents exhibited low, moderate, or no prior intention for uptake. Compared to actual VA at the time of the survey (76.62%), this shows a positive shift towards VA within the study population. Notably, 48.88% of VA respondents reported high intention pre-rollout, while 82.93% of VH respondents reported little to no intention. These figures suggest that increased vaccine availability, peer uptake, and institutional messaging and mandates may have influenced a shift from higher levels of VH to greater VA over time. However, the persistence of VH in nearly a quarter of respondents underscores the complexity of vaccine attitudes and the limitations of availability alone in achieving widespread VA.

5.1.2 Comparison to National and Global COVID-19 Vaccine Hesitancy Prevalence Trends

The 23.38% VH prevalence observed aligns with RSA studies conducted between June 2020 and November 2021, where rates ranged from 18% to 48%. National surveys, including the UJ-HSRC COVID-19 Democracy Survey and NIDS-CRAM Wave 4, reported similar declines in VH from early 2021 to mid-2021 as vaccines became accessible (52,60,62–65,79). The decline from 61.98% VH pre-vaccine rollout to 23.38% post-rollout in this study aligns with these national trends, suggesting that initial reactive VH can shift along the Vaccine Hesitancy Continuum towards VA supported by increased vaccine access (60,62,63,75).

Globally, COVID-19 VA rates range from 23.6% to 97% (76). The VA rates observed in this study (76.62%) and by Modi et al. (83.3%) position the WITS University population within the higher end of global trends, suggesting comparatively lower levels of VH in this population (165). Comparisons to other universities, such as the University of KwaZulu-Natal (24.18% VH), the University of the Western Cape (16.1% VH) and another RSA university (10.5% VH), suggest that tertiary settings may foster lower COVID-19 VH compared to non-university populations (4,169,231). Muthoni et al. reported higher VH among young adults in Soweto (79.2% VH) (3). The VaxScene study found 41% VH among 18–34-year-olds, with greater VH observed among unemployed and low-income individuals (72). This disparity highlights the potential influence of education, institutional messaging, and policies like WITS's mandatory vaccination requirement in shaping attitudes and behaviour (172,232). However, the continued presence of VH, even within the university setting, reflects the broader challenge of addressing entrenched VH.

5.2 Reported Reasons for COVID-19 Vaccine Hesitancy among WITS Undergraduate Students

5.2.1 Cognitive and Emotional Reasons (Thinking & Feeling)

The majority of VH respondents cited cognitive and emotional barriers as their primary reasons for COVID-19 VH, aligning with the 'Thinking & Feeling' driver. 62.60% of respondents reported concerns about vaccine side effects as their reason for VH. Doubts about the speed and rigour of COVID-19 vaccine testing and development followed closely, with 52.85% of VH respondents expressing scepticism. Additionally, 35.77% lacked confidence in vaccine efficacy, while 32.52% believed vaccination was unnecessary for healthy individuals.

These safety concerns mirror patterns observed nationally and globally (185). In RSA, multiple studies have highlighted similar apprehensions, including fears surrounding the rapid development and approval of COVID-19 vaccines (4,52,78,79,145,165,169,59,60,62–64,67,72,75). Globally, concerns about side effects and vaccine approval processes have consistently ranked as the leading cause of COVID-19 VH among young adults, as evidenced in studies from the UK, Sub-Saharan Africa, and university populations

worldwide (177,185,233–235). Supplementary findings reinforce this trend, with 43.90% of VH respondents perceiving vaccines as unsafe compared to just 2.76% of VA respondents (see Appendix E). Similarly, 69.11% of VH respondents expressed concerns about serious side effects. Such concerns have been seen in other vaccination campaigns, such as RSA's HPV 2014 vaccination rollout (100,101,133,134). This suggests that safety-related VH is not unique to COVID-19 but reflects recurring public apprehensions – reactive VH - surrounding new vaccines (17).

Needle phobia and fears of short-term harm, while less prominent, also contributed to COVID-19 VH. A fear of needles was reported by 11.38% of VH respondents and 4.88% cited a fear of pain associated with vaccination. These concerns are consistent with research indicating that needle-related anxieties disproportionately affect younger populations (70,180,236). Studies by Myburgh et al. and Gittings et al. have highlighted how needle phobia negatively influences vaccination motivation among young adults in RSA (59,195). Addressing these fears through desensitisation or alternative vaccine delivery methods has been identified as an effective way to reduce these concerns (236).

Beliefs about personal health and natural immunity reflect the influence of low perceived personal disease risk. 32.52% of VH respondents believed their health protected them from COVID-19, while 9.76% viewed natural immunity as a sufficient substitute for vaccination (59). The misconception that healthy people do not require vaccination has been noted in other studies, usually among men, younger adults, and cultures with lower levels of collectivism (106,131,237). Such misperceptions reflect widespread misunderstandings of vaccine function, evident even among health students, like those at the University of KwaZulu-Natal, who were COVID-19 VA but showed limited understanding of how vaccines worked (174). Supplementary data further highlight this dynamic, with 56.91% of VH respondents doubting vaccination would protect others, compared to just 4.71% of VA respondents (see Appendix E). The belief in natural immunity as a substitute for vaccination aligns with public discourses during the pandemic, which framed natural infection as a viable alternative to vaccination (238–240). However, research consistently demonstrates that herd immunity cannot be achieved through natural infection alone (241). Such findings demonstrate the importance of health literacy regarding vaccination.

5.2.2 Social Processes Influencing VH (Social Processes)

Social factors and influences were also given as reasons for COVID-19 VH. These align with the "Social Processes" driver, highlighting how individual beliefs and broader social environments shape COVID-19 VH. Religious, cultural, and peer influences were evident in the responses. Supplementary results showed that 39.84% of VH respondents believed their religious leaders would not endorse vaccination, while only 5.21% of VA respondents held the same belief (see Appendix E). Similarly, 21.14% of VH respondents felt their close family and friends supported vaccination, contrasting sharply with the 69.40% of VA respondents.

These disparities support research that has highlighted the role of social networks in either reinforcing or undermining VA (21,71,104).

Social pressure and perceived coercion were also cited as reasons for COVID-19 VH. 7.32% of VH respondents reported feeling pressured or coerced into vaccination. This reflects social reactance theory, which posits that individuals resist perceived threats to personal autonomy (188–190). The introduction of WITS University's mandatory vaccination policy during the data collection period may have amplified these perceptions (232). Similar patterns have been observed internationally, where mandates have sometimes exacerbated VH rather than promoted uptake (148,173).

Conspiracy beliefs were also given as reasons for COVID-19 VH. 20.33% of VH respondents believed the vaccine was part of a population control initiative, 19.51% viewed it as profit-driven, and 18.70% saw it as a mechanism for controlling people. Supplementary results (see Appendix E) show 29.01% of VH respondents believed the negative information they had seen about the vaccine. These views reflect the interplay of social mistrust, misinformation, and VH, aligning with the 'Thinking & Feeling' and 'Social Processes' drivers (6,21). Research in RSA and globally shows how social media amplifies conspiracy narratives, particularly among younger populations (3,9,42,72,83,146,179,242). Larson et al. link conspiracy beliefs to distrust and perceived threats to personal freedom and suggest that trust-building interventions, which listen to and address concerns, can improve VA (21). Similarly, Giubilini argues that balancing public health priorities with respect for autonomy fosters VA (243). Supplementary data (see Appendix E) illustrates the depth of mistrust in this population, with 56.91% of VH respondents reporting no trust in the vaccines, compared to 4.71% of VA respondents. Similarly, 67.48% of VH respondents expressed distrust in the RSA government, and 33% reported a lack of trust in healthcare workers. This reflects research that finds VH is shaped not only by distrust of the vaccine itself but also by a broader distrust in authorities and institutions (21,104).

5.2.3 Practical Barriers to Vaccine Uptake (Practical Issues)

Practical barriers were less frequently cited as reasons for COVID-19 VH. Only 2.44% of VH respondents associated their hesitancy with potential financial or time costs, while 3.25% expressed concerns about repeated booster doses. Additionally, 9.01% of VH respondents reported difficulty accessing vaccination sites, compared to just 2.48% of VA respondents. These findings echo RSA and global research that identifies logistical challenges, transport barriers, and pandemic fatigue as impediments to vaccine uptake, particularly in under-resourced or rural areas (51,72,207,208,80,81,117–120,149,195). Although a smaller proportion of respondents cited these practical issues, their presence suggests that structural barriers can reinforce VH or diminish motivation for uptake.

Booster VH could reflect practical issues, such as the inconvenience and cost of repeated visits to vaccination sites and broader pandemic fatigue, where individuals seek a return to normalcy and disengage from extended health interventions. This aligns with the 'Thinking & Feeling' and 'Practical Issues' drivers, showing how logistical challenges intertwine with emotional and cognitive drivers. While practical barriers were not the primary reasons for VH in this study, they still interact with other drivers to shape hesitancy. A similar pattern was observed in the UK, where reduced booster uptake among young adults has been linked to low perceived vulnerability and disengagement from public health measures (244). Although practical issues were less pronounced in this study, the findings suggest they may reinforce VH among those with limited motivation for VA.

5.3 Socio-demographic and Health Factors Associated with COVID-19 Vaccine Hesitancy among WITS Undergraduate Students.

5.3.1 Age

Age emerged as a significant factor influencing COVID-19 VH. Bivariate analysis revealed that 28.96% of respondents aged 21–35 were VH, compared to 19.34% of those aged 18–20 ($p = 0.010$). Logistic regression indicated that respondents aged 21–35 had 1.7 times greater odds of being VH than those aged 18–20 (Model 1: OR = 1.7, $p = 0.025$, CI = 1.07–2.69). This association strengthened in the fully controlled model (Model 3), where the odds increased to 2.09 times (OR = 2.09, $p = 0.012$, CI = 1.17–3.72). Despite this trend, younger undergraduates (18–20 years) represented 47.97% of the total VH group, illustrating that while VH was more prevalent among older students, younger respondents still comprised a substantial proportion of VH respondents. These findings diverge from national and international research, where VH typically declines with age (62–64,72,149,165). However, this study aligns with findings by Muthoni et al., where VH was higher among young adults aged 25–35 in Soweto, relative to those aged 18–24 (3). Similarly, a study in the United States found students aged 27 and older were more likely to be VH compared to younger students (245). Interestingly, Modi et al.'s study of WITS staff and students found no association between age and COVID-19 VH (165). This difference may reflect variations in population composition, affecting autonomy, health decision-making, and social influences. Older undergraduates may make more independent health decisions, while younger peers are more influenced by parental guidance or peer norms. This divergence from Modi's earlier study at WITS suggests that temporal factors may have influenced the vaccine attitudes observed in this study.

5.3.2 Religion

In this study, religious affiliation was significantly associated with COVID-19 VH/VA ($p = 0.004$), with Christian respondents comprising the majority of both groups. Logistic regression revealed that non-religious affiliation was protective against VH (Model 1: OR = 0.32, $p = 0.035$, CI = 0.11–0.92), a finding that persisted in the fully controlled model (Model 3: OR = 0.25, $p = 0.034$, CI = 0.07–0.90). However, no

significant associations were found between specific religions and COVID-19 VH. This suggests that while being non-religious reduced the odds of VH, holding religious beliefs did not directly influence the likelihood of VH. Non-religious respondents may hold fewer vaccine-related concerns or be less influenced by faith-based narratives, but this does not imply that religious individuals are inherently VH. Supplementary results further illustrate this complexity. 30.89% of VH respondents believed their religious leaders did not endorse vaccination, compared to 5.21% of VA respondents (See Appendix E). Conversely, 45.66% of VA respondents believed their religious leaders supported vaccination. These findings highlight how religious influences intersect with social processes to shape vaccine attitudes.

Several studies link religiosity to VH (4,74,76,158,159). The NIDS-CRAM Wave 4 study found higher COVID-19 VH among non-religious individuals, Hindus, and African spiritualists compared to the Christian majority (52,60). However, other research shows that individuals who perceive vaccines as compatible with their faith are more likely to be VA (160,231,246). This dual influence underscores how religious beliefs can heighten or mitigate VH, depending on the alignment of vaccination with personal and communal faith narratives. The protective association observed among non-religious respondents in this study highlights how differing worldviews may shape VH and VA. The absence of significant associations between specific religious affiliations and VH in this study may reflect the university context, where students, regardless of religious background, engage with diverse perspectives that could moderate extreme views on vaccination. Nevertheless, the consistent protective effect observed among non-religious respondents across Model 1 and Model 3 suggests secular perspectives can contribute to VA and lower VH.

5.3.3 Location

Geographic location and residential setting were significantly associated with COVID-19 VH in this study. The bivariate analysis identified associations between VH/VA and family home location (urban, rural, peri-urban) ($p = 0.003$), term-time accommodation (on-campus, off-campus) ($p = 0.024$), and home province ($p = 0.005$). Logistic regression revealed that urban family homes (Model 1: OR = 0.54, $p = 0.030$, CI = 0.31–0.94) and on-campus residence (Model 1: OR = 0.36, $p = 0.002$, CI = 0.19–0.70) were protective against VH. In the fully controlled model, only on-campus accommodation remained significant (OR = 0.37, $p = 0.009$, CI = 0.17–0.78). Although home province was significantly associated with VH, it was excluded from the logistic regression due to small sample sizes across some provinces. Family home location and term-time accommodation were prioritised as they reflected respondents' living environments and access to vaccination services. The persistent protective effect of on-campus accommodation may be mediated by context-specific social influences and institutional policies, such as greater access to vaccination services, exposure to peer norms, and WITS University's mandatory vaccination policy (4,232). For instance, 74.94% of VA respondents believed their friends would vaccinate, likely reflecting the peer-driven vaccination norms on campus and reinforcing the role of immediate social networks in shaping vaccine attitudes.

Broader literature offers mixed findings regarding location and VH. Research in China identified higher VH rates in urban areas, while studies in the United States consistently reported greater hesitancy in rural populations (153,247,248). In RSA, Cooper's 2021 summary of COVID-19 VH research found greater VA among urban dwellers, while the mid-2021 UJ-HSRC Democracy Survey reported higher VH in urban areas (62,194). Rurality is frequently associated with lower vaccine uptake due to logistical barriers and limited healthcare access (149,249). However, findings from this study revealed no significant association between peri-urban or rural family homes and VH in Model 3. Similarly, residing in off-campus accommodation did not significantly alter the odds of VH. These results suggest that while geographic location may influence VH, the relationship between location and vaccine attitudes is more complex than a binary urban-rural distinction. This underscores the need to examine how broader social and structural factors intersect with residential contexts to shape VH.

5.3.4 Health-Related Factors

Health-related factors demonstrated significant associations with VH. Bivariate analysis revealed relationships between VH/VA and prior adult vaccination ($p = 0.001$), chronic illness ($p = 0.044$), and prior COVID-19 infection ($p = 0.047$). Logistic regression confirmed the protective effect of prior adult vaccination (Model 1: OR = 1.83, $p = 0.015$, CI = 1.13–2.98), while prior infection increased the odds of VH (Model 1: OR = 0.59, $p = 0.027$, CI = 0.37–0.94). Neither retained significance in the fully controlled model. Chronic illness was not significantly associated with VH in the logistic regression.

The lack of a significant association between chronic illness and VH contrasts with existing literature, which links heightened vulnerability from chronic conditions to increased VA (73,79). This divergence may stem from the younger, healthier student demographic, where lower chronic illness prevalence may reduce the perceived risk of severe disease and its influence on vaccine decisions. The protective role of prior vaccination aligns with broader research, which indicates greater VA among individuals with established vaccination histories (70,72,74). This may reflect greater trust in healthcare systems, familiarity with vaccination processes, and lower susceptibility to misinformation— all established factors that contribute to VA. These findings reinforce the importance of vaccination health literacy. As prior engagement with vaccination is a predictor of VA, this suggests the potential for targeted outreach to individuals with limited vaccination histories to mitigate VH in future adult vaccination campaigns.

Prior COVID-19 infection possibly reflects a perception of natural immunity as sufficient protection against COVID-19, reducing motivation for vaccination (71,72,238–240). Supplementary supports this: 56.91% of VH respondents believed vaccination would not protect others, compared to just 4.71% of VA respondents (see Appendix E). This gap suggests limited awareness of or belief in the collective benefits of vaccination,

highlighting the influence of personal health experiences on vaccine decision-making. Additionally, research shows experiences of mild illness may reduce COVID-19 risk perceptions, further diminishing the motivation for vaccination (74,81). These findings highlight the importance of addressing misconceptions around natural immunity and reinforcing the protective benefits of vaccination, even for those with previous COVID-19 exposure or good health.

5.3.5 University Policies and COVID-19 Vaccination Beliefs

Beliefs surrounding university vaccination policies and lecture attendance were significantly associated with COVID-19 VH/VA. The bivariate analysis found associations between the binary catergorical variable of COVID-19 VH/VA and opposition to mandatory vaccination for staff and students ($p < 0.001$), permitting unvaccinated individuals to attend lectures ($p < 0.001$), and feeling safe attending lectures with unvaccinated peers ($p < 0.001$). Among VH respondents, 95.93% opposed mandatory vaccination, compared to 25.12% of VA respondents. Additionally, 92.62% of VH respondents supported allowing unvaccinated individuals to attend lectures, and 92.68% reported feeling safe attending in-person classes alongside unvaccinated peers. In contrast, 40.30% of VA respondents supported unvaccinated attendance, while only 33.08% felt safe in these environments. The relationship between these factors and COVID-19 VH was not explored in the binary logistic regression as they were context-specific and not part of the BeSD.

These findings suggest that VH respondents prioritise personal autonomy and perceive a lower infection risk, contributing to greater acceptance of unvaccinated peers in shared spaces. Opposition to mandates and policies among VH respondents likely reflects scepticism toward the vaccine, reinforcing perceptions that its risks outweigh its benefits. This aligns with Eyal et al., who found that many unvaccinated South Africans opposed mandates due to concerns about personal freedom (173). Similarly, Watermeyer et al. found mandates can deepen mistrust in government institutions, particularly among young adults (83). Internationally, Lin et al. observed that mandates often exacerbate resistance rather than encourage uptake, a pattern reflected in this study, where 7.32% of VH respondents cited coercion or social pressure as contributing to their VH (148). These findings evidence the complex relationship between institutional policies, autonomy, and VH. While mandates and policies can drive compliance, they may simultaneously provoke VH through social reactance especially in populations already distrusting of vaccination efforts, authorities, or vaccines themselves.

5.4 Operationalising and Testing the BeSD of COVID-19 Vaccination

This section addresses Objective 4, which examines whether the BeSD framework's proposed drivers—'Thinking & Feeling,' 'Social Processes,' 'Motivation,' and 'Practical Issues'—function as discrete constructs predictive of SARS-CoV-2 VH among WITS University undergraduate students. Specifically, the results of

operationalising the BeSD drivers using EFA and binary logistic regression models to evaluate their predictive validity are discussed. The findings reveal that these drivers do not operate as discrete sequential constructs but converge into four latent constructs. These constructs demonstrate a dynamic interplay of cognitive, emotional, motivational, and social factors influencing vaccine-related behaviours and challenge the theoretical compartmentalisation of the BeSD model. They also emphasise the role of 'Thinking & Feeling' as a foundational driver in vaccination behaviour. These findings suggest there may be an underlying structure at play within the BeSD which mediates the operation of the BeSD drivers, their relationships, and their influence on VH in the study population.

5.4.1 Disrupting the BeSD of COVID-19 Vaccination Drivers – Evidence from Latent Factors

This section explores the four latent constructs that emerged through the EFA: 'COVID-19 Vaccine Confidence,' 'COVID-19 Infection Concerns,' 'Social Norms,' and 'Negative Information about Vaccines.' These constructs cut across or divided the BeSD drivers, revealing a more dynamic interplay of cognitive, emotional, motivational, and social processes than the framework's current structure suggests. The findings indicate that the BeSD drivers do not operate as discrete constructs but instead converge into these latent constructs, challenging the theoretical compartmentalisation of the model. While this disruption does not undermine the utility of the BeSD framework, it highlights the complexities of vaccine decision-making in specific contexts and raises questions about how the framework could be applied or refined.

COVID-19 Vaccine Confidence

'COVID-19 Vaccine Confidence' had the strongest protective effect against COVID-19 VH compared to other constructs and socio-demographic factors (Model 2: OR=0.014, P=0.00, CI=0.003–0.057; Model 3: OR=0.01, P<0.001, CI=0.003–0.06). This construct integrated elements from multiple BeSD drivers—'Thinking & Feeling,' 'Social Processes,' and 'Motivation'—demonstrating how vaccine confidence is shaped by both internal evaluations (perceived safety and efficacy) and external reinforcements (trust in healthcare systems and authorities). Key components of this construct, such as belief in vaccine efficacy and safety, trust in healthcare professionals and government, and personal intention for uptake, illustrate how these factors interact to drive vaccination motivation. The inclusion of 'willingness to recommend the vaccine to others' within this construct extends individual confidence in the vaccine beyond the self. It reflects that VA individuals hold confidence in the vaccine's societal value and safety—specifically, that the vaccine reduces harm rather than causes it.

These findings of this study align with previous research linking vaccine confidence to cognitive and emotional evaluations of safety and efficacy, strengthened by trust in institutions and healthcare systems (21,22).In this context, confidence refers to an individual's assessment of vaccine benefits based on its

perceived safety, efficacy, and reliability. Trust, as part of confidence, requires reliance on the intentions and integrity of external actors—such as healthcare providers, institutions, or governments—when making vaccine-related decisions. Trust, therefore, involves a degree of vulnerability and risk-taking, as faith is placed in the recommendations of individuals, systems, or institutions external to the self. Research shows that trust plays a critical role in public health efforts to promote vaccine uptake (21). This also mirrors the 'Confidence' construct in the 3C and 5C Models, where these factors are foundational to VA (106). Furthermore, this aligns with Larson's "trust chain", which proposes that individual trust in vaccines is shaped by trust in healthcare systems, institutions, and broader socio-political environments (21,198).

The blending of three BeSD drivers within this construct challenges the assumption that these drivers function as distinct but interrelated entities. Instead, the findings suggest that 'Vaccine Confidence' may act as an integrative mechanism, incorporating elements from the 'Thinking & Feeling,' 'Social Processes,' and 'Motivation' drivers of the BeSD. Functionally, within this construct, cognitive certainty, social assurance, and trust in vaccines and the institutions delivering them appear to work together to reduce VH, thereby strengthening motivation for vaccine uptake. This highlights the interdependence of cognitive, emotional, and social factors in shaping vaccine-related behaviours, further emphasising the complexity and importance of 'Vaccine Confidence' as a determinant of VA.

COVID-19 Infection Concerns

The 'COVID-19 Infection Concerns' construct captures cognitive and emotional responses to perceived risks of infection and transmission. Comprised of two items from the 'Thinking & Feeling' driver, its emergence potentially reflects the heightened salience of risk perceptions during the pandemic, where concerns about personal vulnerability and the potential to harm others were central themes in public discourse. This construct's protective association with COVID-19 VH underscores the importance of perceived risk—both to oneself and to others—in reducing VH (Model 2: OR=0.36, P=0.00, CI=0.21–0.61; Model 3: OR=0.40, P=0.002, CI=0.22–0.72).

Beyond individual concerns about personal health, this construct also reflects an awareness of broader social consequences. The blending of personal risk perception with altruistic considerations—such as the potential to reduce the spread of COVID-19—suggests that risk perceptions are not evaluated in isolation but are contextualised within a broader social framework. This finding aligns with constructs from the 5C Model, particularly 'Calculation', which describes how individuals weigh vaccine risks and benefits, and 'Collective Responsibility,' which captures the sense of social obligation to vaccinate to protect others (106). However, the influence of these concerns on VH likely depends on confidence in the vaccine's ability to mitigate perceived risks. This suggests an interaction between 'COVID-19 Infection Concerns' and

‘COVID-19 Vaccine Confidence’, where trust in the vaccine safety and efficacy – reflected as low vaccine risk perceptions - may strengthen the role of disease risk perceptions in motivating uptake.

The emergence of this construct suggests that risk perception is an essential element of the ‘Thinking & Feeling’ driver and that it may play an important role in vaccine decision-making, particularly during times of heightened uncertainty and public health urgency. By recognising the interplay of personal and social dimensions of perceived risk, as well the role of vaccine confidence in reinforcing these perceptions, this construct reinforces the significance of ‘Thinking & Feeling’ in vaccine decision-making. While disease risk perceptions and concern for others act together within the ‘Infection Concerns’ construct to protect against VH, their influence may be amplified when supported by high levels of ‘Vaccine Confidence’.

Social Norms

The ‘Social Norms’ construct highlights the influence of peer and familial attitudes on vaccination decisions, capturing the relational social dynamics that shape vaccination behaviour. Emerging from two of the ‘Social Processes’ driver items, this construct was consistently protective against SARS-CoV2 VH (Model 2: OR=0.28, P=0.00, CI=0.15–0.51; Model 3: OR=0.29, P<0.001, CI=0.15–0.56). It evidences the role of immediate social networks in influencing vaccination behaviours, likely due to conformity, social expectations, and shared values. ‘Social Norms’ emphasises the role of external relational dynamics on vaccination behaviour. As it is the only construct comprised of only 'Social Process' items, this suggests 'Social Norms' may be a key 'Social Process' influence on vaccination behaviour and attitudes in this study population.

Research indicates that peer opinions and norms strongly influence younger adults (8,59). The university setting in this study potentially amplified the protective role of ‘Social Norms’, with visible institutional and peer support for vaccination likely reinforcing pro-vaccine attitudes. This finding contrasts with Potgieter’s research, where social norms were found to reinforce VH among students (169). However, the lack of a specific measure for perceived institutional norms limits insights into how broader structural factors, such as institutional norms, trust, and confidence, shaped vaccine behaviours in this study population. This highlights a potential area for future research.

The protective nature of this construct suggests that familial and peer networks that are pro-vaccination are protective against VH. This finding aligns with broader research, including the VaxScene study, which found that visible pro-vaccination community norms strongly influence individual vaccination decisions and trust in public health guidance (72). WHO guidance also underscores the importance of leveraging community norms and messaging to promote VA (52,204).

Finally, while the 'Social Norms' construct does not explicitly capture social trust, broader research suggests that trust in peers, family, and community may shape how norms influence individual vaccination behaviour (21,71,83). While conformity can operate independently of trust to shape vaccination attitudes and behaviours, shared expectations within trusted networks could potentially enhance the impact of pro-vaccine norms. Future research could explore whether and how social trust interacts with conformity and social desirability to shape vaccine behaviours among young adults.

Negative Information About Vaccines

'Negative Information about Vaccines,' captures exposure to misinformation and negative information about COVID-19 vaccination. Research shows that misinformation is a critical challenge in addressing VH (3,20,71,141,179,250). However, although over 80% of respondents reported exposure to such information and 26.85% of those exposed to negative information about the COVID-19 vaccine stated they believed what they had seen, the construct was not significantly associated with COVID-19 VH (Model 2: OR=1.42, P=0.23, CI=0.797–2.53) and was excluded from Model 3. This lack of significance suggests that factors typically associated with susceptibility to misinformation —such as low baseline confidence in vaccines, distrust in institutions or authorities, or low pro-vaccine social norms—were not strongly present in this population (3,102,179). This interpretation aligns with broader research indicating that misinformation tends to influence individuals with these vulnerabilities.

This finding may also reflect the mitigating influence of the university context. Research has linked higher educational attainment with reduced COVID-19 VH, potentially due to greater health literacy, critical thinking skills, and trust in scientific and institutional guidance (24,43,45,103,146,147). These findings suggest that misinformation alone does not necessarily drive VH but interacts with individual cognitive and emotional appraisals, social dynamics, and contextual factors. Addressing the effects of misinformation may require a broader focus on enhancing critical thinking, health literacy, social trust, and pro-vaccination reinforcement, particularly in populations with lower education levels or heightened distrust (20,21). Future refinements of the BeSD could consider how misinformation interacts with internal appraisals ('Thinking & Feeling') and contextual factors like education level or trust in institutions to influence VA or VH.

5.4.2 Implications for the BeSD of Vaccination

The findings from this study challenge the BeSD framework's conceptualisation of its drivers as discrete constructs, suggesting instead a dynamic and context-dependent interplay. The latent constructs—'*COVID-19* Vaccine Confidence,' '*COVID-19* Infection Concerns,' 'Social Norms,' and 'Negative Information about Vaccines'—highlight overlapping influences across cognitive, emotional, motivational, and social domains. These results raise important questions about the flexibility of the BeSD framework and its ability to

capture the complex dynamics of vaccine decision-making across diverse contexts. This section explores the centrality of 'Thinking & Feeling,' the role of contextual and demographic factors, and potential refinements to the BeSD model.

Interplay Between the BeSD Drivers and the Latent Constructs

The findings reveal that the BeSD drivers—'Thinking & Feeling,' 'Social Processes,' 'Motivation,' and 'Practical Issues'—do not operate as discrete constructs but interact dynamically within and across the latent constructs. These findings align with the WHO's emphasis on the flexibility and adaptability of the BeSD framework but also raise questions about whether its conceptual structure adequately accounts for these dynamic interactions. The results suggest the presence of an underlying structure, not explicitly detailed in the BeSD framework, that influences vaccination behaviour in the study population.

The dominance of 'Thinking & Feeling' across three of the four latent constructs ('COVID-19 Vaccine Confidence,' 'COVID-19 Infection Concerns,' and 'Negative Information about Vaccines') suggests its foundational role in shaping vaccine-related behaviours within the study population. This prominence highlights the importance of cognitive and emotional appraisals in influencing individual evaluations of vaccines and broader perceptions of risk, aligning with the 3C and 5C models, which similarly emphasise these appraisals as the key psychological antecedents of vaccination uptake (3,103).

However, the inclusion of 'Negative Information about Vaccination' items within this driver raises questions about their conceptual alignment. These items measure exposure to misinformation rather than internal cognitive or emotional responses. Reframing these items to focus on how individuals process or interpret negative information—or repositioning them under 'Practical Issues' to reflect barriers related to information dissemination—could potentially improve the framework's conceptual clarity. The prominence of 'Thinking & Feeling' in this study may also reflect the study population's higher education and potentially heightened health literacy, critical thinking skills, and trust in science. Future research could examine whether this driver's prominence extends to other contexts or is moderated by factors such as education, access to information, and socio-political dynamics. If 'Thinking & Feeling' remains dominant in other settings, it may warrant reconsidering its weight relative to other drivers, particularly 'Social Processes,' within the BeSD model.

The integration of 'Motivation' items alongside 'Thinking & Feeling' and 'Social Processes' items within the 'COVID-19 Vaccine Confidence' construct offers two potential interpretations. First, it may support the BeSD framework's conceptualisation of 'Motivation' as an outcome of the interplay between 'Thinking & Feeling' and 'Social Processes.' Alternatively, the findings may suggest that 'Motivation' is not merely an outcome but is embedded within a broader domain of confidence, forming an integrated construct that drives vaccine-related behaviours through converging cognitive, emotional, and social influences.

Social Process items appeared in two of the latent constructs – ‘COVID-19 Vaccine Confidence’ and ‘Social Norms’. The limited representation of ‘Social Processes’ items across the latent constructs suggests that its influence may vary across contexts and populations. In this study, peer and familial norms emerged as the only standalone ‘Social Norms’ construct, indicating that relational dynamics can exert an independent influence on COVID-19 VH. This suggests direct interpersonal relationships were a primary social influence on vaccine decision-making in this study. Trust-related ‘Social Processes’ items – trust in the government and healthcare providers - were embedded within ‘COVID-19 Vaccine Confidence,’ interacting with ‘Thinking & Feeling’ and ‘Motivation’ to reflect their integration into broader cognitive and motivational dynamics. The division of ‘Social Process’ items across the two constructs suggests two possible interpretations regarding the role of ‘Social Processes’ in the BeSD framework. First, the conceptual placement of trust-related items within the BeSD framework warrants reconsideration, as these items may align more closely with ‘Thinking & Feeling’ rather than ‘Social Processes.’ Alternatively, these findings could suggest that ‘Social Processes’ is a multifaceted driver whose role may shift between acting as an independent influence, as seen with ‘Social Norms,’ and as a complementary factor, as evidenced by its integration into ‘COVID-19 Vaccine Confidence.’ This variability underscores the importance of considering contextual and relational factors when applying the BeSD framework.

Three BeSD trust items, drawn from the ‘Thinking & Feeling’ and ‘Social Processes’ drivers, are found in ‘COVID-19 Vaccine Confidence.’ This construct contains items from ‘Thinking & Feeling’, ‘Social Processes’, and ‘Motivation’ suggesting trust may play a role in the interaction of these drivers in supporting vaccine confidence. This aligns with Larsen’s emphasis on trust as fundamental to VA (21,198). While this may be a theoretical overreach, considering the other constructs alongside Larson’s ‘trust chain’ raises questions about whether trust influences vaccine decision-making beyond the dimensions captured in this study or in the BeSD model itself.

Within the BeSD model, the 'Practical Issues' driver follows the 'Motivation' driver, representing the final step in determining whether vaccination intention translates into vaccine uptake (6). The absence of 'Practical Issues' items in the latent constructs indicates that this driver was not a significant influence on vaccination behaviour within the study population. This likely reflects the high accessibility of vaccines in the urban university setting of WITS University, where logistical barriers were minimal and pro-vaccination policies were strongly reinforced. These factors may have reduced the relevance of this driver in influencing COVID-19 vaccination behaviours and attitudes. These findings suggest that the salience of 'Practical Issues' is context-dependent, potentially becoming more pronounced in settings where vaccine availability and access are limited, or logistical challenges hinder uptake.

5.5 Limitations of this Research

This study has several limitations. Recruitment relied on the university email Listserv, which may have excluded students who were less engaged with their email accounts. Although data collection extended into the first two months of the year with reminders sent, the inherent nature of online surveys, which often yield lower response rates, may have affected the sample's representativeness. As a cross-sectional study, the research provides a snapshot of COVID-19 VH at a single point-in-time, limiting the ability to assess changes over time. The use of self-administered questionnaires introduces the potential for response bias, including social desirability bias, where participants may have overstated VA or understated VH. While the findings offer insights into COVID-19 VH in young adults within an urban tertiary education setting, they may not be generalisable to individuals outside these parameters. The study focused primarily on individual and social factors associated with COVID-19 VH; limited attention was given to broader structural or policy-level influences.

5.6 Chapter Conclusion

This chapter examined the study's findings in relation to the research objectives, contextualised within existing literature and the BeSD framework. The findings reveal a decline in COVID-19 VH among WITS undergraduate students following vaccine availability, aligning with national and global trends. However, the persistence of VH in a notable minority highlights the complexity of achieving comprehensive VA. While access plays a role in increasing uptake, the continued presence of VH suggests the need for targeted interventions addressing specific concerns. Research suggests that leveraging peer networks and trusted messengers may be particularly effective in mitigating VH among young adults (71).

The analysis of reasons given by COVID-19 VH respondents demonstrated that safety concerns and risk perceptions were the most influential factors, suggesting that for many, hesitancy was driven more by fears about vaccine risks than by conspiracy theories or belief systems. Additionally, misunderstandings about immune system functioning and health contributed to lower perceived disease risk, reinforcing VH. Socio-demographic and health-related factors also played a role, with variations observed based on age, religious belief, geographic location, and prior vaccination history. These findings reinforce that VH is not a uniform phenomenon but one shaped by individual characteristics and broader contextual influences. Given the interplay of cognitive, social, and logistical factors in shaping COVID-19 VH, multifaceted interventions are needed—not only to address psychological, social, demographic, and structural influences but also to improve health literacy and counter knowledge barriers.

The study's operationalisation of the BeSD framework challenged the compartmentalisation of its drivers, demonstrating that they do not function as discrete sequential constructs but interact in ways not explicitly outlined in the model. The emergence of latent constructs— 'COVID-19 Vaccine Confidence,' 'COVID-19

Infection Concerns,' 'Social Norms,' and 'Negative Information about Vaccines'—suggests an underlying structure that mediates their influence on VH and VA. 'Thinking & Feeling' emerged as a central driver, demonstrating the significant role of cognitive and emotional appraisals in shaping vaccine-related decisions. The varied influence of other drivers, such as the apparent context-dependent role of 'Social Processes' and the limited relevance of 'Practical Issues' in this study population, reflects the importance of socio-demographic and contextual factors in shaping the operationalisation of the BeSD framework. These insights suggest it is important to recognise the interplay between drivers and their sensitivity to contextual influences when applying the BeSD framework.

While these findings provide valuable insights into COVID-19 VH in this context, the limitations of the study should be considered when interpreting them. Nevertheless, the study enhances understanding of the complex cognitive, social, and structural influences on vaccine decision-making among young adults in a tertiary education setting.

CHAPTER 6: CONCLUSION

This chapter summarises the key findings of the study, emphasising their implications for addressing COVID-19 VH and informing future vaccination campaigns targeting young adults, particularly those in tertiary education settings. By synthesising the results, this chapter highlights how the knowledge generated by the study can contribute to understanding COVID-19 VH within this demographic and potentially inform broader efforts to address VH among young adults and undergraduate students. The chapter also considers opportunities for further research, reflecting on the gaps and questions raised by this study and suggesting areas for future exploration.

6.1 Summary of Findings

The study explored the prevalence and factors associated with COVID-19 VH among WITS undergraduate students. Through its four objectives, the research sought to identify the proportion of students who were COVID-19 VH, establish the reported reasons for COVID-19 VH, analyse the socio-demographic and health-related factors associated with COVID-19 VH, and evaluate the applicability and operationalisation of the BeSD in the study population. The results indicated that 23.38% of respondents were COVID-19 VH while 76.62% were COVID-19 VA at the time of data collection – December 2021 – February 2022. Key findings revealed significant associations between COVID-19 VH and factors such as age, religious affiliation, family home and term-time residence, prior vaccination history, and opposition to university COVID-19 policies. Being an older undergraduate student (aged 21–35) and prior infection with COVID-19 were predictive of VH. Conversely, non-religious affiliation, on-campus residence term-time residence, urban family residence, prior adulthood vaccination history, and having a chronic illness were protective against VH. These findings highlight the nuanced ways in which demographic and contextual factors influence vaccine decision-making among the study population.

The study also found that the BeSD framework's drivers did not operate as discrete sequential constructs in the study population. Instead, EFA revealed four latent constructs that captured the underlying dynamics of vaccine-related behaviours among WITS undergraduates. These were ‘COVID-19 Vaccine Confidence,’ ‘COVID-19 Infection Concerns,’ ‘Social Norms,’ and ‘Negative Information about Vaccines.’ These constructs revealed the interdependence of cognitive, emotional, motivational, and social factors in vaccine decision making. Their configuration suggests an underlying dynamic or structure to the BeSD that is not explicitly evident in its model. ‘Thinking & Feeling’ emerged as a central influence across three of the four constructs. The latent construct ‘COVID-19 Vaccine Confidence’ integrated elements from ‘Thinking & Feeling’, ‘Social Processes’, and ‘Motivation’. It captured how cognitive and emotional appraisals of the vaccine interact with trust in healthcare professionals and institutions, influencing vaccination motivation. The presence of ‘Social Norms’ as a distinct construct underscores the role of peer and familial influences in shaping vaccine attitudes.

In this study population, contextual factors—such as high vaccine accessibility and institutional pro-vaccination norms—likely reduced the relevance of 'Practical Issues' in vaccine decision-making. The lack of influence of 'Negative Information About Vaccines' indicates that while misinformation and disinformation were present, they did not significantly shape vaccine behaviours in this population. This suggests that contextual factors—such as high vaccine literacy, institutional policies, and strong 'Social Norms'—may have mitigated their impact. These findings emphasize the cognitive, emotional, and social dimensions of vaccination decision-making among young adults, particularly within a tertiary institution setting.

6.2 Contributions

This study contributes to the understanding of COVID-19 VH by offering a detailed examination of its prevalence, drivers, and socio-demographic influences among young adult undergraduate students in a tertiary education setting. In addition to identifying specific factors predictive of or protective against COVID-19 VH, the study highlights how certain individual, social, and contextual factors intersect to shape vaccine decision-making within this demographic. These insights may assist in advancing the understanding of VH among young adults and tailoring vaccine uptake strategies in similar settings or populations.

This study also offers insights into the operationalisation of the 'BeSD framework' within a specific population, contributing to its ongoing evaluation and refinement. The finding that 'BeSD' drivers did not operate as discrete constructs but instead revealed an underlying structure, as indicated by the emergence of latent constructs, underscores the adaptability of the framework to different contexts. By identifying these latent constructs, the study illustrates how inferential statistical analysis of the 'BeSD framework' can uncover the unique dynamics of vaccine behaviours within specific populations. This suggests that vaccine-related behaviours may be shaped by an underlying structure within the BeSD rather than the isolated influence of each 'BeSD' driver. This highlights the need for further research to explore the BeSD's theoretical structure and application across diverse settings.

Furthermore, this research adds to the relatively limited body of literature on vaccine attitudes and hesitancy among young adults, particularly undergraduate university students, a demographic under-researched in RSA before the COVID-19 pandemic. By identifying the protective role of on-campus residence and highlighting the influence of institutional policies, the study's findings suggest tertiary environments could be strategic focal points for vaccination campaigns targeting young adults. These insights provide a basis for informing strategies not only for COVID-19 vaccination efforts, should they reoccur, but also for broader public health initiatives aimed at improving vaccine uptake or addressing other health initiatives or behaviours within this demographic.

The study provides practical insights that may be beneficial for designing effective vaccination campaigns, particularly those targeting young adults in tertiary education settings. The findings emphasise the importance of supporting 'vaccine confidence' by addressing cognitive and emotional concerns about vaccine safety, efficacy, and perceived risk. The protective role of 'Social Norms' highlights the value of leveraging social norms and peer networks to promote VA, particularly among university undergraduates. Furthermore, the study's observation that misinformation exposure was not a significant driver of COVID-19 VH in this population suggests that the impact of misinformation may vary by demographic and contextual factors. This underlines the necessity of tailoring interventions to address the specific needs and characteristics of different groups rather than assuming what factors drive VH.

Additionally, this study contributes to understanding how the relevance of 'Practical Issues' varies across different settings. Within this study population, 'Practical Issues' did not significantly influence vaccination behaviour, suggesting that the high vaccine accessibility and pro-vaccination institutional norms associated with an urban tertiary setting may have minimised their influence. This highlights the importance of context in determining the role of 'Practical Issues' in vaccine decision-making. While logistical barriers can hinder uptake in some populations, in contexts where vaccines are readily accessible and institutional policies strongly promote vaccination, other factors—such as 'COVID-19 Vaccine Confidence' and 'Social Norms'—may play a more dominant role. By demonstrating that 'Practical Issues' were not a major driver of VH in this study population, this research adds to the evidence base on how contextual factors shape the influence of BeSD drivers, contributing to a more nuanced understanding of vaccine decision-making in different settings.

6.3 Recommendations

Although COVID-19 vaccination campaigns have ceased in RSA, the findings of this study offer insights that can inform future vaccination campaign strategies for other VPDs and strengthen preparedness for other emerging public health challenges. This section provides recommendations that focus on advancing research into VH and the BeSD. While it is beyond the scope of this study's findings to inform policy or actions, the findings do suggest that health literacy, demographic sensitivity, social norms, and the development of institutional trust could be operationalised by university administrators, policymakers, and health communicators to support VA.

6.3.1 Recommendations for Future Research

The study highlights the need for further research on and development of the BeSD framework. Future research should investigate the framework's applicability and underlying structure, including the interactions between the four BeSD drivers. The findings of this research suggest that attention should be

paid to whether the ‘Thinking & Feeling’ driver operates as a dominant influence in other contexts or whether its role is contingent on population-specific factors.

The emergence of latent constructs in this research suggests the presence of a dynamic or underlying structure that is not explicitly captured in the BeSD’s theoretical model. Future research should assess whether these constructs are specific to the WITS University context or generalisable to other populations. Comparative studies in similar tertiary institutions, among non-university-attending young adults, and in rural or peri-urban settings could help determine whether the constructs identified here reflect broader trends or are unique to this study’s institutional and social contexts. Through the identification of these latent constructs, this study demonstrates how inferential statistical analysis of the BeSD framework can uncover the unique dynamics of vaccine behaviours within specific populations. Future research using this approach could contribute to refining the BeSD and developing its theoretical robustness and practical utility.

Larsen asserts that trust is a key factor in vaccination decision-making (21,198). Within the BeSD framework, trust-related items are located across the ‘Thinking & Feeling’ and ‘Social Processes’ drivers. In this study, EFA revealed that BeSD trust-related items loaded onto a single latent construct, ‘COVID-19 Vaccine Confidence.’ However, it is logically plausible that different aspects of trust influence each of the latent constructs and their relationship to vaccination behaviour. Given Larsen’s assertions about trust and her concept of a ‘trust chain’ influencing vaccination behaviour, it may be interesting to examine trust in relation to the BeSD framework. Understanding how trust operates within the BeSD and influences vaccine decision-making processes could contribute to developing more effective interventions tailored to the socio-demographic and contextual diversity of different populations.

While trust did not emerge as an independent construct in this study, its presence through three BeSD items within COVID-19 Vaccine Confidence—a construct comprising items drawn from three BeSD drivers—suggests it may influence vaccine decision-making beyond the dimensions captured in this study. Given Larsen’s emphasis on the foundational role of trust in VA and her concept of a 'trust chain' influencing vaccination behaviour, further research could explore whether trust primarily functions within Thinking & Feeling, serves as a distinct driver, or operates as a broader mediating influence across the BeSD drivers. Investigating this in different contexts could clarify the extent to which trust mediates cognitive, social, and motivational influences on vaccine confidence and uptake.

Further research should consider how contextual and demographic factors associated with VH interact. The findings of this study raise questions about the relationship between age and VH, as older undergraduate students (aged 21–35) were more likely to be VH, contrary to broader research, which typically indicates

that VH declines with age. Future studies could investigate whether this pattern is specific to university contexts or represents a broader trend among young adults. Similarly, the predictive link between previous COVID-19 infection and VH identified in this research encourages further investigation. Additional research could examine whether this reflects perceptions of natural immunity, reduced risk perceptions, or other psychological or contextual factors. Examining these associations across different VPDs could provide valuable insights into how prior infection influences vaccine behaviour and inform counselling strategies for individuals with prior VPD infections about future vaccinations.

Longitudinal studies that track vaccine attitudes, confidence, and literacy over time are also essential for understanding how these factors evolve during periods of health stability and crisis. Such research would provide critical insight into how demographic, cognitive, and structural factors shape VH trajectories over time. This would help to refine public health interventions and enhance pandemic preparedness. By identifying trends and shifts in vaccine-related behaviours, longitudinal VH research would contribute to a more robust and evidence-based response to future health challenges.

6.3.2 Practical Recommendations

The WHO's recognition of VH as a global health threat before the COVID-19 pandemic highlights the importance of sustained efforts to address cognitive and emotional concerns about vaccine safety and efficacy, build vaccine confidence, and reinforce pro-vaccine social norms. These efforts should aim to support informed decision-making while providing emotional reassurance, reducing the risk of baseline VH growing, and equipping populations to respond more effectively to future pandemics or outbreaks of VPDs. The findings of this study align with these broader concerns. This section tentatively suggests several ways in which public health systems and institutional actors might apply these findings in practice.

First, vaccine literacy, and health literacy more broadly, must be understood as an ongoing investment in population health by policymakers, university administrators, and public health communicators. These actors should prioritise proactive health literacy initiatives during periods of health stability to normalise preventative health behaviours and foster confidence in public health systems. These initiatives should be developed with and embedded in everyday institutional and community settings, such as universities, workplaces, healthcare facilities, and places of worship or recreation. They should be developed with input from the communities they aim to reach. They should aim to contribute to population-level understanding and uptake of routine preventative healthcare. Consistent health messaging on vaccine safety and efficacy, delivered during periods of health stability may help counteract misinformation. This could reduce reactive VH during the introduction of new vaccines or a future health crisis. University administrators should collaborate with public health communicators to develop preventative health messaging campaigns that support the health knowledge and behaviours of their student population.

Second, the findings indicate that demographic and health characteristics can shape vaccine decision-making. This suggests that real-time data should inform health communication and health interventions on population sub-groups. Government, public health communicators, and institutional administrators, including university administrators, should support systems that routinely monitor health literacy, behaviours, and attitudes across different segments of a given population. Public health communicators should utilise such data to ensure that their behaviourally informed communication strategies are demographically sensitive and context-specific, with platforms and content tailored to the specific concerns or motivations that research has identified. Such an approach is likely to be more effective than uniform messaging across a population.

Third, this research found that exposure to pro-vaccination social norms was protective against COVID-19 VH. Efforts to strengthen preventative health behaviours should focus on building these norms within institutions, such as universities, and across the population more generally. This requires identifying who holds influence and credibility across different demographic and social groups. In universities this could mean identifying respected student leaders within the university or approaching respected actors from outside the university. On campuses, administrators and health promotion teams could support peer-led initiatives, integrate health messaging into orientation programmes and campus communication systems, and implement campus-wide strategies that encourage preventative health behaviours. Furthermore, they could ensure that basic primary preventative care is accessible to all students by ensuring campus health facilities are stocked, staffed, and functional. Beyond institutional settings, public health authorities could collaborate with faith-based and community leaders to embed positive health behaviours within local values. Policymakers could support this work by investing in peer- and community-led health promotion structures.

An example of how social norms could be used to normalise vaccination is through the integration of routine vaccination into adult healthcare. This study found that adults with no previous adulthood vaccinations had higher odds of COVID-19 VH. This suggests that integrating routine adult vaccinations into accessible healthcare may help normalise the behaviour and reduce baseline VH. For instance, the government could support the provision of free annual influenza vaccines at clinics, campuses, transport hubs, and shopping centres, paired with tailored messaging and local influencers. Such efforts could help make vaccination more familiar, convenient, and socially embedded, and this could foster a population more responsive to vaccination if mass vaccination is ever required in the future.

Fourth, the findings of this and other research evidence the foundational role of trust in shaping health behaviours. Trust in public institutions cannot be assumed; it must be earned and sustained. This includes

building a health system that is responsive, credible, and trustworthy, and a government that is transparent, consultative, and consistent in delivering the basic services to which people are constitutionally entitled. For people to trust vaccines, they must trust the health system. To trust the health system, they must also trust the government. Policymakers and public health leaders should prioritise clear, responsive communication and decentralised functioning health services that engage with their communities respectfully and meaningfully. Additionally, policymakers, institutional administrators, and health communicators should avoid top-down directives, acknowledge uncertainty, and invole affected groups in decision-making processes as this may help to build the kind of institutional trust that supports public cooperation and collective action in future health emergencies.

Finally, universities should recognise and take responsibility for the influential role they can play in shaping health behaviours of their student body, beyond vaccination. The study's findings indicate that the campus environment itself matters - students living on campus were less likely to be VH, while supportive peer norms encouraged VA. This suggests that universities could be a strategic setting for health promotion, as exposure to the campus environment itself can encourage positive health decisions. University administrators should remain cognisant of this and build on these advantages by ensuring basic health literacy and health services are well known to, and easily accessible by, students.

6.4 Chapter Conclusion

This study contributes to the understanding of COVID-19 VH by offering insights into its prevalence, drivers, and associated factors within a specific tertiary education setting among young adult undergraduate students. By applying the 'BeSD framework' and identifying latent constructs, the research adds to the theoretical and practical knowledge base of vaccine-related attitudes and behaviours, while testing the framework and highlighting that it may hold a potential underlying structure. These findings underline the complexity of VH and the importance of further research to explore the impact of specific socio-demographic and contextual factors on the phenomenon.

The recommendations outlined in this chapter suggest pathways for future research and public health practice, emphasising the value of proactive vaccine literacy and preparedness for emerging public health challenges. The study's findings provide insights that may inform strategies for addressing VH among young adults, particularly in tertiary education settings, by underscoring the role of cognitive, emotional, and social factors—particularly vaccine confidence, social norms, and risk perceptions—in shaping vaccine decision-making. This research highlights the importance of evidence-based, context-sensitive approaches in supporting VA and broader public health initiatives.

These findings suggest that while the BeSD framework provides a useful foundation for understanding VH, its conceptualisation of discrete but sequential drivers may require refinement to better capture the interdependent nature of vaccine-related attitudes and behaviours observed in this population. By highlighting the central role of vaccine confidence, risk perceptions, and social norms in vaccine decision-making, this study reinforces the importance of interventions that build vaccine trust, address safety concerns, and strengthen pro-vaccine norms in young adult populations, particularly in tertiary education settings.

REFERENCES

1. Fricker T, Reddy S. UNICEF welcomes 50 per cent COVID—19 vaccination coverage in South Africa. UNICEF [Internet]. 2022 Jun 2 [cited 2023 Sep 12]; Available from: https://www.unicef.org/southafrica/press-releases/unicef-welcomes-50-cent-covid19-vaccination-coverage-south-africa
2. Bergh K, Jonas K, Duby Z, Govindasamy D, Mathews C, Reddy T, et al. Factors Associated with COVID-19 Vaccine Uptake among Schoolgoing Adolescent Girls and Young Women in South Africa. Vaccines [Internet]. 2023 Oct 11;11(10):1581. Available from: https://www.mdpi.com/2076-393X/11/10/1581
3. Muthoni J, Otwombe K, Thaele D, Choge I, Steenberg B, Cutland C, et al. COVID-19 Vaccination Hesitancy among Youths in Soweto, South Africa. Vaccines [Internet]. 2023 May 9;11(5):960. Available from: https://www.mdpi.com/2076-393X/11/5/960
4. George G, Strauss M, Lansdell E, Nadesan-Reddy N, Moroe N, Reddy T, et al. South African University Staff and Students' Perspectives, Preferences, and Drivers of Hesitancy Regarding COVID-19 Vaccines: A Multi-Methods Study. Vaccines [Internet]. 2022 Aug 4;10(8). Available from: http://www.ncbi.nlm.nih.gov/pubmed/36016138
5. World Health Organization. Data for action: achieving high uptake of COVID-19 vaccines (February Interim Guidance) [Internet]. Geneva; 2021. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-vaccination-demand-planning-2021.1
6. World Health Organization. Data for Action: achieving high uptake of COVID-19 vaccines (April Interim Guidance) [Internet]. Geneva; 2021. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-vaccination-demand-planning-2021.1
7. SAGE Working Group on Vaccine Hesitancy. Report of the SAGE Working Group on Vaccine Hesitancy [Internet]. Geneva; 2014. Available from: https://www.who.int/immunization/sage/meetings/2014/october/1_Report_WORKING_GROUP_vaccine_hesitancy_final.pdf
8. Brewer NT, Chapman GB, Rothman AJ, Leask J, Kempe A. Increasing Vaccination: Putting Psychological Science Into Action. Psychological Science in the Public Interest [Internet]. 2017 Dec 3;18(3):149–207. Available from: http://journals.sagepub.com/doi/10.1177/1529100618760521
9. Cooper S, Betsch C, Sambala EZ, Mchiza N, Wiysonge CS. Vaccine hesitancy – a potential threat to the achievements of vaccination programmes in Africa. Human Vaccines & Immunotherapeutics [Internet]. 2018 Oct 3;14(10):2355–7. Available from: https://doi.org/10.1080/21645515.2018.1460987
10. Dubé E, Laberge C, Guay M, Bramadat P, Roy R, Bettinger JA. Vaccine hesitancy: An overview. Human Vaccines & Immunotherapeutics [Internet]. 2013 Aug 8;9(8):1763–73. Available from: http://www.tandfonline.com/doi/abs/10.4161/hv.24657
11. MacDonald NE. Vaccine hesitancy: Definition, scope and determinants. Vaccine [Internet]. 2015 Aug;33(34):4161–4. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0264410X15005009
12. Rodrigues CMC, Plotkin SA. Impact of Vaccines: Health, Economic and Social Perspectives. Frontiers in Microbiology [Internet]. 2020 Jul 14;11. Available from: https://www.frontiersin.org/article/10.3389/fmicb.2020.01526/full
13. Goldstein S, MacDonald NE, Guirguis S. Health communication and vaccine hesitancy. Vaccine [Internet]. 2015 Aug;33(34):4212–4. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0264410X1500506X
14. World Health Organization. Ten threats to global health in 2019 [Internet]. 2019 [cited 2021 Jan 18]. Available from: https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019
15. World Health Organization. Understanding the behavioural and social drivers of vaccine uptake WHO position paper - May 2022. Weekly Epidemiological Record [Internet]. 2022;20(97):209–24. Available from: https://iris.who.int/handle/10665/354460
16. Wiysonge CS. Vaccine hesitancy, an escalating danger in Africa [Internet]. Think Global Health. 2019 [cited 2021 May 1]. Available from: https://www.thinkglobalhealth.org/article/vaccine-hesitancy-

escalating-danger-africa
17. Wiyeh AB, Cooper S, Nnaji CA, Wiysonge CS. Vaccine hesitancy 'outbreaks': using epidemiological modeling of the spread of ideas to understand the effects of vaccine related events on vaccine hesitancy. Expert Review of Vaccines [Internet]. 2018 Dec 2;17(12):1063–70. Available from: https://www.tandfonline.com/doi/full/10.1080/14760584.2018.1549994
18. Sodemann M. Celebrities, cows and contagious ideas about vaccines. Scandinavian Journal of Public Health [Internet]. 2018 Mar 8;46(2):189–93. Available from: http://journals.sagepub.com/doi/10.1177/1403494817724982
19. Cooper S, van Rooyen H, Wiysonge CS. COVID-19 vaccine hesitancy in South Africa: how can we maximize uptake of COVID-19 vaccines? Expert Review of Vaccines [Internet]. 2021 Aug 3;20(8):921–33. Available from: https://www.tandfonline.com/doi/full/10.1080/14760584.2021.1949291
20. Larson HJ. The biggest pandemic risk? Viral misinformation. Nature [Internet]. 2018 Oct 16;562(7727):309–309. Available from: https://www.nature.com/articles/d41586-018-07034-4
21. Larson HJ. Stuck: How vaccine rumours start and why they don't go away. New York: Oxford University Press; 2020.
22. Wellcome Trust. Wellcome Global Monitor 2018 [Internet]. London; 2019. Available from: https://wellcome.org/reports/wellcome-global-monitor/2018/chapter-5-attitudes-vaccines
23. Wolfe RM. Anti-vaccinationists past and present. BMJ [Internet]. 2002 Aug 24;325(7361):430–2. Available from: https://www.bmj.com/lookup/doi/10.1136/bmj.325.7361.430
24. Wiysonge CS, Ndwandwe D, Ryan J, Jaca A, Batouré O, Anya B-PM, et al. Vaccine hesitancy in the era of COVID-19: could lessons from the past help in divining the future? Human Vaccines & Immunotherapeutics [Internet]. 2021 Jan 31;18(1):1–3. Available from: https://doi.org/10.1080/21645515.2021.1893062
25. Puri N, Coomes EA, Haghbayan H, Gunaratne K. Social media and vaccine hesitancy: new updates for the era of COVID-19 and globalized infectious diseases. Human Vaccines and Immunotherapeutics [Internet]. 2020;16(11):1–8. Available from: https://doi.org/10.1080/21645515.2020.1780846
26. Delamater PL, Leslie TF, Yang YT. Examining the spatiotemporal evolution of vaccine refusal: nonmedical exemptions from vaccination in California, 2000–2013. BMC Public Health [Internet]. 2018 Dec 24;18(1):458. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-018-5368-y
27. Nuwarda RF, Ramzan I, Weekes L, Kayser V. Vaccine Hesitancy: Contemporary Issues and Historical Background. Vaccines [Internet]. 2022 Sep 22;10(10):1595. Available from: https://www.mdpi.com/2076-393X/10/10/1595
28. The College of Physicians of Philadelphia. What do Vaccines do? Disease elimination and eradication [Internet]. Vaccine History. 2024 [cited 2024 Oct 3]. Available from: https://historyofvaccines.org/vaccines-101/what-do-vaccines-do/disease-elimination-and-eradication
29. Thompson S, Meyer JC, Burnett RJ, Campbell SM. Mitigating Vaccine Hesitancy and Building Trust to Prevent Future Measles Outbreaks in England. Vaccines [Internet]. 2023 Jan 28;11(2):288. Available from: https://www.mdpi.com/2076-393X/11/2/288
30. Roberts HA, Clark DA, Kalina C, Sherman C, Brislin S, Heitzeg MM, et al. To vax or not to vax: Predictors of anti-vax attitudes and COVID-19 vaccine hesitancy prior to widespread vaccine availability. Gesser-Edelsburg A, editor. PLOS ONE [Internet]. 2022 Feb 15;17(2):e0264019. Available from: https://dx.plos.org/10.1371/journal.pone.0264019
31. Liao H, Lyon CJ, Ying B, Hu T. Climate change, its impact on emerging infectious diseases and new technologies to combat the challenge. Emerging Microbes & Infections [Internet]. 2024 Dec 31;13(1). Available from: https://www.tandfonline.com/doi/full/10.1080/22221751.2024.2356143
32. Bartleson JM, Radenkovic D, Covarrubias AJ, Furman D, Winer DA, Verdin E. SARS-CoV-2, COVID-19 and the aging immune system. Nature Aging [Internet]. 2021 Sep 14;1(9):769–82. Available from: https://www.nature.com/articles/s43587-021-00114-7
33. Mittal A, Manjunath K, Ranjan RK, Kaushik S, Kumar S, Verma V. COVID-19 pandemic: Insights into structure, function, and hACE2 receptor recognition by SARS-CoV-2. Hobman TC, editor. PLOS Pathogens [Internet]. 2020 Aug 21;16(8):e1008762. Available from:

https://dx.plos.org/10.1371/journal.ppat.1008762
34. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020 [Internet]. The World Health Organization. 2020 [cited 2021 May 1]. Available from: https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020
35. Mkhize Z. First case of COVID-19 Coronavirus reported in SA. National Institute for Communicable Diseases [Internet]. 2020 Mar 5; Available from: https://www.nicd.ac.za/first-case-of-covid-19-coronavirus-reported-in-sa/
36. Kollamparambil U, Oyenubi A, Nwosu C. COVID19 vaccine intentions in South Africa: health communication strategy to address vaccine hesitancy. BMC Public Health. 2021;21(1):1–12.
37. Köhler T, Christian R, Carmen E. Trends in COVID-19 public health intervention adherence and vaccine hesitancy in South Africa: 2020-2021. South African Health Review [Internet]. 2021;December(1):273–85. Available from: https://journals.co.za/doi/pdf/10.10520/ejc-healthr-v2021-n1-a29
38. The World Health Organization. WHO adds Janssen vaccine to list of safe and effective emergency tools against COVID-19. 2021 Mar 12; Available from: https://www.who.int/news/item/12-03-2021-who-adds-janssen-vaccine-to-list-of-safe-and-effective-emergency-tools-against-covid-19
39. Harris M. WHO issues its first emergency use validation for a COVID-19 vaccine and emphasizes need for equitable global access. The World Health Organization [Internet]. 2020 Dec 31 [cited 2024 Jul 8]; Available from: https://www.who.int/news/item/31-12-2020-who-issues-its-first-emergency-use-validation-for-a-covid-19-vaccine-and-emphasizes-need-for-equitable-global-access
40. The World Health Organization. WHO lists two additional COVID-19 vaccines for emergency use and COVAX roll-out. 2021 Feb 15; Available from: https://www.who.int/news/item/15-02-2021-who-lists-two-additional-covid-19-vaccines-for-emergency-use-and-covax-roll-out
41. Ipsos. Attitudes to COVID-19 vaccines [Internet]. Ipsos webpage. 2021 [cited 2024 Jul 24]. Available from: https://www.ipsos.com/en/attitudes-covid-19-vaccines
42. Ullah I, Khan KS, Tahir MJ, Ahmed A, Harapan H. Myths and conspiracy theories on vaccines and COVID-19: Potential effect on global vaccine refusals. Vacunas [Internet]. 2021 Mar; Available from: https://linkinghub.elsevier.com/retrieve/pii/S1576988721000108
43. Wilson SL, Wiysonge C. Social media and vaccine hesitancy. BMJ Global Health [Internet]. 2020 Oct;5(10):e004206. Available from: https://gh.bmj.com/lookup/doi/10.1136/bmjgh-2020-004206
44. The Wellcome Trust. Wellcome Global Monitor 2018: Content overview - Africa. London; 2019.
45. Pires C. Global Predictors of COVID-19 Vaccine Hesitancy: A Systematic Review. Vaccines. 2022;10(8).
46. Wake AD. The willingness to receive covid-19 vaccine and its associated factors: "vaccination refusal could prolong the war of this pandemic" – a systematic review. Risk Management and Healthcare Policy. 2021;14(June):2609–23.
47. National Institute for Communicable Diseases. Latest confirmed cases of COVID-19 in South Africa (30 Dec 2020) [Internet]. National Institute for Communicable Diseases. 2020 [cited 2024 Jul 23]. Available from: https://www.nicd.ac.za/latest-confirmed-cases-of-covid-19-in-south-africa-30-dec-2020/
48. Bekker L, Gray G, Goga A, Garrett N, Fairall L, Sanne I, et al. The Sisonke Trial: Eight lessons for the nationwide vaccine roll-out [Internet]. Bhekisisa. Cape Town; 2021 [cited 2024 Jul 17]. Available from: https://www.news.uct.ac.za/article/-2021-06-10-the-sisonke-trial-eight-lessons-for-the-nationwide-vaccine-roll-out
49. Department of Communication and Information System. COVID-19 vaccination messaging guideline [Internet]. Government Communications. Pretoria; 2021 May. Available from: https://www.gcis.gov.za/vaccine-guideline
50. Fox SJ, Potu P, Srinivasan R, Lachmann M. The COVID-19 herd immunity threshold is not low: A re-analysis of European data from spring of 2020. medRxiv [Internet]. 2020;December. Available from: https://www.medrxiv.org/content/10.1101/2020.12.01.20242289v1
51. Dzinamarira T, Nachipo B, Phiri B, Musuka G. COVID-19 Vaccine Roll-Out in South Africa and Zimbabwe: Urgent Need to Address Community Preparedness, Fears and Hesitancy. Vaccines [Internet]. 2021 Mar 12;9(3):250. Available from: https://www.mdpi.com/2076-393X/9/3/250

52. Burger R, Buttenheim A, English R, Maughan-Brown B, Kohler T, Tameris M, et al. COVID-19 vaccine hesitancy in South Africa: Results from NIDS-CRAM Wave 4 [Internet]. South Africa; 2021 [cited 2022 Sep 17]. Available from: https://cramsurvey.org/wp-content/uploads/2021/05/3.-Burger-R.-Buttenheim-A.-English-R.-Maughan-Brown-B.-Kohler-T.-_-Tameris-M.-2021.-COVID-19-vaccine-hesitancy-in-South-Africa-Results-from-NIDS-CRAM-Wave-4.pdf
53. Kadkhoda K. Herd Immunity to COVID-19. American Journal of Clinical Pathology [Internet]. 2021 Mar 15;155(4):471–2. Available from: https://academic.oup.com/ajcp/article/155/4/471/6063411
54. Gumel AB, Iboi EA, Ngonghala CN, Ngwa GA. Toward Achieving a Vaccine-Derived Herd Immunity Threshold for COVID-19 in the U.S. Frontiers in Public Health [Internet]. 2021 Jul 23;9. Available from: https://www.frontiersin.org/articles/10.3389/fpubh.2021.709369/full
55. Suryawanshi YN, Biswas DA. Herd Immunity to Fight Against COVID-19: A Narrative Review. Cureus [Internet]. 2023 Jan 9; Available from: https://www.cureus.com/articles/116952-herd-immunity-to-fight-against-covid-19-a-narrative-review
56. Madhi SA. COVID-19 herd immunity v. learning to live with the virus. South African Medical Journal [Internet]. 2021 Aug 5;111(9):852. Available from: http://www.samj.org.za/index.php/samj/article/view/13371
57. Discovery. Understanding the progress of SA's vaccination rollout plan [Internet]. 2021 [cited 2024 Jul 18]. Available from: https://www.discovery.co.za/corporate/covid-19-understanding-sa-vaccine-rollout-plan
58. The World Health Organization. WHO COVID-19 dashboard: COVID-19 vaccination, South Africa data [Internet]. WHO Data. 2024 [cited 2024 Sep 13]. Available from: https://data.who.int/dashboards/covid19/vaccines?m49=710&n=c
59. Gittings L, Casale M, Kannemeyer N, Rayalo N, Cluver L, Kelly J, et al. Even if I'm well informed, I will never get it": COVID-19 vaccine beliefs, intentions and acceptability among adolescents and young people in South Africa. South African Health Review [Internet]. 2021;2021(1). Available from: https://journals.co.za/doi/abs/10.10520/ejc-healthr-v2021-n1-a31
60. Burger R, Köhler T, Golos AM, Buttenheim AM, English R, Tameris M, et al. Longitudinal changes in COVID-19 vaccination intent among South African adults: evidence from the NIDS-CRAM panel survey, February to May 2021. BMC Public Health [Internet]. 2022;22(1):1–10. Available from: https://doi.org/10.1186/s12889-022-12826-5
61. van der Merwe C. Vaccine hesitancy growing among South African youth [Internet]. Research Professional News. 2021 [cited 2024 Oct 1]. Available from: https://www.researchprofessionalnews.com/rr-news-africa-south-2021-8-vaccine-hesitancy-growing-among-south-african-youth/
62. Alexander K, Runciman C, Roberts B, Bekker M, Bohler-Muller N. UJ-HSRC Covid-19 Democracy Survey - Vaccine acceptance and hesitancy: Findings from the UJ/HSRC Covid-19 Democracy Survey. Johannesburg; 2021.
63. Runciman C, Alexander K, Roberts B, Orkin M, Nyamukokoko M, Bohler-Muller N. UJ-HSRC COVID-19 Democracy Survey Round 5: Research briefing - Vaccine inequality and hesitancy [Internet]. Johannesburg; 2021. Available from: https://www.uj.ac.za/wp-content/uploads/2022/02/2022-02-02-r5-vaccine-acceptance-and-hesitancy.pdf
64. Runciman C, Roberts B, Alexander K, Bohler-Muller N, Bekker M. UJ-HSRC COVID-19 Democracy Survey - Willingness to take a COVID-19 vaccine: A research briefing. Johannesburg; 2021.
65. Maughan-Brown B, Tameris M. A shot in the arm for South Africa-increased openness to accepting a COVID-19 vaccine: Evidence from NIDS-CRAM Waves 4 and 5. 2021.
66. Ipsos. Global Attitudes on a Covid-19 vaccine October 2020: COVID-19 vaccination intent is decreasing globally [Internet]. 2020 [cited 2024 Jul 24]. Available from: https://www.ipsos.com/en/global-attitudes-covid-19-vaccine-october-2020
67. Ipsos, The World Economic Forum. Global attitudes on a COVID-19 vaccine - February 2021: COVID-19 vaccination intent has soared across the world [Internet]. 2021 [cited 2024 Jul 24]. Available from: https://www.ipsos.com/sites/default/files/ct/news/documents/2021-03/global-attitudes-on-a-covid-19-vaccine-march-2021-report_.pdf
68. Ipsos. Global Attitudes on a COVID-19 vaccine - July/August 2020: Three in four adults globally say they would get a vaccine for COVID-19 [Internet]. Ipsos. Johannesburg; 2020 [cited 2024 Jul 24].

Available from: https://www.ipsos.com/en-za/three-four-adults-globally-say-they-would-get-vaccine-covid-19#:~:text=for COVID -19-,Three in four adults globally say they,a vaccine for COVID -19&text=Johannesburg%2C September 17%2C 2020 —,19 if it were available.
69. Ipsos, The World Economic Forum. Global Attitudes on a Covid-19 vaccine - December 2020: U.S. and U.K. are optimistic indicators for COVID-19 vaccination uptake [Internet]. 2020 [cited 2024 Jul 24]. Available from: https://www.ipsos.com/en/global-attitudes-covid-19-vaccine-december-2020
70. Engelbrecht M, Heunis C, Kigozi G. COVID-19 Vaccine Hesitancy in South Africa: Lessons for Future Pandemics. International Journal of Environmental Research and Public Health [Internet]. 2022 May 30 [cited 2022 Sep 17];19(11):6694. Available from: https://doi.org/10.3390/ijerph19116694
71. Marinda E, Mathentamo Q, Coulson N, Parker S, DMC Katoto P, Houston G, et al. Impact evaluation of a youth led intervention to increase COVID-19 vaccine uptake in Kwazulu-Natal, South Africa. Vaccine [Internet]. 2024;42(8):2089–98. Available from: https://doi.org/10.1016/j.vaccine.2024.02.052
72. Katoto PDMC, Parker S, Coulson N, Pillay N, Cooper S, Jaca A, et al. Predictors of COVID-19 Vaccine Hesitancy in South African Local Communities: The VaxScenes Study. Vaccines. 2022;10(3):1–23.
73. Kollamparambil U, Oyenubi A, Nwosu C. Mental distress, COVID19 vaccine distrust and vaccine hesitancy in South Africa: A causal mediation regression analysis. PLoS ONE [Internet]. 2023;18(3 March):1–14. Available from: http://dx.doi.org/10.1371/journal.pone.0278218
74. Sewpaul R, Sifunda S, Gaida R, Mokhele T, Naidoo I, Reddy SP. Vaccine hesitancy and related factors among South African adults in 2021: unpacking uncertainty versus unwillingness. Frontiers in Public Health. 2023;11(November):1–15.
75. Ipsos SA, Harris M, Nsiki E. Press Release: COVID-19 vaccination intent has risen in the past few weeks – also in South Africa [Internet]. IPSOS. Fourways; 2021 [cited 2021 Jun 15]. Available from: https://www.ipsos.com/en-za/covid-19-vaccination-intent-has-risen-past-few-weeks-also-south-africa
76. Sallam M. Covid-19 vaccine hesitancy worldwide: A concise systematic review of vaccine acceptance rates. Vaccines. 2021;9(2):1–15.
77. Markovitz G, Russo A. Survey shows rising vaccine hesitancy threatening COVID-19 recovery [Internet]. World Economic Forum. 2020 [cited 2020 Jan 19]. Available from: https://www.weforum.org/press/2020/11/survey-shows-rising-vaccine-hesitancy-threatening-covid-19-recovery/
78. Human Sciences Research Council. UJ-HSRC democracy survey summary findings. Pretoria; 2020.
79. Kollamparambil U, Oyenubi A, Nwosu CO. NIDS-CRAM Wave 5: Mental Health, COVID-19 Vaccine Distrust and Vaccine Hesitancy in South Africa Mental Health. Johanesburg; 2021.
80. Kahn K, Pettifor A, Mataboge P, Kelly NK, Mashinini DP, Nair H, et al. COVID-19 vaccine hesitancy in rural South Africa: Deepening understanding to increase uptake and access. 2022;12:5013. Available from: www.jogh.org
81. Gengiah TN, Naidoo DC, Maduma N, Govender S, Dhindayal S, Lewis L. COVID-19 vaccine hesitancy in KwaZulu-Natal, South Africa: A survey of unvaccinated adults. Health SA Gesondheid. 2024;29:1–8.
82. George G, Nota PB, Strauss M, Lansdell E, Peters R, Brysiewicz P, et al. Understanding COVID-19 Vaccine Hesitancy among Healthcare Workers in South Africa. Vaccines. 2023;11(2):1–13.
83. Watermeyer J, Scott M, Kapueja L, Ware LJ. To trust or not to trust: an exploratory qualitative study of personal and community perceptions of vaccines amongst a group of young community healthcare workers in Soweto, South Africa. Health Policy and Planning [Internet]. 2022;37(9):1167–76. Available from: https://doi.org/https://doi.org/10.1093/heapol/czac060
84. Robson LS, Shannon HS, Goldenhar LM, Hale AR. Guide to Evaluating the Effectiveness of Strategies for Preventing Work Injuries. In: Guide to Evaluating the Effectiveness of Strategies for Preventing Work Injuries: How to Show Whether a Safety Intervention Really Works [Internet]. Cincinnati: Department of Health and Human Services; 2001. p. 17–28. Available from: http://www.burgess-limerick.com/site/Resources_files/01-119.pdf
85. Poletti P, Tirani M, Cereda D, Trentini F, Guzzetta G, Marziano V, et al. Age-specific SARS-CoV-2 infection fatality ratio and associated risk factors, Italy, February to April 2020. Eurosurveillance [Internet]. 2020 Aug 6;25(31). Available from:

https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.31.2001383
86. World Health Organization. Covid-19 Virtual Press Conference 30 July 2020. In Geneva: World Health Organization; 2020. Available from: https://www.who.int/docs/default-source/coronaviruse/transcripts/covid-19-virtual-press-conference---30-july.pdf
87. Li R, Pei S, Chen B, Song Y, Zhang T, Yang W, et al. Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV-2). Science [Internet]. 2020 May;368(6490):489–93. Available from: https://www.science.org/doi/10.1126/science.abb3221
88. Wilson RF, Sharma AJ, Schluechtermann S, Currie DW, Mangan J, Kaplan B, et al. Factors Influencing Risk for COVID-19 Exposure Among Young Adults Aged 18–23 Years — Winnebago County, Wisconsin, March–July 2020. MMWR Morbidity and Mortality Weekly Report [Internet]. 2020 Oct 16;69(41):1497–502. Available from: https://www.cdc.gov/mmwr/volumes/69/wr/mm6941e2.htm
89. Monod M, Blenkinsop A, Xi X, Hebert D, Bershan S, Tietze S, et al. Age groups that sustain resurging COVID-19 epidemics in the United States. Science [Internet]. 2021 Mar 26;371(6536). Available from: https://www.science.org/doi/10.1126/science.abe8372
90. Liao J, Fan S, Chen J, Wu J, Xu S, Guo Y, et al. Epidemiological and Clinical Characteristics of COVID-19 in Adolescents and Young Adults. The Innovation [Internet]. 2020 May;1(1):100001. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2666675820300011
91. Boehmer TK, DeVies J, Caruso E, van Santen KL, Tang S, Black CL, et al. Changing Age Distribution of the COVID-19 Pandemic — United States, May–August 2020. MMWR Morbidity and Mortality Weekly Report [Internet]. 2020 Oct 2;69(39):1404–9. Available from: http://www.cdc.gov/mmwr/volumes/69/wr/mm6939e1.htm?s_cid=mm6939e1_w
92. Maluleke R. Mid-year population estimates 2021. Pretoria; 2021.
93. CNN staff. Why vaccine hesitancy in young adults matters. WMC5. 2021 Apr 30;
94. Almaghaslah D, Alsayari A, Kandasamy G, Vasudevan R. COVID-19 Vaccine Hesitancy among Young Adults in Saudi Arabia: A Cross-Sectional Web-Based Study. Vaccines [Internet]. 2021 Apr 1;9(4):330. Available from: https://www.mdpi.com/2076-393X/9/4/330
95. Crist C. Vaccine hesitancy increases among Gen Z Adults [Internet]. WebMD. 2021 [cited 2021 May 11]. Available from: https://www.webmd.com/vaccines/covid-19-vaccine/news/20210421/vaccine-hesitancy-increases-among-gen-z-adults
96. Michael N. Vaccine hesitancy among young women “swayed by influencers.” Irish Examiner [Internet]. May; Available from: https://www.irishexaminer.com/news/arid-40280321.html
97. World Health Organization (WHO). Behavioural and social drivers of vaccination: tools and practical guidance for achieving high uptake. Geneva; 2022.
98. Dubé E, Gagnon D, Nickels E, Jeram S, Schuster M. Mapping vaccine hesitancy—Country-specific characteristics of a global phenomenon. Vaccine [Internet]. 2014 Nov;32(49):6649–54. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0264410X14013073
99. Callender D. Vaccine hesitancy: More than a movement. Human Vaccines and Immunotherapeutics [Internet]. 2016;12(9):2464–8. Available from: http://dx.doi.org/10.1080/21645515.2016.1178434
100. Khosa LA, Meyer JC, Motshwane FMM, Dochez C, Burnett RJ. Vaccine Hesitancy Drives Low Human Papillomavirus Vaccination Coverage in Girls Attending Public Schools in South Africa. Frontiers in Public Health. 2022;10(May):1–11.
101. Milondzo T, Meyer JC, Dochez C, Burnett RJ. Human Papillomavirus Vaccine Hesitancy Highly Evident among Caregivers of Girls Attending South African Private Schools. Vaccines. 2022;10(4):1–9.
102. Garett R, Young SD. Online misinformation and vaccine hesitancy. Translational Behavioral Medicine. 2021;11(12):2194–9.
103. Cooper S, Wiysonge CS. Towards a More Critical Public Health Understanding of Vaccine Hesitancy: Key Insights from a Decade of Research. Vaccines. 2023;11(7):1–10.
104. Larson HJ, Jarrett C, Eckersberger E, Smith DMD, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007–2012. Vaccine [Internet]. 2014 Apr;32(19):2150–9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0264410X14001443
105. Betsch C, Bach Habersaat K, Deshevoi S, Heinemeier D, Briko N, Kostenko N, et al. Sample study protocol for adapting and translating the 5C scale to assess the psychological antecedents of vaccination. BMJ Open [Internet]. 2020 Mar 10;10(3):e034869. Available from:

https://bmjopen.bmj.com/lookup/doi/10.1136/bmjopen-2019-034869
106. Betsch C, Schmid P, Heinemeier D, Korn L, Holtmann C, Böhm R. Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. Angelillo IF, editor. PLOS ONE [Internet]. 2018 Dec 7;13(12):e0208601. Available from: https://dx.plos.org/10.1371/journal.pone.0208601
107. Houle SKD, Andrew MK. RSV vaccination in older adults: Addressing vaccine hesitancy using the 3C model. Canadian Pharmacists Journal / Revue des Pharmaciens du Canada [Internet]. 2024 Jan 24;157(1):39–44. Available from: http://journals.sagepub.com/doi/10.1177/17151635231210879
108. Frugoli AG, Prado R de S, Silva TMR da, Matozinhos FP, Trapé CA, Lachtim SAF. Vaccine fake news: an analysis under the World Health Organization's 3Cs model. Revista da Escola de Enfermagem da USP [Internet]. 2021;55(e03736):1–8. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0080-62342021000100439&tlng=pt
109. Beirakdar S, Klingborg L, Herzig van Wees S. Attitudes of Swedish Language Twitter Users Toward COVID-19 Vaccination: Exploratory Qualitative Study. JMIR Infodemiology [Internet]. 2023 Feb 22;3:e42357. Available from: https://infodemiology.jmir.org/2023/1/e42357
110. Gerretsen P, Kim J, Quilty L, Wells S, Brown EE, Agic B, et al. Vaccine Hesitancy Is a Barrier to Achieving Equitable Herd Immunity Among Racial Minorities. Frontiers in Medicine [Internet]. 2021 Nov 24;8. Available from: https://www.frontiersin.org/articles/10.3389/fmed.2021.668299/full
111. Gerretsen P, Kim J, Caravaggio F, Quilty L, Sanches M, Wells S, et al. Individual determinants of COVID-19 vaccine hesitancy. Inbaraj LR, editor. PLOS ONE [Internet]. 2021 Nov 17;16(11):e0258462. Available from: https://dx.plos.org/10.1371/journal.pone.0258462
112. Bedford H, Attwell K, Danchin M, Marshall H, Corben P, Leask J. Vaccine hesitancy, refusal and access barriers: The need for clarity in terminology. Vaccine [Internet]. 2018 Oct;36(44):6556–8. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0264410X17310708
113. Machida M, Nakamura I, Kojima T, Saito R, Nakaya T, Hanibuchi T, et al. Trends in COVID-19 vaccination intent from pre- to post-COVID-19 vaccine distribution and their associations with the 5C psychological antecedents of vaccination by sex and age in Japan. Human Vaccines & Immunotherapeutics [Internet]. 2021 Nov 2;17(11):3954–62. Available from: https://www.tandfonline.com/doi/full/10.1080/21645515.2021.1968217
114. Nath R, Imtiaz A, Nath SD, Hasan E. Role of Vaccine Hesitancy, eHealth Literacy, and Vaccine Literacy in Young Adults' COVID-19 Vaccine Uptake Intention in a Lower-Middle-Income Country. Vaccines [Internet]. 2021 Nov 29;9(12):1405. Available from: https://www.mdpi.com/2076-393X/9/12/1405
115. Hester KA, Sakas Z, Ogutu EA, Dixit S, Ellis AS, Yang C, et al. Critical interventions for demand generation in Zambia, Nepal, and Senegal with regards to the 5C psychological antecedents of vaccination. Vaccine: X [Internet]. 2023 Aug;14:100341. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2590136223000827
116. Eitze S, Felgendreff L, Horstkötter N, Seefeld L, Betsch C. Exploring pre-pandemic patterns of vaccine decision-making with the 5C model: results from representative surveys in 2016 and 2018. BMC Public Health [Internet]. 2024 Apr 30;24(1):1205. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-024-18674-9
117. Jiang B, Cao Y, Qian J, Jiang M, Huang Q, Sun Y, et al. Healthcare Workers' Attitudes toward Influenza Vaccination: A Behaviour and Social Drivers Survey. Vaccines. 2023;11(1).
118. Alagarsamy S, Mehrolia S, Pushparaj U, Jeevananda S. Explaining the intention to uptake COVID-19 vaccination using the behavioral and social drivers of vaccination (BeSD) model. Vaccine: X [Internet]. 2022 Jan 5 [cited 2022 Sep 17];10:100140. Available from: https://doi.org/10.1016/j.jvacx.2021.100140
119. Bon HB, Brouwers SA, Mote J, de Almeida S, Markle L, Sommariva S, et al. Measuring behavioral and social drivers of COVID-19 vaccination in health workers in Eastern and Southern Africa. BMC Proceedings [Internet]. 2023 Jul 12;17(S7):14. Available from: https://bmcproc.biomedcentral.com/articles/10.1186/s12919-023-00262-1
120. Neusser S, Neumann A, zur Nieden P, Speckemeier C, Schlierenkamp S, Walendzik A, et al. Facilitators and barriers of vaccine uptake in patients with autoimune inflammatory rheumatic disease: a scoping review. RMD Open. 2022;8(2):1–14.
121. Godlee F, Smith J, Marcovitch H. Wakefield's article linking MMR vaccine and autism was fraudulent.

BMJ [Internet]. 2011 Jan 5;342(jan05 1):c7452–c7452. Available from: https://www.bmj.com/lookup/doi/10.1136/bmj.c7452
122. Motta M, Stecula D. Quantifying the effect of Wakefield et al. (1998) on skepticism about MMR vaccine safety in the U.S. Useche SA, editor. PLOS ONE [Internet]. 2021 Aug 19;16(8):e0256395. Available from: https://dx.plos.org/10.1371/journal.pone.0256395
123. Ghinai I, Willott C, Dadari I, Larson HJ. Listening to the rumours: What the northern Nigeria polio vaccine boycott can tell us ten years on. Global Public Health. 2013;8(10):1138–50.
124. Aylward RB, Heymann DL. Can we capitalize on the virtues of vaccines? Insights from the polio eradication initiative. American journal of public health [Internet]. 2005 May;95(5):773–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15855451
125. Dlamini N. Immunisation. In: District Health Barometer 2017/2018. Durban: Health Systems Trust; 2019.
126. Vaccines for Africa. South Africa vaccine coverage: 1980 -2013. University of Cape Town. 2015.
127. Burnett RJ, Von Gogh LJ, Moloi MH, François G. A profile of anti-vaccination lobbying on the South African internet, 2011 - 2013. South African Medical Journal [Internet]. 2015 Oct 9;105(11):922–6. Available from: http://www.samj.org.za/index.php/samj/article/view/9654
128. Harries J, Moodley J, Barone MA, Mall S, Sinanovic E. Preparing for HPV vaccination in South Africa: Key challenges and opinions. Vaccine [Internet]. 2009 Jan;27(1):38–44. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0264410X08014242
129. Wiysonge CS, Ngcobo NJ, Jeena PM, Madhi SA, Schoub BD, Hawkridge A, et al. Advances in childhood immunisation in South Africa: where to now? Programme managers' views and evidence from systematic reviews. BMC Public Health [Internet]. 2012 Dec 31;12(1):578. Available from: ???
130. Mothiba TM, Tladi FM. Challenges faced by professional nurses when implementing the Expanded Programme on Immunisation at rural clinics in Capricorn District, Limpopo. African Journal of Primary Health Care & Family Medicine [Internet]. 2016 May 13;8(2):1–5. Available from: https://phcfm.org/index.php/phcfm/article/view/923
131. Wright SCD, Maja TMM, Furaha SA. The impact of mothers' knowledge on the immunisation of children younger than five in Ga-Rankuwa, South Africa. Africa Journal of Nursing and Midwifery. 2011;13(2):29–42.
132. Francis SA, Battle-Fisher M, Liverpool J, Hipple L, Mosavel M, Soogun S, et al. A qualitative analysis of South African women's knowledge, attitudes, and beliefs about HPV and cervical cancer prevention, vaccine awareness and acceptance, and maternal-child communication about sexual health. Vaccine [Internet]. 2011 Nov;29(47):8760–5. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0264410X11011662
133. Ledibane TD, Ledibane NR, Matlala M. Performance of the school-based human papillomavirus vaccine uptake in Tshwane, South Africa. Southern African Journal of Infectious Diseases. 2023;38(1):1–6.
134. Amponsah-Dacosta E, Blose N, Nkwinika VV, Chepkurui V. Human Papillomavirus Vaccination in South Africa: Programmatic Challenges and Opportunities for Integration With Other Adolescent Health Services? Frontiers in Public Health. 2022;10(January):1–12.
135. Ndwandwe D, Nnaji CA, Wiysonge CS. The magnitude and determinants of missed opportunities for childhood vaccination in South Africa. Vaccines. 2020;8(4):1–8.
136. Hall K. Immunisation coverage of children [Internet]. Cape Town; 2024 [cited 2024 Oct 10]. Available from: http://childrencount.uct.ac.za/indicator.php?domain=5&indicator=28#:~:text=The lower immunisation rate for,global shortage of Hexavalent vaccine.&text=In 2017 the immunisation rate,low as 61%25 in Limpopo.
137. Solanki G, Cornell M, Lalloo R. Uptake and cost of influenza vaccines in a private health insured South African population. Southern African Journal of Infectious Diseases [Internet]. 2018 Aug 20;33(5). Available from: https://sajid.co.za/index.php/sajid/article/view/138
138. Duque J, Gaga S, Clark D, Muller M, Kuwane B, Cohen C, et al. Knowledge, attitudes and practices of South African healthcare workers regarding the prevention and treatment of influenza among HIV-infected individuals. Borrow R, editor. PLOS ONE [Internet]. 2017 Mar 16;12(3):e0173983. Available from: https://dx.plos.org/10.1371/journal.pone.0173983
139. Ngcobo NJ, Burnett RJ, Cooper S, Wiysonge CS. Human papillomavirus vaccination acceptance and

hesitancy in South Africa: Research and policy agenda. South African Medical Journal [Internet]. 2018 Dec 13;109(1):13. Available from: http://www.samj.org.za/index.php/samj/article/view/12516
140. Wiyeh AB, Cooper S, Jaca A, Mavundza E, Ndwandwe D, Wiysonge CS. Social media and HPV vaccination: Unsolicited public comments on a Facebook post by the Western Cape Department of Health provide insights into determinants of vaccine hesitancy in South Africa. Vaccine [Internet]. 2019 Oct;37(43):6317–23. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0264410X19312198
141. Milondzo T, Meyer JC, Dochez C, Burnett RJ. Misinformation Drives Low Human Papillomavirus Vaccination Coverage in South African Girls Attending Private Schools. Frontiers in Public Health [Internet]. 2021 Feb 19;9. Available from: https://www.frontiersin.org/articles/10.3389/fpubh.2021.598625/full
142. Ngcobo NJ, Burnett RJ, Cooper S, Wiysonge CS. Human papillomavirus vaccination acceptance and hesitancy in south africa: Research and policy agenda. South African Medical Journal. 2019;109(1):13–5.
143. Maughan-Browna B, Köhler T, Burger R, Rossouw L, Christian C, English R. National Income Dynamics Study (NIDS) – Coronavirus Rapid Mobile Survey (CRAM) Wave 3: Covid-19 risk perceptions, preventative behaviour and COVID-fatigue during a lull in the epidemic in SOuth Africa [Internet]. 2021. Available from: https://cramsurvey.org/wp-content/uploads/2021/02/6.-Maughan-Brown-B.-Kohler-T.-Burger-R.-Rossouw-L.-Christian-C.-English-R.-2021-COVID-19-risk-perceptions-preventive-behaviour-and-COVID-fatigue-during-a-lull-in-the-epidemic-in-South-Africa.pdf
144. Burger R, Buttenheim A, English R, Maughan-Brown B, Kohler T, Tameris M. COVID-19 vaccine hesitancy in South Africa: Results from NIDS-CRAM Wave 4 [Internet]. 2021. Available from: https://cramsurvey.org/reports/#wave-2
145. Ipsos. Global Attitudes on a COVID-19 vaccine - January 2021: COVID-19 vaccination intent has risen in the past few weeks [Internet]. Ipsos webpage. 2021 [cited 2024 Jul 24]. Available from: https://www.ipsos.com/en/global-attitudes-covid-19-vaccine-january-2021
146. Carrieri V, Guthmuller S, Wübker A. Trust and COVID-19 vaccine hesitancy. Scientific Reports [Internet]. 2023 Jun 7;13(1):9245. Available from: https://doi.org/10.1038/s41598-023-35974-z
147. Peters MDJ. Addressing vaccine hesitancy and resistance for COVID-19 vaccines. International Journal of Nursing Studies [Internet]. 2022 Jul;131(January):104241. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0020748922000700
148. Lin C, Tu P, Beitsch LM. Confidence and Receptivity for COVID-19 Vaccines: A Rapid Systematic Review. Vaccines [Internet]. 2020 Dec 30;9(1):16. Available from: https://www.mdpi.com/2076-393X/9/1/16
149. Kahn K, Pettifor A, Mataboge P, Kelly NK, Mashinini DP, Nair H, et al. COVID-19 vaccine hesitancy in rural South Africa: Deepening understanding to increase uptake and access. Journal of Global Health. 2022;12:1–7.
150. Toshkov D. Explaining the gender gap in COVID-19 vaccination attitudes. European Journal of Public Health [Internet]. 2023 Jun 1;33(3):490–5. Available from: https://academic.oup.com/eurpub/article/33/3/490/7161755
151. Ishimaru T, Okawara M, Ando H, Hino A, Nagata T, Tateishi S, et al. Gender differences in the determinants of willingness to get the COVID-19 vaccine among the working-age population in Japan. Human Vaccines & Immunotherapeutics [Internet]. 2021 Nov 2;17(11):3975–81. Available from: https://www.tandfonline.com/doi/full/10.1080/21645515.2021.1947098
152. Nery N, Ticona JPA, Cardoso CW, Prates APPB, Vieira HCA, Salvador de Almeida A, et al. COVID-19 vaccine hesitancy and associated factors according to sex: A population-based survey in Salvador, Brazil. Kumar S, editor. PLOS ONE [Internet]. 2022 Jan 21;17(1):e0262649. Available from: https://dx.plos.org/10.1371/journal.pone.0262649
153. Miao Y, Bai J, Shen Z, Li Y, Zhang W, Zhu D, et al. How urban versus rural population relates to COVID-19 booster vaccine hesitancy: A propensity score matching design study. Human Vaccines & Immunotherapeutics [Internet]. 2024 Dec 31;20(1). Available from: https://www.tandfonline.com/doi/full/10.1080/21645515.2023.2297490
154. Baghani M, Fathalizade F, Loghman AH, Samieefar N, Ghobadinezhad F, Rashedi R, et al. COVID-19

vaccine hesitancy worldwide and its associated factors: a systematic review and meta-analysis. Science in One Health [Internet]. 2023;2:100048. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2949704323000422
155. Sayles JN, Macphail CL, Newman PA, Cunningham WE. Future HIV vaccine acceptability among young adults in South Africa. Health Education and Behavior. 2010;37(2):193–210.
156. Kibongani Volet A, Scavone C, Catalán-Matamoros D, Capuano A. Vaccine Hesitancy Among Religious Groups: Reasons Underlying This Phenomenon and Communication Strategies to Rebuild Trust. Frontiers in Public Health [Internet]. 2022 Feb 7;10. Available from: https://www.frontiersin.org/articles/10.3389/fpubh.2022.824560/full
157. Tiwana MH, Smith J. Faith and vaccination: a scoping review of the relationships between religious beliefs and vaccine hesitancy. BMC Public Health [Internet]. 2024 Jul 6;24(1):1806. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-024-18873-4
158. Jin S, Cook AR, Kanwagi R, Larson HJ, Lin L. Comparing role of religion in perception of the COVID-19 vaccines in Africa and Asia Pacific. Communications Medicine [Internet]. 2024 Oct 24;4(1):212. Available from: https://www.nature.com/articles/s43856-024-00628-2
159. Netshapapame TS. COVID-19 vaccination hesitancy in South Africa: Biblical discourse. HTS Teologiese Studies / Theological Studies [Internet]. 2023 May 3;79(4). Available from: https://hts.org.za/index.php/hts/article/view/7795
160. Wiysonge CS, Alobwede SM, de Marie C Katoto P, Kidzeru EB, Lumngwena EN, Cooper S, et al. COVID-19 vaccine acceptance and hesitancy among healthcare workers in South Africa. Expert Review of Vaccines [Internet]. 2022 Apr 3;21(4):549–59. Available from: https://www.tandfonline.com/doi/full/10.1080/14760584.2022.2023355
161. Mann S, Christini K, Chai Y, Chang C-P, Hashibe M, Kepka D. Vaccine hesitancy and COVID-19 immunization among rural young adults. Preventive Medicine Reports [Internet]. 2022 Aug;28:101845. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2211335522001528
162. Danabal KGM, Magesh SS, Saravanan S, Gopichandran V. Attitude towards COVID 19 vaccines and vaccine hesitancy in urban and rural communities in Tamil Nadu, India – a community based survey. BMC Health Services Research [Internet]. 2021 Dec 21;21(1):994. Available from: https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-021-07037-4
163. Botha MH, Van der Merwe FH, Snyman LC, Dreyer G. The Vaccine and Cervical Cancer Screen (VACCS) project: Acceptance of human papillomavirus vaccination in a school-based programme in two provinces of South Africa. South African Medical Journal [Internet]. 2015 Nov 28;105(1):40. Available from: http://www.samj.org.za/index.php/samj/article/view/8419
164. Adeniyi OV, Stead D, Singata-Madliki M, Batting J, Wright M, Jelliman E, et al. Acceptance of covid-19 vaccine among the healthcare workers in the eastern cape, south africa: A cross sectional study. Vaccines. 2021;9(6):1–11.
165. Modi BH, Pretorius D, Francis JM. A study on willingness to take the COVID-19 vaccine at a tertiary institution community in Johannesburg, South Africa. African Journal of Primary Health Care and Family Medicine. 2022;14(1):1–7.
166. Wong KK, Cohen AL, Norris SA, Martinson NA, von Mollendorf C, Tempia S, et al. Knowledge, attitudes, and practices about influenza illness and vaccination: a cross-sectional survey in two South African communities. Influenza and other Respiratory Viruses. 2016;10(5):421–8.
167. Katz IT, Nkala B, Dietrich J, Wallace M, Bekker LG, Pollenz K, et al. A Qualitative Analysis of Factors Influencing HPV Vaccine Uptake in Soweto, South Africa among Adolescents and Their Caregivers. PLoS ONE. 2013;8(8).
168. Ashkir S, Abel T, Khaliq OP, Moodley J. COVID-19 vaccine hesitancy among pregnant women in an antenatal clinic in Durban, South Africa. Southern African Journal of Infectious Diseases. 2023;38(1):1–7.
169. Potgieter N, Kimmie-Dhansay F, Meyer A, Marais S, Mansoor I, Mkololo Y, et al. COVID-19 vaccine hesitancy and its drivers among dental students at University of the Western Cape, South Africa. Health SA Gesondheid. 2022;27:1–6.
170. Oduwole EO, Mahomed H, Ayele BT, Wiysonge CS. Estimating vaccine confidence levels among healthcare students and staff of a tertiary institution in South Africa: Protocol of a cross-sectional survey. BMJ Open. 2021;11(5).

171. Mashau TS, Shibambo LM. Students' Perceptions of Covid-19 Vaccines Hesitancy at a University in South Africa. Journal of Educational Studies [Internet]. 2023;22(1). Available from: https://journals.co.za/doi/full/10.10520/ejc-jeds_v22_n1_a9
172. O'Regan V. More universities implement mandatory vaccination policies. The Daily Maverick. 2021 Dec 14;Online publication.
173. Eyal K, Njozela L, Köhler T, Ingle K, Brophy T, Buttenheim A, et al. Correlates of COVID-19 vaccination intentions and opinions about mandates among four groups of adults in South Africa with distinct vaccine intentions: evidence from a large national survey. BMC Public Health [Internet]. 2023;23(1):1–12. Available from: https://doi.org/10.1186/s12889-023-16584-w
174. Suleman MH, Govender S, Mhlongo EM, Naidoo K. Knowledge, attitudes and perceptions of nursing students regarding vaccines. South African Family Practice [Internet]. 2024 Jan 31;66(1):1–7. Available from: https://safpj.co.za/index.php/safpj/article/view/5825
175. George G, Strauss M, Chirawu P, Rhodes B, Frohlich J, Montague C, et al. Barriers and facilitators to the uptake of voluntary medical male circumcision (VMMC) among adolescent boys in KwaZulu–Natal, South Africa. African Journal of AIDS Research [Internet]. 2014 Apr 3;13(2):179–87. Available from: http://www.tandfonline.com/doi/abs/10.2989/16085906.2014.943253
176. Le CN, Nguyen UTT, Do DTH. Predictors of COVID-19 vaccine acceptability among health professions students in Vietnam. BMC Public Health [Internet]. 2022 Dec 28;22(1):854. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-022-13236-3
177. Asres F, Umeta B. COVID-19 vaccines: awareness, attitude and acceptance among undergraduate University students. Journal of Pharmaceutical Policy and Practice [Internet]. 2022 Dec 26;15(1):32. Available from: https://joppp.biomedcentral.com/articles/10.1186/s40545-021-00397-6
178. Lucia VC, Kelekar A, Afonso NM. COVID-19 vaccine hesitancy among medical students. Journal of Public Health. 2020;1–5.
179. Bangalee A, Bangalee V. Fake news and fallacies: Exploring vaccine hesitancy in South Africa. South African Family Practice. 2021;63(1):1–3.
180. Purasram M, Bangalee V, Oosthuizen F, Moodley R. Knowledge, attitudes and perceptions of a patient population on the COVID-19 vaccine rollout. Health SA Gesondheid. 2022;27:1–10.
181. Kabakama S, Konje ET, Dinga JN, Kishamawe C, Morhason-Bello I, Hayombe P, et al. Commentary on COVID-19 Vaccine Hesitancy in sub-Saharan Africa. Tropical Medicine and Infectious Disease. 2022;7(7):1–4.
182. Kashte S, Gulbake A, El-Amin SF, Gupta A. COVID-19 vaccines: rapid development, implications, challenges and future prospects. Human Cell [Internet]. 2021;34(3):711–33. Available from: https://doi.org/10.1007/s13577-021-00512-4
183. Parimi K, Gilkeson K, Creamer BA. COVID-19 vaccine hesitancy: Considerations for reluctance and improving vaccine uptake. Human Vaccines and Immunotherapeutics [Internet]. 2022;18(5). Available from: https://doi.org/10.1080/21645515.2022.2062972
184. Savoia E, Harriman NW, Piltch-Loeb R, Bonetti M, Toffolutti V, Testa MA. Exploring the Association between Misinformation Endorsement, Opinions on the Government Response, Risk Perception, and COVID-19 Vaccine Hesitancy in the US, Canada, and Italy. Vaccines. 2022;10(5).
185. Majid U, Ahmad M, Zain S, Akande A, Ikhlaq F. COVID-19 vaccine hesitancy and acceptance: A comprehensive scoping review of global literature. Health Promotion International. 2022;37(3):1–12.
186. Piltch-Loeb R, Mazibuko L, Stanton E, Mngomezulu T, Gareta D, Nxumalo S, et al. COVID-19 vaccine uptake, confidence and hesitancy in rural KwaZulu-Natal, South Africa between April 2021 and April 2022: A continuous cross-sectional surveillance study. PLOS Global Public Health [Internet]. 2023;3(6):e0002033. Available from: http://dx.doi.org/10.1371/journal.pgph.0002033
187. de Figueiredo A, Temfack E, Tajudeen R, Larson HJ. Declining trends in vaccine confidence across sub-Saharan Africa: A large-scale cross-sectional modeling study. Human Vaccines and Immunotherapeutics [Internet]. 2023;19(1):1–9. Available from: https://doi.org/10.1080/21645515.2023.2213117
188. Sprengholz P, Felgendreff L, Böhm R, Betsch C. Vaccination policy reactance: Predictors, consequences, and countermeasures. Journal of health psychology [Internet]. 2022 May;27(6):1394–407. Available from: http://www.ncbi.nlm.nih.gov/pubmed/34488460

189. Verpaalen IAM, Ritter SM, van Hooff MLM, van Stekelenburg A, Fransen ML, Holland RW. Psychological reactance and vaccine uptake: a longitudinal study. Psychology & Health [Internet]. 2023 Mar 22;1–21. Available from: https://www.tandfonline.com/doi/full/10.1080/08870446.2023.2190761
190. Salali GD, Uysal MS, Bozyel G, Akpinar E, Aksu A. Does social influence affect COVID-19 vaccination intention among the unvaccinated? Evolutionary human sciences [Internet]. 2022;4:e32. Available from: http://www.ncbi.nlm.nih.gov/pubmed/37588925
191. Amin AB, Bednarczyk RA, Ray CE, Melchiori KJ, Graham J, Huntsinger JR, et al. Association of moral values with vaccine hesitancy. Nature Human Behaviour [Internet]. 2017 Dec 4;1(12):873–80. Available from: https://www.nature.com/articles/s41562-017-0256-5
192. Rossen I, Hurlstone MJ, Dunlop PD, Lawrence C. Accepters, fence sitters, or rejecters: Moral profiles of vaccination attitudes. Social Science & Medicine [Internet]. 2019 Mar;224:23–7. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0277953619300395
193. Galagali PM, Kinikar AA, Kumar VS. Vaccine Hesitancy: Obstacles and Challenges. Current Pediatrics Reports [Internet]. 2022;10(4):241–8. Available from: https://doi.org/10.1007/s40124-022-00278-9
194. Cooper S. Covid-19 vaccine hesitancy in South Africa: Summary of existing studies. Cochrane South Africa, South African Medical Research Council. Johannesburg; 2021.
195. Myburgh N, Mulaudzi M, Tshabalala G, Beta N, Gutu K, Vermaak S, et al. A Qualitative Study Exploring Motivators and Barriers to COVID-19 Vaccine Uptake among Adults in South Africa and Zimbabwe. Vaccines. 2023;11(4):1–16.
196. Gesser-Edelsburg A, Diamant A, Hijazi R, Mesch GS. Correcting misinformation by health organizations during measles outbreaks: A controlled experiment. Angelillo IF, editor. PLOS ONE [Internet]. 2018 Dec 19;13(12):e0209505. Available from: https://dx.plos.org/10.1371/journal.pone.0209505
197. Brewer NT. What works to increase vaccination uptake. Academic Pediatrics. 2021;21(4S):9–16.
198. Larson HJ, Clarke RM, Jarrett C, Eckersberger E, Levine Z, Schulz WS, et al. Measuring trust in vaccination: A systematic review. Human Vaccines & Immunotherapeutics [Internet]. 2018 Jul 3;14(7):1599–609. Available from: https://www.tandfonline.com/doi/full/10.1080/21645515.2018.1459252
199. Caserotti M, Girardi P, Sellaro R, Rubaltelli E, Tasso A, Lotto L, et al. To vaccinate or not to vaccinate? The interplay between pro- and against- vaccination reasons. BMC Public Health [Internet]. 2023 Nov 9;23(1):2207. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-023-17112-6
200. Lehohla P. Cause of Death Certification: A guide for completing the Notice of Death/Stillbirth (DHA-1663) [Internet]. Statistics South Africa, editor. Pretoria: Statistics South Africa; 2012. Available from: https://www.samrc.ac.za/sites/default/files/files/2017-07-03/CODcertificationguideline.pdf
201. Meyer JC, Burnett RJ. Communication to counter vaccine hesitancy. SA Pharmaceutical Journal. 2021;88(1):39–41.
202. Moodley I, Mubaiwa V, Tathiah N, Denny L. High uptake of Gardasil vaccine among 9 - 12-year-old schoolgirls participating in an HPV vaccination demonstration project in KwaZulu-Natal Province. South African Medical Journal [Internet]. 2013 Mar 1;103(5):318. Available from: http://www.samj.org.za/index.php/samj/article/view/6414/5030
203. Yale Institute for Global Health; UNICEF. Vaccine Messaging Guide [Internet]. New Haven; 2020. Available from: https://www.unicef.org/media/93661/file/Vaccinemessagingguide.pdf
204. World Health Organization Technical Advisory Group on Behavioural Insights and Sciences for Health. Behavioural considerations for acceptance and uptake of COVID-19 vaccines. World Health Organization (WHO). Geneva; 2020.
205. Mavundza EJ, Ndwandwe D, Wiysonge CS. COVID-19 vaccine demand protest might have increased vaccine acceptance and uptake in South Africa. Human Vaccines and Immunotherapeutics [Internet]. 2022;18(5):2020–2. Available from: https://doi.org/10.1080/21645515.2022.2064691
206. Mykhalovskiy E, French M. COVID-19, public health, and the politics of prevention. Sociology of Health & Illness [Internet]. 2020 Nov 6;42(8). Available from: https://onlinelibrary.wiley.com/doi/10.1111/1467-9566.13192
207. Rivera T, Brustrom J, Vera Antelo M, Puertas EB, Rhoda DA, Velandia-Gonzalez M. Understanding

COVID-19 Vaccine Acceptance among Latin American Health Workers: Implications for Designing Interventions. Vaccines. 2023;11(9):1–15.
208. Bonner KE, Vashist K, Abad NS, Kriss JL, Meng L, Lee JT, et al. Behavioral and Social Drivers of COVID-19 Vaccination in the United States, August–November 2021. American Journal of Preventive Medicine [Internet]. 2023 Jun;64(6):865–76. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0749379723000168
209. Moola S, Gudi N, Nambiar D, Dumka N, Ahmed T, Sonawane IR, et al. A rapid review of evidence on the determinants of and strategies for COVID-19 vaccine acceptance in low- and middle-income countries. Journal of Global Health. 2021;11.
210. Sartorius B, Cohen C, Chirwa T, Ntshoe G, Puren A, Hofman K. Identifying high-risk areas for sporadic measles outbreaks: lessons from South Africa. Bulletin of the World Health Organization. 2013;91(3):174–83.
211. Delany-Moretlwe S, Kelley KF, James S, Scorgie F, Subedar H, Dlamini NR, et al. Human Papillomavirus Vaccine Introduction in South Africa: Implementation Lessons From an Evaluation of the National School-Based Vaccination Campaign. Global Health: Science and Practice [Internet]. 2018 Oct 3;6(3):425–38. Available from: http://www.ghspjournal.org/lookup/doi/10.9745/GHSP-D-18-00090
212. Lawal L, Aminu Bello M, Murwira T, Avoka C, Yusuf Ma'aruf S, Harrison Omonhinmin I, et al. Low coverage of COVID-19 vaccines in Africa: current evidence and the way forward. Human Vaccines and Immunotherapeutics [Internet]. 2022;18(1):1–5. Available from: https://doi.org/10.1080/21645515.2022.2034457
213. Morroni C, Meyer L. Study Design. In: Ehrlich R, Joubert G, editors. Epidemiology: A research manual for South Africa. Third. Cape Town: Oxford University Press Southern Africa; 2014. p. 78–96.
214. Crosley C. University of the Witwatersrand 2021 registered student numbers -personal correspondence (email). Johannesburg: Registrar's Division, The University of the Witwatersrand; 2021.
215. Van Mol C. Improving web survey efficiency: the impact of an extra reminder and reminder content on web survey response. International Journal of Social Research Methodology [Internet]. 2017 Jul 4;20(4):317–27. Available from: http://dx.doi.org/10.1080/13645579.2016.1185255
216. Krejcie RV, Morgan DW. Determining sample size for research activities. Educational and Psychological Measurement. 1970;30(3):607–10.
217. Eysenbach G. Improving the Quality of Web Surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES). Journal of Medical Internet Research [Internet]. 2004 Sep 29;6(3):e34. Available from: http://www.jmir.org/2004/3/e34/
218. Saleh A, Bista K. Examining Factors Impacting Online Survey Response Rates in Educational Research: Perceptions of Graduate Students. Journal of MultiDIsciplinary Evaluation. 2017;13(29):63–74.
219. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. Journal of Biomedical Informatics [Internet]. 2009 Apr;42(2):377–81. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1532046408001226
220. Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, et al. The REDCap consortium: Building an international community of software platform partners. Journal of Biomedical Informatics [Internet]. 2019 Jul;95:103208. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1532046419301261
221. Braeken J, van Assen MALM. An empirical Kaiser criterion. Psychological Methods [Internet]. 2017 Sep;22(3):450–66. Available from: https://doi.apa.org/doi/10.1037/met0000074
222. Hair JF, Black WC, Babin BJ, Anderson RE. Multivariate Data Analysis. 7th ed. Upper Saddle River, New Jersey USA: Pearson Education Limited; 2010. 125–126 p.
223. Wassenaar D. Ethical issues in social science research. In: Blanche MT, Durrheim K, Painter D, editors. Research in Practice: Applied Methods for the Social Sciences. Second. Cape Town: University of Cape Town Press; 2006. p. 60–79.
224. Young S, Wheeler AC, McCoy SI, Weiser SD. A Review of the Role of Food Insecurity in Adherence to Care and Treatment Among Adult and Pediatric Populations Living with HIV and AIDS. AIDS and

Behavior [Internet]. 2014 Oct 11;18(S5):505–15. Available from: http://link.springer.com/10.1007/s10461-013-0547-4
225. Weiser SD, Tuller DM, Frongillo EA, Senkungu J, Mukiibi N, Bangsberg DR. Food Insecurity as a Barrier to Sustained Antiretroviral Therapy Adherence in Uganda. Grietens KP, editor. PLoS ONE [Internet]. 2010 Apr 28;5(4):e10340. Available from: https://dx.plos.org/10.1371/journal.pone.0010340
226. Militao EMA, Uthman OA, Salvador EM, Vinberg S, Macassa G. Association between Food Insecurity, Socioeconomic Status of the Household Head, and Hypertension and Diabetes in Maputo City. Annals of Global Health [Internet]. 2024 Dec 10;90(1):79. Available from: https://account.annalsofglobalhealth.org/index.php/up-j-agh/article/view/4569
227. Pourebrahim F, Omidvar N, Rezazadeh A, Eini-Zinab H, Shirani P, Ghodsi D. Food security and its association with socioeconomic status and dietary diversity in free living older people in Tehran, Iran. BMC Geriatrics [Internet]. 2024 Feb 2;24(1):128. Available from: https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-024-04705-y
228. Wagner F, Kaneli T, Masango M. Exploring the relationship between food insecurity with hunger and academic progression at a large South African University. South African Journal of Higher Education [Internet]. 2021 Oct;35(5). Available from: https://www.journals.ac.za/index.php/sajhe/article/view/4099
229. Msimango LI. Vulnerability to food insecurity among students: A quantitative study at the University of KwaZulu-Natal. University of KwaZulu-Natal;
230. Mansvelt N, Schenck R, Soji Z. Students' conceptualizations of student hunger. South African Journal of Higher Education [Internet]. 2022;36(5). Available from: https://www.journals.ac.za/sajhe/article/view/4725
231. Oduwole EO, Esterhuizen TM, Mahomed H, Wiysonge CS. Estimating vaccine confidence levels among healthcare staff and students of a tertiary institution in south africa. Vaccines. 2021;9(11):1–13.
232. Bome E. MVax Policy takes positive strides, one month in. WITS Vuvuzela [Internet]. 2022 Apr 8; Available from: https://witsvuvuzela.com/2022/04/08/mvax-policy-takes-positive-strides-one-month-in/
233. Wang D, Chukwu A, Mwanyika-Sando M, Abubakari SW, Assefa N, Madzorera I, et al. COVID-19 vaccine hesitancy and its determinants among sub-Saharan African adolescents. Atulomah NO, editor. PLOS Global Public Health [Internet]. 2022 Oct 5;2(10):e0000611. Available from: https://dx.plos.org/10.1371/journal.pgph.0000611
234. Jones B, Wardman L, Tinkler L. Coronavirus vaccine hesitancy in younger adults: June 2021 [Internet]. Office of National Statistics: Data and Analysis from Census 2021. 2021 [cited 2024 Nov 10]. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandwellbeing/articles/coronavirusvaccinehesitancyinyoungeradults/june2021
235. Boccalini S, Vannacci A, Crescioli G, Lombardi N, Del Riccio M, Albora G, et al. Knowledge of University Students in Health Care Settings on Vaccines and Vaccinations Strategies: Impact Evaluation of a Specific Educational Training Course during the COVID-19 Pandemic Period in Italy. Vaccines [Internet]. 2022 Jul 6;10(7):1085. Available from: https://www.mdpi.com/2076-393X/10/7/1085
236. Freeman D, Lambe S, Yu L-M, Freeman J, Chadwick A, Vaccari C, et al. Injection fears and COVID-19 vaccine hesitancy. Psychological Medicine [Internet]. 2023 Mar 11;53(4):1185–95. Available from: https://www.cambridge.org/core/product/identifier/S0033291721002609/type/journal_article
237. Leonhardt JM, Ridinger G, Rong Y, Talaei-Khoe A. Invincibility threatens vaccination intentions during a pandemic. Nishi A, editor. PLOS ONE [Internet]. 2021 Oct 27;16(10):e0258432. Available from: https://dx.plos.org/10.1371/journal.pone.0258432
238. Biggs AT, Littlejohn LF. Vaccination and natural immunity: Advantages and risks as a matter of public health policy. The Lancet Regional Health - Americas [Internet]. 2022 Apr;8:100242. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2667193X2200059X
239. Gazit S, Shlezinger R, Perez G, Lotan R, Peretz A, Ben-Tov A, et al. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Naturally Acquired Immunity versus Vaccine-induced

Immunity, Reinfections versus Breakthrough Infections: A Retrospective Cohort Study. Clinical Infectious Diseases [Internet]. 2022 Aug 24;75(1):e545–51. Available from: https://academic.oup.com/cid/article/75/1/e545/6563799
240. Lumley SF, Rodger G, Constantinides B, Sanderson N, Chau KK, Street TL, et al. An Observational Cohort Study on the Incidence of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection and B.1.1.7 Variant Infection in Healthcare Workers by Antibody and Vaccination Status. Clinical Infectious Diseases [Internet]. 2022 Apr 9;74(7):1208–19. Available from: https://academic.oup.com/cid/article/74/7/1208/6314286
241. Rasmussen AL. Vaccination Is the Only Acceptable Path to Herd Immunity. Med [Internet]. 2020 Dec;1(1):21–3. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2666634020300325
242. Moore R, Purvis RS, Willis DE, Worley KC, Hervey D, Reece S, et al. The vaccine hesitancy continuum among hesitant adopters of the COVID-19 vaccine. Clinical and Translational Science. 2022;15(12):2844–57.
243. Giubilini A. Vaccination ethics. British Medical Bulletin [Internet]. 2021 Mar 25;137(1):4–12. Available from: https://academic.oup.com/bmb/article/137/1/4/6047735
244. Williams L, Gallant A, Brown L, Corrigan K, Crowe K, Hendry E. Barriers and facilitators to the future uptake of regular COVID-19 booster vaccinations among young adults in the UK. Human Vaccines & Immunotherapeutics [Internet]. 2022 Nov 30;18(6). Available from: https://www.tandfonline.com/doi/full/10.1080/21645515.2022.2129238
245. Gilbert-Esparza E, Brady A, Haas S, Wittstruck H, Miller J, Kang Q, et al. Vaccine Hesitancy in College Students. Vaccines [Internet]. 2023 Jul 15;11(7):1243. Available from: https://www.mdpi.com/2076-393X/11/7/1243
246. Mao Z-F, Li Q-W, Wang Y-M, Zhou J. Pro-religion attitude predicts lower vaccination coverage at country level. Humanities and Social Sciences Communications [Internet]. 2024 Jan 5;11(1):64. Available from: https://www.nature.com/articles/s41599-023-02598-7
247. Curran G, Mosley C, Gamble A, Painter J, Ounpraseuth S, Brewer NT, et al. Addressing COVID-19 vaccine hesitancy in rural community pharmacies: a protocol for a stepped wedge randomized clinical trial. Implementation Science [Internet]. 2023 Dec 18;18(1):72. Available from: https://implementationscience.biomedcentral.com/articles/10.1186/s13012-023-01327-7
248. Reichelt M, Cullen JP, Mayer-Fried S, Russell HA, Bennett NM, Yousefi-Nooraie R. Addressing COVID-19 vaccine hesitancy in rural communities: A case study in engaging trusted messengers to pivot and plan. Frontiers in public health [Internet]. 2023;11:1059067. Available from: http://www.ncbi.nlm.nih.gov/pubmed/36844863
249. Botha MH, Van der Merwe FH, Snyman LC, Dreyer G. The Vaccine and Cervical Cancer Screen (VACCS) project: Acceptance of human papillomavirus vaccination in a school-based programme in two provinces of South Africa. South African Medical Journal [Internet]. 2014 Nov 28;105(1):40. Available from: http://www.samj.org.za/index.php/samj/article/view/8419
250. Steenberg B, Sokani A, Myburgh N, Mutevedzi P, Madhi SA. COVID-19 Vaccination Rollout: Aspects of Hesitancy in South Africa. Vaccines. 2023;11(2):1–12.

APPENDICES

Appendix A: Plagiarism Declaration and Turnitin Report

I, **Alice Ruth Morrison**, am a postgraduate student registered for a Master of Public Health degree at the University of the Witwatersrand in the year 2025.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix (see Appendix A) a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.



_____

11 February 2025

_____

AR Morrison 698308 MPH SBCC Research Report turnitin.docx

ORIGINALITY REPORT

14%	9%	10%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Witwatersrand Student Paper	4%
2	wiredspace.wits.ac.za Internet Source	1%
3	www.mdpi.com Internet Source	<1%
4	www.medrxiv.org Internet Source	<1%
5	www.esp.org Internet Source	<1%
6	www.frontiersin.org Internet Source	<1%
7	www.hst.org.za Internet Source	<1%
8	Camden-Smith, Taryn. "Associations Between Young Children's Development and Their Caregiver's Practices and Knowledge About Child Development in Soweto, Johannesburg",	<1%

Signed by Supervisor: Dr A Mosam

Prof Susan Goldstein Supervisor

School of Public Health

Faculty of Health Sciences, University of the Witwatersrand, 27 St Andrews Road, (Wits Education Campus)
Parktown, 2193, South Africa • Telephone +27 11 717 2543 • Fax +27 11 717 2084

27 February 2025

To Whom it may concern

Re: Research Report submitted by Alice Ruth Morrison Student number: 698308 entitled "Demographic, psychosocial, and motivational factors associated with SARSCoV2 vaccine hesitancy among undergraduate students at a university in Johannesburg, South Africa, 2021."

The Turnitin report for this thesis returned as 14%. I have carefully examined the content of the Turnitin Report and I believe that there is no plagiarism in Alice Morrison's report. I m happy for her to proceed to examination.

Yours sincerely,



Prof Susan Goldstein
Director, SAMRC/Centre for Health Economics & Decision Science – PRICELESS SA
Room 231 | Wits School of Public Health Education Campus | 27 St. Andrews Road| Parktown 2193| Johannesburg| South Africa
Landline | 011 717-2083
Cell| 0828514080
Website: www.pricelesssa.ac.za

Appendix B: Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/49 Miss Alice Morrison

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M210832

NAME: (Principal Investigator)	Miss Alice Morrison
DEPARTMENT:	School of Public Health
PROJECT TITLE:	Demographic, psychosocial, and motivational factors associated with SARS COV2 vaccine hesitancy among undergraduate students at a university in Johannesburg, South Africa, 2021
DATE CONSIDERED:	27/08/2021
DECISION:	Approved unconditionally
CONDITIONS:	
NOTE:	If contact information regarding student study participants is required, please contact the University Registrar's office <Nicoleen.Potgieter@wits.ac.za>
SUPERVISOR:	Prof S. Goldstein and Dr A. Mosam
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	04/10/2021

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions.Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. I **agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **August** and will therefore be due in the month of **August** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix C: Study Invitation and Information Sheet

This Appendix provides the invitation email that was sent out to potential undergraduate respondents via the WITS University email Listserv system.

Invitation to participate in a study on vaccine hesitancy

Greetings. My name is Alice Morrison and I am a Masters student in the School of Public Health at the University of the Witwatersrand, Johannesburg. To fulfil the research component of my Masters in Public Health degree I am conducting research into what WITS undergraduate students think and feel about COVID-19 vaccines.

The study is titled: Demographic, psychosocial, and motivational factors associated with COVID-19 vaccine hesitancy among undergraduate students at a university in Johannesburg, South Africa, 2021.

I am inviting students between 18 and 35 years old to participate in this study by completing an online questionnaire. The questionnaire is mainly in the form of multiple-choice questions and will take approximately 10 minutes to complete. Please be assured that the data collected will not be traceable back to you, it will be anonymous. Data collected will be held securely on a password protected laptop and stored in my password protected OneDrive. Participating in this study is entirely voluntary and anonymous, you may choose to withdraw from this research study at any stage. Choosing to participate in the study or not to participate will have no impact on you or your academic outcomes. If you chose not to participate or who withdraw from the study, there will not be any consequences. The findings from the research will be written up as the researcher's masters dissertation, published in a research paper, and shared with WITS University.

Please note that you will be required to indicate that you consent to participate in the study prior to beginning the questionnaire and that submitting the completed questionnaire is taken to mean that you are consenting to participate in this study.

The study can be accessed at the following link (url for the survey was pasted here). If you have any questions or concerns regarding this research, please contact:

Researcher: Alice Morrison (698308@students.wits.ac.za),

Supervisor: Prof Sue Goldstein (Susan.Goldstein@wits.ac.za)

Co-supervisor: Dr Aitya Moosam (Atiya.Mosam@wits.ac.za)

Wits Human Research Ethics Committee (Medical):

Chairman of WITS HREC (Medical): CB Penny (clement.penny@wits.ac.za) or 0117172301

HREC (Medical) Committee Secretariat: Ms. Z Ndlovu (zanele.ndlovu@wits.ac.za) or Mr. Rhulani Mkansi (Rhulani.mkansi@wits.ac.za) or 011 717 2700/1234

Thank you for reading this information sheet.

Appendix D: Adapted BeSD Questionnaire - including informed consent

The table below contains the adapted BeSD questionare that was loaded onto REDCap for respondents to access via the URL that was contained in the invitation to participate in the study which was emailed to all undergraduate students. Within the table, different drivers within the BeSD have been highlighted in the following colours:

- Thinking & Feeling (yellow/orange)
- Social Processes (green)
- Motivation (red/orange)
- Practical Issues (blue)

Socio-demographic and health related factors are not highlighted.

Table D : Adapted BeSD Questionnaire

Item Number	Question	Response Options
0	**INFORMED CONSENT:** Please note that by completing this questionnaire you are indicating that you are consenting to participate in this study. Furthermore, you are indicating that you understand that - Your participation is voluntary, and you may withdraw from the study at any stage. - Your participation will have no positive or adverse impact on your academic outcome. - Your participation is entirely confidential and no identifying information will be recorded. - You understand that there will be no immediate benefit to you, should you agree to participate - You understand that you will not be paid to participate in the study. - Your participation will cost you nothing but your time. - You know that if you have any questions or concerns you may contact the researcher, her supervisors, or the Wits Human Research Ethics Committee (Medical). o Researcher: Alice Morrison (698308@students.wit.ac.za) o Supervisor: Prof Sue Goldstein (susan.goldstein@wits.ac.za) o Co-Supervisor: Atiya Mosam (atiya.mosam@wits.ac.za) o Chairman of WITS HREC (Medical): CB Penny (clement.penny@wits.ac.za) or 0117172301 o HREC (Medical) Committee Secretariat: Ms. Z Ndlovu (zanele.ndlovu@wits.ac.za) or Mr. Rhulani Mkansi (Rhulani.mkansi@wits.ac.za) or 011 717 2700/1234 Please indicate if you consent to participate in this study by selecting YES, or if you do not wish to continue, please select NO.	• Yes • No

Section A (part 1): Socio-demographic factors		
A.1.a)	What year were you born?	
A.1.b)	Age at the time of completing the survey?	
A.2.	What is your gender?	• Female • Male • Non-binary • Prefer not to say
A.3	Which is the main language you speak at home with your family?	• Afrikaans • English • isiNdebele • isiXhosa • isiZulu • Sesotho • Sesotho sa Leboa • Setswana • siSwati • Tshivenda • Tsonga • Sign language • Other, specify ……..
A.4	What is your race?	• Black • White • Indian • Coloured • Prefer not to say
A.5	What is your religion?	• Islam • Christianity (all denominations) • Hindu • Judaism • African Traditional Beliefs • Other • No religion
A.6	Which province do you live in when you are not at WITS?	• Eastern Cape • Free State • Gauteng • KwaZulu Natal • Limpopo • Mpumalanga • North West • Northern Cape • Western Cape • International Student
A.7	Is your family home in a rural or urban area?	• Rural • Urban • Peri-urban
A.8	Where do you stay during term-time?	• On-campus • Off-campus
A.9	In the last year, how often have you experienced food insecurity, that is not knowing where your next meal is coming from, or eating less food than you need, on a regular basis, for a period lasting more than one month?	• Daily • A couple of times a week • Once a week • A couple of times a month • Once a month • A few times during the year • Never
A.10	In which faculty are you registered as an undergraduate student at WITS?	• Commerce, Law, and Management • Engineering and Built Environment

		• Health Sciences • Humanities • Science
A.11	What year of study are you currently registered for?	• 1st year • 2nd year • 3rd year • 4th year • 5th year • 6th year
Section A (part 2): Health characteristics and beliefs		
A.12	Do you have a chronic illness?	• Yes, please specify _____ • No • Prefer not to say
A.13.a)	To your knowledge, are you, or have you been, infected with COVID-19?	• Yes • No If "YES" respondent goes to part B, if "NO" then skip question to next question
A.13.b)	Was it mild or severe?	• Mild (treated at home) • Severe (treated at hospital)
A.14.a)	To your knowledge have any of your family or friends been infected with COVID-19?	• Yes • No If "YES" respondent goes to part B. If "NO" then skip pattern to next question.
A.14.b)	To your knowledge has anyone you know personally (friends or family) died of COVID-19?	• Yes • No
A.15	I think students that have not been vaccinated against COVID-19 should be allowed to attend lectures in person.	• Strongly agree • Agree • Disagree • Strongly disagree
A.16	I would feel safe to attend lectures in person knowing that not everyone in my class had been vaccinated against COVID-19?	• Strongly agree • Agree • Disagree • Strongly disagree
A.17	Do you agree with mandatory vaccination for WITS University staff and students?	• Strongly agree • Agree • Disagree • Strongly disagree
A.18	Who do you believe is responsible for ensuring that WITS students are vaccinated against COVID-19? Select all that apply.	• WITS University • The government • Each individual student • Parents of students • Other, please specify …….
A.19.a	Motivation item: The COVID-19 vaccine is now available to you, will you be vaccinated?	• I have already had the COVID-19 vaccine • I definitely will have the COVID-19 vaccine • I probably will have the COVID-19 vaccine • I am delaying having the COVID-19 vaccine • I probably will refuse the Covid-19 vaccine • I definitely will not have the COVID-19 vaccine Skip pattern if first two option selected, if last four are selected than respondent is moved to part b.
A.19. b	Which of the following factors influenced your previous choice? Choose all options that apply to you.	• I don't like needles • I think vaccines are dangerous

		• I do not think that they tested the COVID-19 vaccine properly • I do not think COVID-19 vaccines work • I think the COVID-19 vaccine is a scam to make other people money • I am healthy so I don't need to be vaccinate against COVID-19 • I worry that getting a vaccine will cost me time or money • I worry about side effects • I think it will hurt • I think the COVID-19 vaccines make people sick • I think COVID-19 vaccines are used to control people • I think COVID-19 vaccines are used to limit population growth • Other, please specify _____
A.20	Motivation item: Before COVID-19 vaccines became available to your age group in South Africa, how keen were you to be vaccinated?	• Already vaccinated in RSA • Already vaccinated outside RSA • Very much • Moderately • A little • Not at all
A.21	Practical Issues item: Have you ever received a vaccine other than the COVID-19 vaccine as an adult?	• Yes • No • I am not sure
Section B: BeSD Items only		
B.1	Thinking & Feeling item: How concerned are you about your close family and friends getting COVID-19 from you?	• Not at all concerned • A little concerned • Moderately concerned • Very concerned
B.2	Thinking & Feeling item: Do you trust the COVID-19 vaccines that are available to you?	• Not at all • A little • Moderately • Very much
B.3	Thinking & Feeling item: How concerned (worried) are you about getting COVID-19?	• Not at all concerned • A little concerned • Moderately concerned • Very concerned
B.4	Thinking & Feeling item: How important do you think getting a COVID-19 vaccine will be for your health?	• Not at all important • A little important • Moderately important • Very important
B.5	Thinking & Feeling item: How much do you think getting a COVID-19 vaccine for yourself will protect other people in your community from COVID-19?	• Not at all • A little • Moderately • Very much
B.6	Thinking & Feeling item: How safe do you think a COVID-19 vaccine will be for you?	• Not at all safe • A little safe • Moderately safe • Very safe
B.7	Thinking & Feeling item: How concerned are you that a COVID-19 vaccine could cause you to have a serious reaction or harmful side effects?	• Very concerned • Moderately concerned • A little concerned

		• Not at all concerned
B.8	Motivation item: Do you recommend to family and friends that they be vaccinated against COVID-19?	• No, I am forbidding them from vaccinating • No, I am discouraging them • I am not sure • Yes, I am encouraging them • Yes, I am strongly encouraging them
B.9	Social Processes item: In your family, who will have the final say in deciding whether you have a COVID-19 vaccine?	• Me • My spouse/partner • My mother • My father • My mother-in-law • My father-in-law • My daughter(s) • My son(s)
B.10	Social Processes item: Do you think most of your close family and friends would want you to get a COVID-19 vaccine?	• Yes • No • I am not sure
B.11	Social Processes item: Do you think most of your friends will be getting vaccinated against COVID-19?	• Yes • No • I am not sure
B.12	Social Processes item: Do you think your religious leaders would want you to get a COVID-19 vaccine?	• Yes • No • I am not sure • I am not religious
B.13	Social Processes item: How much do you trust the health care providers (doctors and nurses) who would give you a COVID-19 vaccine?	• Not at all • A little • Moderately • Very much
B.14	Social Processes item: In general, how much do you trust the South African government?	• Not at all • A little • Moderately • Very much
B.15.	Thinking & Feeling item: Have you seen or heard anything negative about any vaccines (not just COVID-19 vaccines)?	• Yes • No
B.16.a)	Thinking & Feeling item: Have you seen or heard anything bad specifically about COVID-19 vaccines?	• Yes • No If answered YES, then respondent moves to part b.
B.16.b)	Thinking & Feeling item: If you answered yes above, do you believe the bad things you have seen or heard about COVID-19 vaccinations?	• Yes • No • I am not sure what to believe
B.17.a)	Practical Issues item: It is easy for me to access a vaccination site.	• Strongly agree • Agree • Disagree • Strongly disagree
B.17.b)	Practical Issues item: Please provide a reason for your answer to the previous question.	Reason:……

Appendix E: Supplementary Results – BeSD Items

Table E (p. 94) summarises the responses to the items that make up the BeSD drivers. Responses are grouped by COVID-19 VH and COVID-19 VA respondents. This descriptive analysis highlights clear differences in the attitudes, concerns, and influences across the two groups. These supplementary results offer further depth to the results and discussion chapters.

Trust and perceptions of safety stand out as key areas of divergence. Over half of VH respondents (56.91%) report having no trust in the available vaccines, and 43.9% feel the vaccines are unsafe. In contrast, nearly half of VA individuals (48.88%) strongly trust the vaccines, with 52.13% believing they are safe for personal use. Additionally, a higher percentage of VA respondents trusted the government and healthcare workers than VH respondents. Concern for others also seems to play a role in vaccine acceptance. Almost half (47.64%) of VA respondents are very concerned about transmitting COVID-19 to their close family and friends, while 27.64% of VH individuals indicate no concern about infecting others. Personal health worries show a similar pattern, with 42.28% of the VH group reporting no concern about contracting the virus, compared to just 16.13% among those who are VA.

Social influences appear to shape attitudes significantly. Among the VH, only 21.14% believe their close family and friends support vaccination, while 69.4% of VA respondents feel their family is in favour. Similar trends are evident when it comes to perceptions of friends and religious leaders, highlighting a gap in the perceived social endorsement of vaccines. Motivation and intent also differ sharply. Before vaccines became widely available, 82.93% of VH respondents reported little to no interest in vaccinating. This lack of motivation extends to influencing others, with over half (52.46%) unsure about recommending vaccines to family and friends. In contrast, 86.56% of the VA group were willing to encourage or strongly encourage others to get vaccinated.

Practical barriers, while less pronounced, may still contribute to hesitancy. Access to vaccination sites was seen as difficult by 7.32% of VH respondents, compared to just 1.49% of those who are VA. Additionally, exposure to negative vaccine information appears widespread. A significant 95.12% of VH individuals recall hearing negative messages about COVID-19 vaccines, compared to 80.4% of the VA group. These patterns reflect the broader constructs identified in the analysis and reinforce the role of trust, social norms, and personal health concerns in shaping vaccine attitudes.

Table E: BeSD Item Responses by COVID-19 Vaccine Hesitant and COVID-19 Vaccine Accepting Groups			
	All n(%)	**COVID-19 VH n(%)**	**COVID-19 VA n(%)**
DRIVER 1: Thinking & Feeling - What people think and feel about vaccines			
COVID-19 Vaccine Hesitancy Continuum: Will you have the COVID-19 Vaccine? (n=526)			
Already had the COVID-19 vaccine	381 (72.43%)	N/A	N/A
Definitely will have the COVID-19 vaccine	22 (4.18%)		
Probably will have the COVID-19 vaccine	15 (2.85%)		
Delaying having the COVID-19 vaccine	42 (7.99%)		
Probably will not have the COVID-19 vaccine	27 (5.10%)		
Definitely will not have the COVID-19 vaccine	39 (7.42%)		
CONCERN FOR OTHERS: How concerned are you about your close family and friends getting COVID-19 from you? (n=526)			
Very	219 (41.63%)	27 (21.95%)	192 (47.64%)
Moderately	132 (25.10%)	24 (19.51%)	108 (26.80%)
A little	111 (21.10%)	38 (30.89%)	73 (18.11%)
Not at all	64 (12.17%)	34 (27.64%)	30 (7.44%)
TRUST IN VACCINES: Do you trust the COVID-19 vaccines that are available to you? (n=526)			
Very much	199 (37.83%)	2 (1.63%)	197 (48.88%)
Moderately	152 (28.90%)	13 (10.57%)	139 (34.49%)
A little	85 (16.16%)	38 (30.89%)	47 (11.66%)
Not at all	90 (17.11%)	70 (56.91%)	20 (4.96%)
CONCERN FOR SELF: How concerned (worried) are you about getting COVID-19? (n=526)			
Very	129 (24.52%)	17 (13.82%)	112 (27.79%)
Moderately	137 (26.05%)	22 (17.89%)	115 (28.54%)
A little	143 (27.19%)	32 (26.02%)	111 (27.54%)
Not at all	117 (22.24%)	52 (42.28%)	65 (16.13%)
VACCINE FOR HEALTH: How important do you think getting a COVID-19 vaccine will be for your health? (n=526)			
Very	233 (44.30%)	4 (3.25%)	229 (58.82%)
Moderately	140 (26.62%)	18 (14.63%)	122 (30.27%)
A little	64 (12.17%)	28 (22.76%)	36 (8.93%)
Not at all	89 (16.92%)	73 (59.35%)	16 (3.97%)
PROTECTING OTHERS: How much do you think getting a COVID-19 vaccine for yourself will protect other people in your community from COVID-19? (n=526)			
Very	226 (42.97%)	2 (1.63%)	224 (55.58%)
Moderately	141 (26.81%)	17 (13.82%)	124 (30.77%)
A little	70 (13.31%)	34 (27.64%)	36 (8.93%)
Not at all	89 (16.92%)	70 (56.91%)	19 (4.71%)
VACCINE SAFETY: How safe do you think a COVID-19 vaccine will be for you? (n=522)			
Very	211 (40.42%)	3 (2.44%)	208 (52.13%)
Moderately	158 (30.27%)	16 (13.01%)	142 (35.59%)
A little	88 (16.86%)	50 (40.65%)	38 (9.52%)
Not at all	65 (12.45%)	54 (43.90%)	11 (2.76%)
SIDE EFFECTS: How concerned are you that a COVID-19 vaccine could cause you to have a serious reaction or harmful side effects? (n=525)			
Not at all	144 (27.43%)	4 (3.25%)	140 (34.83%)
A little	146 (27.81%)	14 (11.38%)	132 (32.84%)
Moderately	76 (14.48%)	20 (16.26%)	56 (13.93%)
Very	159 (30.29%)	85 (69.11%)	74 (18.41%)
NEGATIVE INFORMATION: Seen or heard anything negative about vaccines (not just COVID-19 vaccines)? (n=526)			
Yes	404 (76.81%)	94 (76.42%)	310 (76.92%)
No	122 (23.19%)	29 (23.58%)	93 (23.08%)
NEGATIVE INFORMATION COVID-19: Seen or heard anything negative about COVID-19 vaccinations? (n=526)			
Yes	441 (83.83%)	117 (95.12%0	324 (80.40%)
No	84 (16.16%)	6 (4.88%)	79 (19.60%)
NEGATIVE INFORMATION: Believe the negative information you have seen or heard about COVID-19 vaccines? (n=437)			
Yes	114 (26.09%)	75 (64.10%)	39 (12.19%)
No	186 (42.56%)	4 (3.42%)	182 (56.88%)

I don't know what to believe	137 (31.35%)	38 (32.48%)	99 (30.94%)
BeSD DRIVER 2: Social Processes - Social Process that support or inhibit vaccine uptake			
DECISION AUTONOMY: In your family who will have the final say in deciding whether you have a COVID-19 vaccine? (n=526)			
Me	463 (88.02%)	108 (87.80%)	355 (88.09%)
My father	20 (3.80%)	6 (4.88%)	14 (3.47%)
My mother	39 (7.41%)	7 (5.69%)	32 (7.94%)
My spouse/partner	1 (0.57%)	2 (1.63%)	1 (0.25%)
My son(s)	3 (0.19%)	0 (0.00%)	1 (0.25%)
FAMILY NORMS: Do you think most of your close family and friends would want you to get a COVID-19 vaccine? (n=525)			
Yes	305 (58.10%)	26 (21.14%)	279 (69.40%)
No	88 (16.76%)	50 (40.65%)	38 (9.45%)
Not sure	132 (25.14%)	47 (38.21%)	85 (21.14%)
FRIEND NORMS: Do you think most of your friends will be getting vaccinated? (n=526)			
Yes	355 (67.49%)	53 (43.09%)	302 (74.94%)
No	56 (10.65%)	30 (24.39%)	26 (6.45%)
Not sure	115 (21.86%)	40 (32.52%)	75 (18.61%)
RELIGIOUS NORMS: Do you think your religious leaders would want you to get a COVID-19 vaccine? (n=526)			
Yes	200 (38.02%)	16 (13.01%)	184 (45.66%)
No	59 (11.22%)	38 (30.89%)	21 (5.21%)
Not sure	151 (28.71%)	49 (39.84%)	102 (25.31%)
Not religious	116 (22.05%)	20 (16.26%)	96 (23.82%)
TRUST HEALTH WORKERS: How much do you trust the healthcare providers (doctors and nurses) who would give you a COVID-19 vaccine? (n=526)			
Very much	216 (41.06%)	12 (9.76%)	204 (50.62%)
Moderately	193 (36.69%)	37 (30.08%)	156 (38.71%)
A little	62 (11.79%)	33 (26.83%)	29 (7.20%)
Not at all	55 (10.46%)	41 (33.33%)	14 (3.47%)
TRUST GOVERNMENT: In general, how much do you trust the South African government? (n=526)			
Very much	14 (2.66%)	1 (0.81%)	13 (3.23%)
Moderately	147 (27.95%)	12 (9.76%)	135 (33.50%)
A little	166 (31.56%)	27 (21.95%)	139 (34.49%)
Not at all	199 (37.83%)	83 (67.48%)	116 (28.78%)
BeSD DRIVER 3: Motivation - Individual motivation/hesitancy to obtain a vaccine			
EXTENT OF INTENTION: Before COVID-19 vaccines became available to your age group in RSA, how keen were you to be vaccinated? (n=526)			
High (including already vaccinated)	200 (38.02%)	3 (2.44%)	197 (48.88%)
Moderately	68 (12.93%)	3 (2.44%)	65 (16.13%)
A little	71 (13.50%)	15 (12.20%)	56 (13.90%)
Not at all	187 (35.55%)	102 (82.93%)	85 (21.09%)
WILLINGNESS TO RECOMMEND: Do you recommend to family and friends that they be vaccinated against COVID-19? (n=524)			
Yes, strongly encouraging them	217 (41.41%)	2 (1.64%)	215 (53.48%)
Yes, encouraging them	136 (25.95%)	3 (2.46%)	133 (33.08%)
I am not sure	110 (20.99%)	64 (52.46%)	46 (11.44%)
No, discouraging them	53 (10.11%)	46 (37.70%)	7 (1.74%)
No, forbidding them	8 (1.53%)	7 (5.74%)	1 (0.25%)
BeSD DRIVER 4: Practical Issues - Practical issues regarding seeking or receiving a COVID-19 vaccination			
ACCESSIBILITY: Easy to access a vaccination site (n=526)			
Strongly Agree	336 (63.88%)	64 (52.03%)	272 (67.49%)
Agree	169 (32.13%)	48 (39.02%)	121 (30.02%)
Disagree	15 (2.85%)	9 (7.32%)	6 (1.49%)
Strongly disagree	6 (1.14%)	2 (1.63%)	4 (0.99%)
VACCINATION AS AN ADULT – other than COVID-19 vaccine (n=526)			
Yes	231 (43.92%)	38 (30.89%)	193 (47.89%)
No	271 (51.52%)	81 (65.85%)	190 (47.15%)
I am not sure	24 (4.56%)	4 (3.25%)	20 (4.96%)