Identifying Effective Strategies for Combatting COVID Misinformation

in

the Digital Age

by

Shalini Sivanandam

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved May 2023 by the
Graduate Supervisory Committee:

Bradley Doebbeling, Chair
Yunro Chung
Alexis Koskan
Kristy Roschke

ARIZONA STATE UNIVERSITY

August 2023

ABSTRACT

The unprecedented amount and sources of information during the COVID-19 pandemic resulted in an indiscriminate level of misinformation that was confusing and compromised healthcare access and delivery. The World Health Organization (WHO) called this an 'infodemic', and conspiracy theories and fake news about COVID-19, plagued public health efforts to contain the COVID-19 pandemic. National and international public health priorities expanded to counter misinformation. As a multi-disciplinary study encompassing expertise from public health, informatics, and communication, this research focused on eliciting strategies to better understand and combat misinformation on COVID-19.

The study hypotheses is that 1) factors influencing vaccine-acceptance like socio-demographic factors, COVID-19 knowledge, trust in institutions, and media related factors could be leveraged for public health education and intervention; and 2) individuals with a high level of knowledge regarding COVID-19 prevention and control have unique behaviors and practices, like nuanced media literacy and validation skills that could be promoted to improve vaccine acceptance and preventative health behaviors.

In this biphasic study an initial survey of 1,498 individuals sampled from Amazon Mechanical Turk (MTurk) assessed socio-demographic factors, an 18-item test of COVID-19 knowledge, trust in healthcare stakeholders, and measures of media literacy and consumption. Subsequently, using the Positive Deviance Framework, a diverse subset of 25 individuals with high COVID-19 knowledge scores were interviewed to identify these deviants' information and media practices that helped avoid COVID-19 misinformation.

Access to primary care, higher educational attainment and living in urban communities were positive socio-demographic predictors of COVID-19 vaccine acceptance emphasizing the need to invest in education and rural health. High COVID-19 knowledge and trust in government and health providers were also critical factors and associated with a higher level of trust in science and credible information sources like the Centers for Disease Control (CDC) and health experts.

Positive deviants practiced media literacy skills that emphasized checking sources for scientific basis as well as hidden bias; cross-checking information across multiple sources and verifying health information with scientific experts. These identified information validation and confirmation practices may be useful in educating the public and designing strategies to better protect communities against harmful health misinformation.

DEDICATION

This dissertation is dedicated to,

My dear husband: Kumara Singaravelu,

Thank you for your patience, kindness, and love through all my ups and downs. I could not have done this without your constant encouragement and support.

My loving daughter: Nila Kumara,

You are my greatest joy! I'm inspired by your constant energy and enthusiasm for learning new things and hope this accomplishment inspires you in return.

My devoted sister: Poorni Sivanandam,

I started this effort with the hope of showing you at a time of our profound grief over the loss of our parents, that life goes on. Every time I faltered, you reminded me of our parents' unconditional love and encouragement of all our endeavors. Thank you for always being there.

My guardian angels: Srinivasan Sivanandam and Mallika Rani Sivanandam,

Always in my thoughts guiding my every action, you are both a constant presence in our lives as we embrace loving memories with you. When I need advice, I turn to lessons you have imparted to us from our precious days together. I know you are here to share this with me.

I am grateful to you all.

ACKNOWLEDGMENTS

I would like to sincerely thank my advisor, Dr. Bradley Doebbeling, for his mentorship and constant support of my research. I am forever indebted to him for his unwavering faith in me and incredible guidance. His academic accomplishments, notwithstanding he has taken time to help me learn many skills required for the academic world. He has enormous kindness for all his colleagues and has taught me the valuable lesson to listen more and learn by observing. He has trusted my abilities and provided me with opportunities and exposure at many instances. This dissertation would not have been possible without his constant encouragement.

I would also like to extend my gratitude and appreciation to the rest of my committee. Dr. Alexis Koskan, serving on my committee, provided her incredible public health expertise. She has taught me the nuances of qualitative research and helped me learn valuable skills that I will now cherish and apply in future work. Dr. Kristy Roschke has provided me with enormous guidance about media science of which my knowledge is limited. She has encouraged me with sharp insights and shown how collaborative research across various disciplines can be meaningful and satisfying. I thank Dr. Yunro Chung for his continued support, advice and sharing his wealth of knowledge in data science and the health informatics domain. He has encouraged me to explore different approaches to data analysis to arrive at informative results.

Finally, I acknowledge and appreciate the time and consideration afforded to me by our PhD Program Director, Dr. Dongwen Wang. He has been a tremendous support on this PhD journey and helped me navigate this undertaking.

TABLE OF CONTENTS

Page

CHAPTER Page

CHAPTER Page

LIST OF TABLES

LIST OF FIGURES

Figure Page

1. INTRODUCTION

1.1 Background

During the COVID-19 pandemic there has been an enormous influx of healthcare related information. As people gained access to public health facts through news and social media, and received updates as more knowledge about the virus and its impact became available, they were also inundated with numerous versions of inaccurate or misleading information. The World Health Organization (WHO) and the United Nations (UN) declared this an "infodemic", and the Office of the Surgeon General released an action agenda to tackle the problem of misinformation (Office of the Surgeon, 2021).

The pandemic saw the emergence of myths, rumors, and falsehoods at such an unprecedented level that it became extremely confusing and affected the ability of the public to acquire and act on good health information. It had detrimental effects on social cohesion and respect for others, as well as people's mask wearing, social distancing, vaccine acceptance and several other critical health behaviors (Roozenbeek et al., 2020). Various disciplines such as public health, the media industry (news and social media), and health informatics all played key roles in managing the pandemic and have undergone transformations to battle this misinformation landscape.

1.1.1 Public Health and COVID-19 Misinformation

The World Health Organization (WHO) defines an infodemic as "an overabundance of information, including false or misleading information during a disease outbreak".

In a conference to address the challenge of the global COVID infodemic, the WHO identified a public health research agenda (Calleja et al., 2021). Three important workstreams were identified:

1. measuring and continuously monitoring the impact of infodemics during health emergencies.
2. detecting signals and understanding the spread and risk of infodemics.
3. promoting the development, adaptation, and application of interventions and toolkits for infodemic management.

This research agenda outlined further entails the assessment of the role of actors, influencers, platforms and channels, and an understanding of how misinformation affects behavior in different populations. It is thus evident that understanding the problem of misinformation and its impact on health literacy and moreover, vaccine acceptance, is critical. Because of the diverse roots and complexity of this problem of public health misinformation, we felt it important to approach it from an interdisciplinary perspective. This approach may be one of the unique aspects of this investigation.

The impact of socio-economic factors on COVID-19 outcomes was evident and studies revealed health disparities, amidst local communities, states, and nations and across political affiliations (Hudson & Montelpare, 2021). The access issues range from access to masks, vaccines, clinical care and COVID knowledge. Misinformation affected individuals based on age, gender, race, income, and type of community they resided in, but disproportionately affected vulnerable minority populations (Hudson & Montelpare, 2021; Kumari et al., 2021). Considering the extraneous circumstances, COVID vaccine

research and development has been a remarkable achievement of the government and pharmaceutical industry in recent times. However, ensuring high levels of prevention and control measures and specifically, vaccine acceptance, has been an uphill battle in this climate of misinformation and remains a significant public health challenge.

1.1.2 Health Informatics and COVID Misinformation

In the United States, radical changes to reimbursement policies and incentives to incorporate telemedicine in practices during the COVID-19 pandemic came with an enormous push to improve informatics adoption by patients and providers (Omboni et al., 2022). Advances such as mobile tracing apps for surveillance and tools for information sharing via social media evolved and were employed to some extent during the pandemic. By contrast, the use of technology to disseminate timely and accurate health information has been suboptimal, as there has been an exponential influx of both good and bad information.

The level of misinformation and disparity in the public's knowledge of COVID-19 treatment and prevention has alarmed healthcare providers and public health professionals. The digital tools developed in the past decade were greatly expected to help tackle major public health problems such as this (Hamel et al.; Ting, Carin, Dzau, & Wong, 2020). Health informaticists anticipated that the availability of digital technologies such as the Internet of Things (IoT), big data, Artificial Intelligence and Blockchain would play a crucial role in supplementing classic infection-control and public health measures to contain COVID-19. However, the reality has revealed substantial gaps in our approach to public health education and emphasized the need to better understand and

serve the health information-seeking behaviors of patients and the public. It is evident that technological advancement must be combined with education and outreach of patients and providers.

eHealth (electronic health) as a component of health informatics has played a significant role in the pandemic and deserves particular attention in the context of misinformation. As per the WHO, eHealth is the use of information and communication technologies for health care purposes ("WHO Definition of eHealth.,"). An independent consultation commissioned by the WHO to develop a framework, highlights the need to quantify the impact through analysis of digital and non-digital data for infodemic management (Tangcharoensathien et al., 2020).

1.1.3 Media Industry and COVID-19 misinformation

As the pandemic affected individuals across the globe, the media industry was charged with informing people of the magnitude of the healthcare crisis. National news coverage competed with local news campaigns throwing so much exposure on the calamity faced in various countries (Pew Research Center, 2020). While people were forced to stay at home with social distancing, media consumption soared. However, studies reveal that all media sources, including professional news and social media contributed to the dissemination of healthcare misinformation (L. Bode & Vraga, 2018; Bunker, 2020). Research suggests COVID-related knowledge was consequently impacted negatively, and all media sources have contributed to negative health impacts (Su, Borah, & Xiao, 2022).

The pandemic has demonstrated that media literacy which is the ability to access and evaluate media in all forms plays an important role in people's health behaviors and understanding the interplay is critical to combat misinformation (Hamel L, 2021; NAMLE, 2023). Misinformation in media has led to the corrosion of trust in the public and as per the Edelman Trust Barometer drove fear to peak levels in the community (Barometer, 2021). Furthermore, political factors also led to greater misinformation and erosion of faith in government and public health, particularly the CDC.

1.2 Statement of need

The negative impact of COVID-19 misinformation has been detrimental to safe and effective healthcare delivery and remains a deeply divisive issue in our communities. Health outcomes range from vaccination, clinical complications, mortality, loss of income/jobs and changes to health seeking behaviors. Personal and political beliefs have intensified through the pandemic and mistrust of our government and healthcare are substantial barriers to overcome (Capasso, Caso, & Zimet, 2022). To make meaningful strides to reverse the harm in public trust and ensure that public health and healthcare knowledge is based on accurate clinical and scientific information, we suggest a multi-pronged interdisciplinary approach to combat misinformation.

1.2.1 Interdisciplinary Research Approach

The pursuit of this research is to develop an understanding how the infodemic has impacted COVID-19 knowledge in the public, and consequently adoption of preventive health practices such as vaccination and subsequent COVID-19 infection, hospitalization, and mortality. This population health informatics study is unique in its inter-disciplinary

approach to address misinformation in healthcare. It combines research expertise from the areas of public health, infectious diseases epidemiology, implementation science, journalism, and health informatics. A robust survey was developed in consultation with clinical and epidemiologic experts to elicit data from a range of socio-demographic variables, healthcare access, COVID knowledge, trust, media literacy and news consumption behaviors. This collaborative problem-solving should both allow us to identify innovative solutions but also suggest strategies for the dissemination of meaningful findings and public health education approaches to a wider audience.

1.2.2 Positive Deviance Framework

This study further builds on the initial survey with a follow-up interview of a subset of individuals with a high level of COVID knowledge. It is novel in its application of Positive Deviance to study COVID misinformation. Previous attempts to assess public knowledge focused on behaviors (e.g., vaccine uptake, mask-wearing), instead of knowledge (Inoue, Shimoura, Nagai-Tanima, & Aoyama, 2022; Kumari et al., 2021; Ruiz & Bell, 2021).

Positive deviance is an approach that allows to identify individuals that have uncommon behaviors or health practices, such as overcoming childhood malnutrition, preventing hospital acquired infections, or improving education. It has also been successfully used to identify unique practices or strategies that overcome challenges in healthcare (Bradley et al., 2009; Sreeramoju et al., 2018; Toscos, Carpenter, Flanagan, Kunjan, & Doebbeling, 2018). This will yield a better understanding of how consumers of health awareness campaigns receive, process, and share their knowledge. The

potential to impact health education and health literacy and improve health outcomes is significant.

Positive deviance has been employed successfully to discover approaches that work and improve quality of health care (Bradley et al., 2009; Marsh, Schroeder, Dearden, Sternin, & Sternin, 2004; Sreeramoju et al., 2018). This assumes that the exceptional outcomes experienced by some healthcare consumers suggest that they have the know-how to navigate the healthcare system and manage their personal health (Bradley et al., 2009). The positive deviance approach has been shown to improve health outcome of complex problems across the globe such as infection control, pregnancy outcomes, childhood nutrition etc. (Bradley et al., 2009; Sreeramoju et al., 2018).

By studying the behaviors of positive deviants (PDs), we can learn about practices that helped acquire reliable health information and means to combat misinformation. This will allow us to develop and disseminate public health education efforts and improve quality of health outreach efforts.

The positive deviance framework in this study was focused on two main goals:

1. exploring information practices to acquire high COVID-19 knowledge while withstanding misinformation and,
2. effective methods for sharing and promoting reliable health information.

Given the context of COVID-19 misinformation inundating healthcare consumers in this digital age, it has become difficult for individuals to identify accurate and reliable knowledge that helps them adopt important preventative health behaviors such as mask

use, social distancing, and vaccination. We may promote these practices by working with stakeholders to increase adoption of such best practices.

By identifying positive deviants with comprehensive and accurate knowledge of COVID-19 prevention and control measures, we may be able to uncover strategies to effectively design and implement community intervention, information, and health literacy educational programs. This could provide key perspectives on gaps in how we educate our citizens to be more critical consumers of news that may not be available by conventional public health or media educational approaches.

1.3 Research Aims

Aim 1: Systematic review of literature on COVID Misinformation, health literacy and vaccine acceptance.

Conduct a literature review of methodological approaches to assess current evidence on COVID-19 knowledge is acquired and the key predictors of the of health literacy, public health information literacy, critical appraisal of media and vaccine acceptance.

Aim 2: Survey participants to assess the impact of socio-demographic factors, COVID-19 knowledge, trust, and media literacy.

Assess the factors that impact COVID-19 knowledge and vaccination, and to help address gaps identified in Aim 1.

Aim 3: Interview positive deviants with high COVID-19 knowledge to understand and improve how they combatted misinformation while acquiring and sharing reliable information.

Based on the findings from the survey results, apply a mixed method approach to interview and review information from participants to assess best practices that protect against misinformation.

1.4 Outline of Thesis

In this chapter, an introduction on the need to combat COVID-19 misinformation and the various domains of research to tackle this problem are presented. The purpose of the unique interdisciplinary nature of this study and the positive deviance framework are presented with the research aims. In Chapter 2, an overview of the literature on the COVID-19 misinformation, media and health literacy as it pertains to COVID-19 knowledge, and roles and responsibilities of entities that impact knowledge and vaccination outcomes is presented. Chapter 3 summarizes the outcomes of the initial survey and describes factors associated with high knowledge scores and identifies the key determinants (socio-demographic, trust, and media literacy). The quantitative data from this survey is used to develop a predictive model for COVID-19 vaccination and the interpretations from the logistic regression are presented. The follow up interview data of the subset of participants who are positive deviants with high knowledge scores based on their response to the initial survey is analyzed and findings from this qualitative data is summarized in Chapter 4. Conclusions and suggested strategies for various public health education and COVID-19 vaccine acceptance are discussed in Chapter 5.

2. OVERVIEW OF LITERATURE

2.1 Search Strategy

The goal of this literature review was to address these primary research questions:

"What were the key predictors of COVID-19 vaccine acceptance?"

and

"What were the key predictors of a perfect or near-perfect score on COVID-19 prevention and control knowledge questions?"

Three literature search tools: Pubmed, Google Scholar, and ASU Library's One Search were used concurrently to capture articles using the search terms: Health informatics and COVID health literacy, COVID-19 misinformation, vaccine hesitancy, COVID infodemic, COVID-19 vaccine survey, COVID-19 knowledge survey. Similar articles and link out features of the databases were further employed to identify articles cited in key papers and article citing key papers with particular attention to the health informatics focus. The search was limited to peer-reviewed articles relevant to the U.S. population health perspective or commonly used health informatics approaches of relevance.

After screening 113 articles based on those criteria, an in-depth full text assessment to evaluate their potential impact on the research study was completed. The articles were classified as high (32), medium (24) and low (57) impact. A detailed review of the literature is presented with findings from high and medium impact articles.

2.2 Key Findings and Methods for Research Consideration

2.2.1 COVID-19 Misinformation

The extraordinary flood of inaccurate information regarding COVID-19 pandemic has been extensively documented in the literature as "COVID infodemic", and defined as false information regardless of intent to mislead (Bin Naeem & Kamel Boulos, 2021). The importance of combatting misinformation has been repeatedly emphasized by the scientific community (Hotez et al., 2021; Lee et al., 2020). Misinformation alters an individual's perceptions and beliefs and affects their healthcare decision-making with detrimental effects. An inaccurate understanding of COVID-19 reduced the perceived threat of infection and perceived benefit of healthy preventive behaviors as well.

To allow sufficient herd immunity, research has suggested that at least 55% of the population needed to be vaccinated (Loomba, de Figueiredo, Piatek, de Graaf, & Larson, 2021). COVID-19 misinformation has threatened herd immunity goals by the negative effects to public perceptions about the pandemic, compliance with public health guidance and vaccine acceptance. Trust in health authorities and inherent bias amid certain socio-demographic are compounded by even brief exposure to misinformation which affects the long-term outcomes (Loomba et al., 2021; Roozenbeek et al., 2020). Misinformation has been strongly associated with reduction in vaccine intent and is especially the case when the misinformation is more scientific sounding (Loomba et al., 2021). Clear communication on vaccine safety and efficacy must be effective in undoing the damage of exposure to misinformation.

In addressing misinformation, however, it is important to address these false claims with cultural and religious awareness in mind (Skafle, Nordahl-Hansen, Quintana, Wynn, & Gabarron, 2022). An assessment of type of misinformation and the source of misinformation, demonstrated that it varies country to country. The forms of misinformation range from vaccine-specific nonfactual claims, adverse effects leading to genocide, corrupt elites, government distrust, concerns about violation of autonomy and privacy, DNA alterations, evangelical hubs with conspiracy theories etc. (Skafle et al., 2022)

Research suggests that COVID-19 misinformation could be broadly classified into the following three domains; 1. medical misinformation, 2. conspiracy claims and 3. vaccine development myths (Skafle et al., 2022). Medical misinformation encompassed concerns about vaccine side effects, or that they could cause COVID-19, or be poisonous. Conspiracy claims referred to secret societies and hidden power structures with agenda such as Big Pharma, race depopulation and corrupt elites as well as the speculation that COVID-19 was man made. Finally, some forms of misinformation suggested problems with skipping crucial steps in vaccine development, the content of the vaccines and that the vaccine was developed before the existence of COVID-19(Skafle et al., 2022).

2.2.2 Infodemic

The overabundance of information was termed “infodemic” by the World Health Organization (WHO) as concern over the inundation of accurate and inaccurate information during COVID was raised. There has been widespread apprehension that reliable information for informed decision-making was impaired and consequently

increased the public health risk (Calleja et al., 2021; Cole, Tulloch, Schmidt-Sane, Hrynick, & Ripoll, 2022; Gisondi, Barber, et al., 2022; *WHO Director General, Tedros Adhanom Ghebreyesus at the Munich Security Conference*, Feb, 2020).

The concept of an infodemic, however, is not limited to mass media or social media. It extends to a massive number of academic publications that was generated subsequent to the pandemic, with a surge in COVID-19 related submissions and corresponding increase in corrections and retractions in peer-reviewed literature as well (Balkányi, Lukács, & Cornet, 2021).

COVID-19 pandemic saw changes in information and communication ecosystems which created enormous public health challenges (Calleja et al., 2021; Gisondi, Barber, et al., 2022; Himelein-Wachowiak et al., 2021). One such issue was computational amplification of polarizing messages and the use of bots and cyborgs to manipulate search engines and boost certain social media messages. Microtargeting of individuals with a susceptible mindset to propagate personal or political agenda has been seen extensively (Himelein-Wachowiak et al., 2021). Especially among social media users, microtargeting resulted in individuals being restricted to their own social media echo chambers. Additionally, the unfavorable trend of modified media practices in TV and radio enabled propagation of online information of poor quality.

2.2.3 Health Literacy

Health literacy is the ability to access, understand, evaluate and use information to promote health (Inoue et al., 2022). It includes both individual characteristics and societal resources that someone requires to obtain health information, understand the

information gathered and the ability to apply the health information in healthcare decision-making (Bin Naeem & Kamel Boulos, 2021). In terms of COVID-19 even when reliable evidence-based information has been available, vaccine-related health literacy was limited by people's ability to comprehend the information accurately and interpret the findings from research (Biasio, Bonaccorsi, Lorini, & Pecorelli, 2021). Excessive influx of academic knowledge beyond the scope of laypeople and conflicting opinions between regulatory agencies further compounded the situation with propaganda of "fake news." A survey on vaccine literacy by Biasio et al.(Biasio et al., 2021), conducted when vaccine development was in its early stages, showed that health literacy had a strong association to positive attitudes towards vaccine acceptance. According to this study as vaccine development progressed it was accompanied by a corresponding increase in search for reliable information. However, the complexity and technicality associated with this information limited comprehension even among highly educated populations.

Another study which examined the correlations between Japanese adults' COVID-19 information sources and their knowledge about the virus showed that mass media was the primary medium, followed by digital media, face-to-face communication, and social media (Inoue et al., 2022). This research further demonstrated that higher health literacy was associated with higher COVID-19 knowledge.

2.2.3.1 Digital Health Literacy

Digital health literacy is a form of health literacy where an individual's information is acquired through electronic media. Living in the digital age where not every piece of information is subject to authenticity and validity checks, it is imperative

that people develop the ability to critically appraise content and protect themselves against misinformation (Bin Naeem & Kamel Boulos, 2021).

It is believed that digital health literacy can help improve preventative health behaviors and capacity building about one's health and seeking out various treatment options (Choukou et al., 2022). For example, with the COVID-19 lock down, there was a growth in digital health technologies that allowed online services and patient education content. But during the COVID-19 pandemic, social distancing also resulted in a breakdown of in-person communications, causing a reliance on digital platforms for social connection (Choukou et al., 2022). Users were found to increase their presence and reliance of social media platforms such as Facebook, Instagram, Reddit, TikTok and YouTube.

As activity on social media platforms and access to e-services related to COVID-19 health news increased, so did the complexity of knowledge and difficulty in identifying reliable information online. Given this context, it has become imperative to focus on digital health literacy as a fundamental skill, to empower citizens (Dib, Mayaud, Chauvin, & Launay, 2022). It equips people to recognize misinformation and make informed decisions about vaccination and other COVID related measures.

To combat the issues of an infodemic, research by (Eysenbach, 2020) proposes an approach with four pillars. The authors recommend as the first pillar, accurate knowledge translation to help understand the facts. The second pillar is to refine knowledge through filtering and fact-checking. The third aspect is to build eHealth literacy with the ability to

appraise health information from electronic sources. The final pillar is monitoring and social listening with infoveillance.

2.2.3.2 Health Literacy Guidelines.

Systematic efforts to provide guideline to address fake news and improve COVID health literacy were undertaken during the pandemic, and one such widely accepted resource is from the International Federation of Library Associations' (IFLA) (Bin Naeem & Kamel Boulos, 2021; "The International Federation of Library Associations and Institutions (IFLA). How to Spot Fake News – COVID-19 Edition,"). Their checklist identifies eight steps: (i) "consider the source", (ii) "check the author", (iii) "check the date", (iv) "check your biases", (v) "read beyond", (vi) "seek supporting sources", (vii) ask "is it a joke?", and (viii) "ask the experts".

Another checklist from Meriam Library, California State University called CRAAP (Currency, Relevance, Authority, Accuracy and Purpose) (Blakeslee, 2004; Blizzard, 2021), encourages one to evaluate if a resource based on the criteria of (i) is it current; (ii) is it relevant, (iii) is it accurate and truthful, (iv) who is the author and (v). what is the purpose of the content.

A mnemonic based approach (CRABS) proposes assessing Conflict of interest, References, Author, Buzzwords, Scope of practice for identify misinformation (Stokes-Parish, 2022).

2.2.4 Social Media Platforms

While COVID misinformation spans traditional news media such as newspapers and television news and digital media, social media platforms have been identified as

being particularly rampant with misinformation. Traditional media is associated with higher financial costs when compared to social media which is free, resulting in an explosion of information on social media and available to a large audience (Corinti, Pontillo, & Giansanti, 2022; Gisondi, Barber, et al., 2022). However, unlike traditional media, social media is not held to the higher standard of fact-checking and verification which can take time and lacks the permanence of traditional media as it can be altered multiple times. Information can be modified/changed almost instantly and thus prone to high levels of variability and misinformation.

COVID-19 misinformation is a global problem. According to a meta-analysis study across data from multiple countries to assess the prevalence of misinformation, it was found that prevalence could range from 2.5 to 55.4% of the general population, but be as high as 96.7% in the anti-vaccine group (Zhao et al., 2023). Health misinformation was found to be particularly high on Twitter and analysis of tweets relayed alarmingly high levels of fake information (Suarez-Lledo & Alvarez-Galvez, 2021).

However, some forms of information from electronic media can be useful in predicting disease outbreaks or spread too. (Eysenbach, 2009) wrote, “Infodemiology can be defined as the science of distribution and determinants of information in an electronic medium, specifically the Internet, or in a population, with the ultimate aim to inform public health and public policy.” Pioneering research by this team in 2006 showed how data on search terms could predict influenza outbreaks.

2.2.5 Social Responsibility

Research suggests that with popular social media platforms such as Facebook, Twitter, WhatsApp, Instagram and YouTube having extraordinary membership reaching billions of consumers, corporate social responsibility of these entities must be explored. Avenues for proprietary computer algorithms in reducing harmful information from being propagated must be further addressed (Gisondi, Barber, et al., 2022; Himelein-Wachowiak et al., 2021; Lurie et al., 2022). While ethical obligations of media entities are regulated to some extent, the COVID-19 pandemic has exposed the need for further policy review. The scientific community must also expand the focus from research and implementation to public health messaging and health education.

2.2.6 Health Informatics and Health Literacy

Artificial Intelligence (AI) driven approaches to improve eHealth literacy are proposed to help augment the human capacity to filter, appraise and assimilate health information (Liu & Xiao, 2021). AI assisted language translation, AI driven content filtering and incorporation of eHealth literacy in K-12 curriculum are proposed as solutions to combat misinformation. Other informatics methods such as topic modeling and sentiment analysis have also been demonstrated to help monitor COVID related beliefs and perceptions(Lyu, Han, & Luli, 2021; Monselise, Chang, Ferreira, Yang, & Yang, 2021). By studying not only negative emotions toward COVID information, but also positive emotions we are able to leverage plans for dissemination of authoritative information.

To further tackle this issue, the WHO Information Network for Epidemics (EPI-WIN) developed an analysis methodology for signals detection (Purnat, Vacca, Burzo, et al., 2021; Purnat, Vacca, Czerniak, et al., 2021). By creating a taxonomy of keywords for social listening they have been able to form qualitative insights on the scope of narratives that have the most engagement from the digital public. Several similar efforts to understand the scope of misinformation in social media by identifying spurious data are being pursued (Muric, Wu, & Ferrara, 2021; Ngai, Singh, & Yao, 2022; Pool, Fatehi, & Akhlaghpour, 2021). By identifying keywords that promote strong antivaccination sentiments on Twitter data and correlating it with the users' political affiliation researchers can identify individuals' moral values and stance on social issues. Knowing this allows the design of future public health messaging and campaigns.

2.2.7 Vaccine Hesitancy

A systematic review of literature identified key predictors of COVID-19 vaccine hesitancy(Hudson & Montelpare, 2021). These predictors include the following socio-demographic factors: age, income, education, health literacy, rurality and parental status. Individual factors which predicted vaccine hesitancy include mistrust in authority, risk aversion and disgust sensitivity. Another survey of psychological variables that negatively influenced vaccine acceptance demonstrated that anti-vaccine conspiracy theories directly influenced individuals' trust in science and government, reducing individuals likelihood of choosing to vaccinate (Capasso et al., 2022; Viswanath et al., 2021).

Lack of trust has remained an issue amongst marginalized communities because of a history of mistreatment by science, politicians and judicial system, and specifically in evaluating vaccine acceptance was identified as another key determinant (Gisondi, Chambers, et al., 2022). These communities further suffer from a lack of access to adequate and accurate information. Individual, collective, and commercial accountability plays a very important role in establishing trust (Gisondi, Chambers, et al., 2022). The pandemic has also demonstrated the inequities in health care, access in general and vaccine availability. Inherent issues with equity in healthcare access and affordability also require tackling.

Another determinant of COVID-19 vaccine hesitancy is the impact of rumors and conspiracy theories, especially regarding vaccine development (Islam et al., 2021). Some rumors were in the track that critical steps in vaccine trials were skipped, and examples of conspiracy theories were in the track of microchips that would be inserted with the COVID-19 vaccines (Islam et al., 2021). Numerous such rumors and conspiracy theories have been perpetuate, such misinformation has to be countered by educating the public with credible fact-based information.

To combat vaccine specific inaccuracies, it is important to emphasize risk communication and community engagement. Misinformation disrupts the cognitive processes and fragments one's ability to think logically, according to one author (Stokes-Parish, 2022). Also, according to this research by Stokes-Parish, 2022, people are prone to believe misinformation that supports their worldview. By prebunking false information in advance, the idea of cognitive inoculation allows people to fortify their cognitive

defenses (Pilditch, Roozenbeek, Madsen, & van der Linden, 2022). It has been shown to be effective in other contexts like climate change and political disinformation. This concept suggests use of inoculation messages that foreworn the public of impending attack and preemptively refuting specific myths. Cognitive inoculation of the public with active efforts to debunk myths and educate has been proposed as a possible strategy in combatting COVID-19 misinformation (Islam et al., 2021; Kožuh & Čakš, 2021; Kumari et al., 2021; Liew & Lee, 2021). These authors recommend improving prior knowledge to enhance cognition of accurate scientific information fosters trust.

2.3 Summary of Literature Review

Misinformation created chasms in COVID-19 knowledge in the population and competed with reliable public health messaging from credible sources. To improve vaccine acceptance and ensure health behaviors to prevent the spread of COVID, it is essential to understand the interplay of misinformation. Several socio-demographic differences have been identified in people's susceptibility to misinformation with corresponding increases in unsafe health behaviors. Compliance with public health guidelines such as mask use, hand washing, social distancing, and awareness of impact to at-risk individuals were all dependent on the level of accurate COVID-19 knowledge individuals possessed. Consequently, to improve vaccine acceptance, collaboration across several disciplines beyond healthcare became apparent. Public health information was no longer limited to dissemination by healthcare entities, but now expanded to include digital platforms, media outlets as well political leaders.

It is evident that assessing which areas of COVID-knowledge were problematic, and the characteristics of those with good knowledge relative to other populations would be useful. The need for understanding how COVID-knowledge interplays with trust as it relates to vaccine acceptance was also apparent. Another area that needed to be accounted for in fighting misinformation was media literacy. This literature review thus informs the analytical approach to the subsequent survey and interview data of this study.

3. ANALYSIS OF QUANTITATIVE DATA

3.1 Methods

3.1.1 Survey Design

A 58-item initial web-based survey was developed with input from the Arizona State University (ASU) COVID Translational Team leaders (including a group of doctoral-level faculty in medicine, public health, and informatics). Questions included those on socio-demographic background, healthcare access, COVID-19 knowledge, political ideology, trust, media literacy and media consumption. It included some validated survey items to assess the knowledge of effective prevention and control strategies against COVID-19. This survey also utilized eight questions from the Kaiser Family Foundation myths and facts about COVID (Hamel L, 2021; Kaiser Family Foundation, 2021). A brief evaluation of 15 practices recommended by CDC was framed and administered. Trust in different entities that disseminated information about COVID was evaluated. To measure attributes of media literacy, participants answered several 5-point Likert-type scale questions drawn from previous media related research. Participants also answered a series of questions about their typical media usage, their trusted sources of information, and demographic characteristics. The complete survey is presented in Appendix A.

3.1.2 Survey Recruitment

Amazon Mechanical Turk (MTurk) was used to recruit a survey sample. Study participants for the survey were selected using river sampling (incentivizing workers in an online platform where individuals are paid to complete surveys) via MTurk. Eligibility criteria included (a) being 18 years and older (b) residing in the U.S. MTurk enables

large, diverse samples from a nationwide sample from across the U.S. Cloud Research filtration was administered for screening of the participants to overcome the limitations of MTurk sampling (Litman & Robinson, 2020). This initial survey was administered to 1510 study participants in September 2022, of which 12 participants were removed as several responses were missing answers, with a final participant N of 1498.

3.1.3 Data Analysis

Data from MTurk was generated into an excel database. Statistical Analysis Software (SAS) 9.4 version was used to import this data. Data cleaning and reverse coding of some variables scored on the Likert scale was performed.

The survey data included key demographics (gender, age, language, community type, race, education, employment status and household income). It also collected data on political affiliation, level of trust (government/CDC/Pharma/doctor/pharmacist), health coverage, COVID-19 diagnosis, and treatment (personal/near and dear) as well as vaccination status. Survey participants then responded to 18 COVID knowledge questions. Another critical component of the survey includes participant information related to news media literacy, discrimination of misinformation, self-reported media literacy skill, media consumption (social media, newspaper, tv news vs digital newspapers). Univariate and bivariate statistics were performed to describe the participant characteristics and summarize their responses as they related to a perfect or near-perfect COVID-19 knowledge score and vaccination status.

Subsequent analysis of this data was mainly focused on the outcome variable of vaccination status with the goal of developing a predictive model using logistic

regression. After a preliminary descriptive analysis was completed, the binary outcome variable vaccinated was created with value '1' assigned to those who either received the original or original plus booster dose of the vaccine. Those who either planned to or did not intend to receive the vaccine were coded with the value '0'. Appropriate tests of significance such as the chi-square and t-tests were performed to identify key input variables.

There were a small number of missing values that were imputed based on median values grouped by Education, Race and COVID knowledge level for certain input variables such Age, Gender, health insurance, previous covid diagnosis etc. (Summarized in Table 3.1). The data set was then randomly split into 70 and 30 % training (n=989) and validation (n=509) data sets that were generated that reflected the same percentage of the vaccination rate (76%) in both datasets. Some categorical variables with too many levels or levels with too few cases were collapsed for thresholding. As all 'other' gender participants were vaccinated, the gender level 'other' was excluded as it created a perfect separation error when building the predictive model.

The trust questions were found to be highly correlated and consolidated into one Trust score. Correlation and rotational matrixes were generated for the media questions and grouped into three highly correlated areas of which corresponded to three common domain areas identified in research: media mindfulness, media locus of control and media self-efficacy.

Table 3.1 Summary of Range of Key Input Variables and Missing Values

Variables	N	Missing	Mean	Std Dev	Min	Max
No missing values						
Total knowledge score	1498	0	15.4	3.35	3	18
Education	1498	0				
Race	1498	0				
Socio-demographic						
Age	1483	15	43.1	13.04	19	84
Gender	1487	11				
Community	1494	4				
Employment Status	1495	3				
Household Income	1496	2				
Political Affiliation	1495	3				
Health related questions						
Health insurance coverage	1496	2				
Previous COVID diagnosis	1495	3				
Primary Care access	1495	3				
Trust questions						
Trust in CDC	1497	1	3.2	1.26	1	5
Trust in Doctor	1496	2	3.7	0.96	1	5
Trust in Natl Govt	1496	2	3.0	1.12	1	5
Trust in State Govt	1497	1	2.9	1.09	1	5
Trust in Pharmacist	1495	3	3.5	0.94	1	5
Trust in Pharma Companies	1495	3	2.5	1.04	1	5
Media questions						
Dislike Thinking	1497	1	3.8	1.14	1	5
Tendency to Avoid situations	1497	1	3.9	1.14	1	5
Preference for complex problems	1497	1	3.2	0.03	1	5
Attention to multiple sources	1497	1	3.8	0.98	1	5
Ability to take right actions	1497	1	4.1	0.82	1	5
Skills to interpret media	1493	5	4.0	0.71	1	5
Ability to judge news accuracy	1491	7	4.0	0.77	1	5
Acceptance of news at face value	1496	2	3.7	1.16	1	5
Press obligation of diverse views	1494	4	3.7	1.05	1	5
Ability to critically review news	1493	5	4.4	0.69	1	5

To perform the variable selection for the final logistic model, we first assessed interaction between terms using a forward variable selection. None of the interaction terms were significant. The Bayesian information criterion (bic) value was calculated as 0.008665 and this was used in comparing main effects models with a best subset approach based on the bic value. Based on the need for interpretive value, political affiliation comparing republican vs. democrats and news consumption from CNN and Fox News were included as explanatory variables. The results of this final logistic regression are presented in the next section.

3.2 Results

The findings from the data analysis are summarized and presented in this section.

3.2.1 Socio-Demographics

Table 3.2 summarizes the socio-demographic characteristics of the survey participants. Of the 1,498 participants there was a slightly lower proportion of 697(46.9%) men compared to 776 (52.2%) women. Age ranged from a minimum of 19 years old to a maximum of 84 years old. The mean age of the population was 43 (+/- 13.04) years. As expected because of the nature MTurk survey participants, 884(59%) of them were in the age group 19-44, followed by 480(32%) in the age group 45-64. The remaining 119(7.9%) that reported an age were in the age group 65-84%.

In terms of race the participants were predominantly White (75.7%, n=1,134) survey responses and the remaining split into Black (8.6% n=129), Asian (4.6%, n=109), Hispanic (4.6%, n=69), another race (3.8%, n=57). About 232 (15.5%) of the participants

were from rural communities, with most remaining from either small cities, suburbs of large cities or large cities.

The population was mostly college educated (69.1%), with 20.5% having a postgraduate education. Only 10.4% had an education level lower than or equal to high school. They were also mostly employed with 1,167 (78.1%) in the workforce, and small proportions of unemployed (10.2%), retired (7.0%). Household income however was not very skewed with 670 (44.8%) participants declaring income below $52,000 and another 536 (35.8%) with incomes between $52,000-74,999. Those with incomes above $75,000 for the remaining 19.4%. Political affiliation was mostly Democrat (44.9%) as opposed to Republican (22.8%) or other (32.3%).

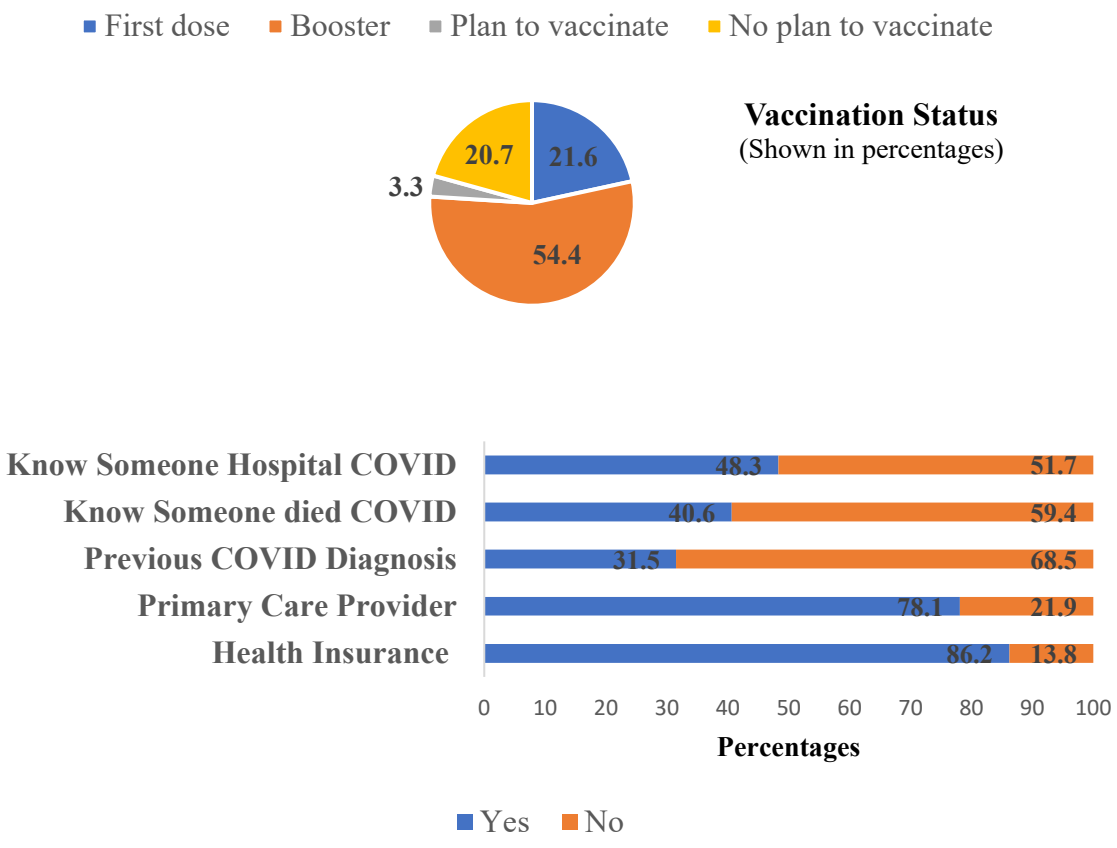
Table 3.2 Participant Demographics

Participant Characteristic		*(N=1,498)* Frequency	%
Age Range	19 - 44	884	59.0
	45 - 64	480	32.0
	65 - 84	119	7.9
	Unknown	15	1.0
Gender	Male	697	46.9
	Female	776	52.2
	Other	14	0.9
Race/Ethnicity	White	1134	75.7
	Hispanic	69	4.6
	Asian	109	7.3
	Black	129	8.6
	Other	57	3.8
Community	Rural	232	15.5
	Small city	425	28.5
	Suburb large city	561	37.6
	Large city	276	18.4
Education	High school or lower	156	10.4
	College	1035	69.1
	Postgraduate	723	20.5
Employment Status	Unemployed	152	10.2
	Employed	1,167	78.1
	Retired	106	7.0
	Other	70	4.7
Household income	Under $52,000	670	44.8
	$52,000 - $74,999	536	35.8
	$75,000 and above	290	19.4
Political Affiliation	Democrat	664	44.9
	Republican	341	23.0
	Other	483	32.1

3.2.2 Healthcare Characteristics

Fig 3.1 captures the healthcare characteristics that were measured in the survey. An overall of 76.1% of the population received at least one dose of a COVID-19 vaccine, with 21.6% (n=) having received only one dose, and 54.4% (n=) having received the initial doses and a booster dose. Of the remaining another 3.3% mentioned that they plan to be vaccinated. 20.7% of them did not plan to vaccinate. The survey participants had moderately good healthcare access with only 21.9% of survey participants without access to a primary care provider or with no health insurance (13.8%).

Fig 3.1 Healthcare Characteristics of Survey Population



When asked about a previous COVID-19 diagnosis, 31.5% of participants claimed to have contracted the illness. 48.3% of the population knew someone hospitalized with COVID-19 and 40.6% knew someone who died of COVID-19.

3.2.3 COVID-19 Knowledge Questions

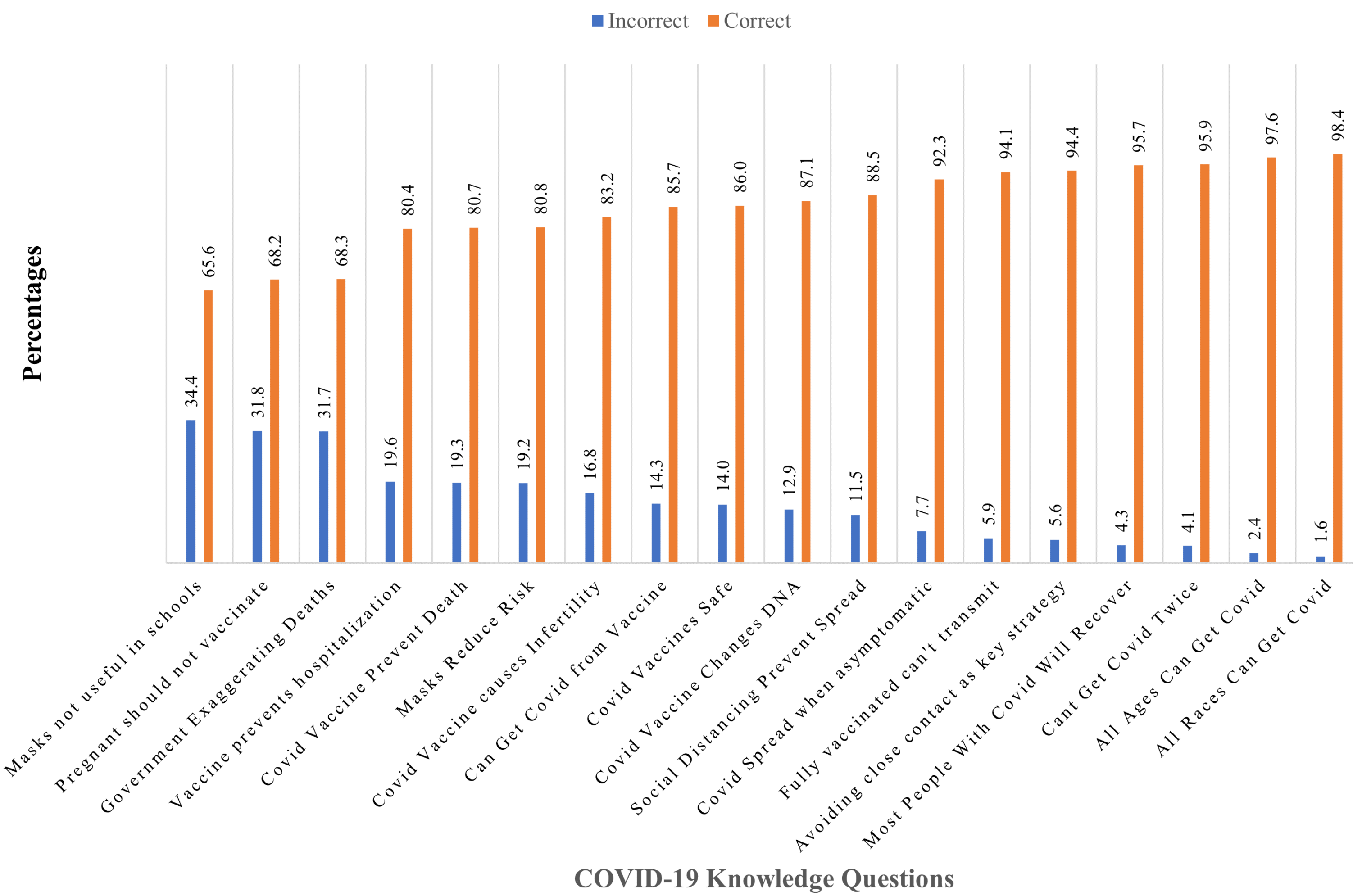
Eighteen True/False questions were administered as a key component of this survey and assessed knowledge on multiple areas of COVID-19 related information that was disseminated with some topics controversial with the high level of COVID-19 misinformation. They are presented in Table 3.3 with the answer key.

3.2.3.1 Topics of Low Performance: As shown in Fig 3.2, the questions were reordered based on the percentage of accuracy across all survey participants to understand which topic areas were more problematic. The use of masks in children attending school to reduce disease spread had the highest percentage of inaccurate responses (34.4%). Another myth we tested with 31.8% wrong answers was on the topic of vaccination of pregnant women. 31.7% of the survey participants wrongly believed that the government was exaggerating the number of COVID-19 deaths. Regarding vaccine effectiveness, 19.6% of the participants were reluctant to believe vaccines could be effective in reducing hospitalization or that they could reduce COVID-19 deaths (19.3%). Another significant area of controversy was with 16.8% believing vaccines could cause infertility, or that one could get COVID-19 from the vaccine (14.3%), while others believed the vaccine changes the DNA (12.9%). Mistrust of masks in their ability to reduce risk was at 19.2% and 11.5% of the survey participants did not believe social distancing could reduce spread of COVID.

Table 3.3 ***List of COVID-19 Knowledge Questions with Answer Key***

1.	The COVID-19 vaccines (Pfizer, Moderna) are safe for most recipients.	*True*
2.	The COVID-19 vaccines (Pfizer, Moderna) are effective in preventing hospitalization. T*rue*	
3.	The COVID-19 vaccines (Pfizer, Moderna) are effective in preventing death.	*True*
4.	Regular use of masks in high-risk settings will lessen your SOMEONE'S risk of developing or spreading COVID-19.	*True*
5.	Avoiding close contact with others who have been exposed to or are sick with COVID is a key strategy in preventing COVID-19.	*True*
6.	Those who are fully vaccinated cannot transmit COVID-19.	*False*
7.	The use of masks in schools has not been shown to reduce the risk of COVID-19 infection in children.	*False*
8.	BD COVID-19 can only be spread by those who are exhibiting symptoms.	*False*
9.	Those who have had COVID-19 cannot contract the disease again.	*False*
10.	Social distancing (6 feet away from others) can help prevent the spread of COVID.	*True*
11.	The government is exaggerating the number of COVID-19 deaths.	*False*
12.	Pregnant women should not get the COVID-19 vaccine.	*False*
13.	The COVID-19 vaccines have been shown to cause infertility.	*False*
14.	You can get COVID-19 from the vaccine.	*False*
15.	The COVID-19 vaccines can change your DNA.	*False*
16.	People of all ages can become infected with COVID-19.	*True*
17.	People of all racial and ethnic groups can become infected with COVID-19.	*True*
18.	BN Most people who are infected with the COVID-19 virus recover from it.	*True*

Fig 3.2
Accuracy of responses to COVID knowledge questions



Topics of high performance

Participants were predominantly aware that all races could contract COVID-19 (98.4%) as well as that all ages can get COVID-19 (97.6%). They also believed strongly that one could get COVID-19 twice with 95.9% responding correctly and were mostly confident that most people would recover from a COVID-19 illness (95.7%). Many also believed avoiding close contact was a key strategy to prevent COVID-19 (94.4%) and were aware that fully vaccinated individuals (94.1%) and asymptomatic people could still transmit COVID-19 (92.3%).

3.2.4 Positive deviance: The Perfect Knowledge Score & High Level of Trust

The COVID-19 knowledge survey data was analyzed, and 603(40.3%) out of the 1,498 participants were found to have a perfect knowledge score of 18/18. The range (3-18) for total knowledge score with its corresponding frequency and percent of the total are displayed in Table 3.4. This initial survey data was instrumental in applying the positive deviance framework in the next phase of this study. We identified participants with a perfect knowledge score and reached out to interview candidates willing to complete a follow-up interview. When comparing those with a perfect score against the others we found similarities in distribution across most socio-demographic variables except community and political affiliation. Those with perfect knowledge score were distributed with a higher likelihood 365/603 (60.5%) of living in large city or suburb in comparison those who did not have a perfect score 472/895 (52.7%). The participants with a perfect score were more likely to have a political affiliation with the democratic party 412/603(68.3%) in comparison to 259/895(28.9%) those who scored less that 18.

Their vaccination rates were significantly higher at 571/603 (94.67%) when compared to the 568/895 (63.46%) to those who scored less than 18.

Table 3.4
Frequency Table of Total Knowledge Score

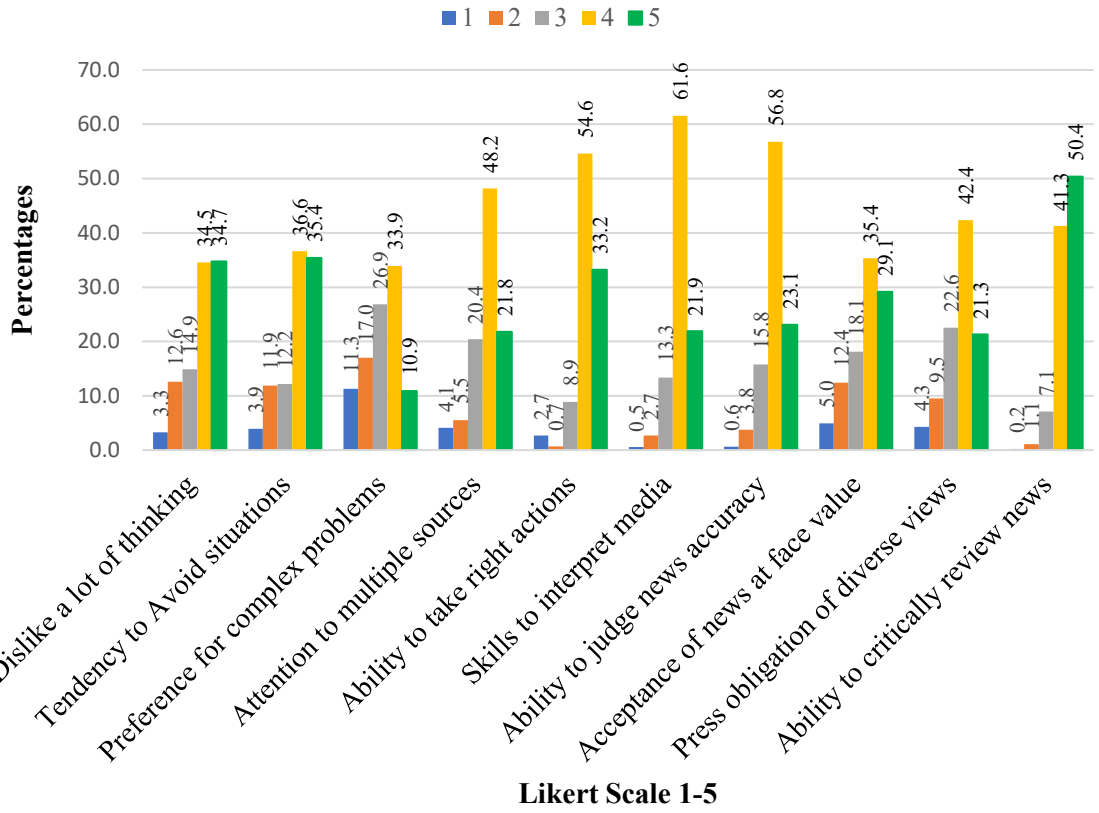
Total Score	Frequency	%
3	1	0.1
4	2	0.1
5	4	0.3
6	17	1.1
7	22	1.5
8	45	3.0
9	48	3.2
10	55	3.7
11	44	2.9
12	56	3.7
13	62	4.1
14	65	4.3
15	86	5.7
16	127	8.5
17	261	17.4
18	603	40.3

Another key characteristic of this group was that they demonstrated a higher level of trust across all stakeholders that were assessed in the survey. Trust was assessed on a scale of very low, low, moderate, high, and very high and measured with individual survey items for the CDC, their doctor, national and state government, pharmaceutical companies, and their pharmacist. There was a consistently higher measure of trust across all the above-mentioned stakeholders among those with perfect knowledge scores. These findings are summarized in Appendix B.

3.2.5 Media Literacy Questions

Media literacy was measured against a Likert scale of 1 -5, and as seen in Fig 3.3, participants self-reported a higher score on all the media literacy questions. Questions on self-efficacy, such as the ability to take right actions, skills to interpret media and the ability to judge news accuracy scored high on the Likert scale. Media mindfulness questions such as whether they dislike thinking a lot, tendency to avoid situations or complex of control were relatively moderate. Media locus of control questions such the

Figure 3.3
Media Literacy Questions with Percentages on the Likert Scale of 1-5



ability to critically review news, the obligation of the press to present diverse viewpoints and if individual should accept news at face value were not scored as high as the self-efficacy questions but fared better than media mindfulness.

3.2.6 Logistic Regression

The output from the final logistic regression model to predict the outcome of vaccination in the study population identified the main explanatory variables as shown in Table 3.7. The first part of building this logistic regression consisted of identifying the predictor variables with a significant bivariate relationship with the outcome variable of vaccination. Continuous variables such as age and knowledge score were tested using t-tests and categorical variables were tested using chi-square tests.

Table 3.5: Bivariate Relationship Between Socio-demographic Input Variables and Vaccination in the Survey Population (N=1,484)

Input Variable	Vaccination Frequency	%	Vaccination Rate	p-value
Age range				
19-44	643	57.16	72.74	0.0005
45-84	378	33.6	78.59	
85+	104	9.24	87.39	
Gender				
Male	539	47.91	77	0.3112
Female	586	52.09	74.74	
Race				
White	847	75.29	75.29	0.0036
Black	92	8.18	71.88	
Asian	98	8.71	90.74	
Hispanic	48	4.27	71.64	
Other	40	3.56	71.43	
Community				
Rural	148	13.16	62.71	<.0001
Small city	318	28.27	76.08	
Suburb	447	39.73	80.4	
Large city	212	18.84	77.37	
Education				
High school	80	7.11	51.61	<.0001
College	779	69.24	76	
Postgraduate	266	23.64	87.5	
Employment				
Unemployed	106	9.42	70.67	0.3452
Employed	879	78.13	76.04	
Retired	85	7.56	80.19	
Other	55	4.89	76.39	
Income				
<$52,000	465	41.33	70.14	<.0001
$52,000-74,999	409	36.36	77.02	
>$75,000	251	22.31	86.55	
Political Affiliation				
Democrat	598	53.25	90.06	<0.0001
Republican	207	18.43	60.7	
Other	320	28.32	66.81	

Table 3.6
Bivariate Relationship Between Healthcare, Knowledge and Media Input Variables and Vaccination in the Survey Population (N=1,125)

Input Variable	Vaccination Frequency	%	Vaccination Rate	p-value
Knowledge level				
Low (3-12)	90	8	30.72	<0.0001
Medium (13-16)	237	21.07	70.12	
High (17-18)	798	70.93	93.55	
Know COVID Death				
Yes	493	43.82	82.17	<0.0001
No	632	56.18	71.49	
Know COVID Hospitalization				
Yes	577	51.29	80.81	<0.0001
No	548	48.71	71.17	
Previous COVID Diagnosis				
Yes	354	31.47	76.13	0.8456
No	771	68.53	75.66	
Health Insurance				
Yes	1007	89.51	78.55	<0.0001
No	118	10.49	58.42	
Primary Care Provider				
Yes	924	82.13	79.66	<0.0001
No	201	17.87	62.04	
Perfect Score				
Yes	563	50.04	94.62	<0.0001
No	562	49.96	63.22	
CNN				
Yes	416	36.98	83.53	<0.0001
No	709	63.02	71.91	
Fox News				
Yes	223	19.82	63.9	<0.0001
No	902	80.18	79.47	

Key results from this step are presented for the socio-demographic variables in Table 3.5 and for the healthcare, knowledge, media, and trust variables in Table 3.6.

Table 3.7 Logistic Regression Equation for Vaccination (N=1,484)

Predictor Variable	% of N= 1,484	Coefficient	OR	95% CI		p-value
Community						
Rural (ref)	13.16	-	1.000	-	-	-
Small city	28.27	0.3728	1.452	0.900	2.341	0.1258
Suburb	39.73	0.5636	1.757	1.109	2.781	0.0161
Large city	18.84	0.2246	1.252	0.722	2.178	0.4245
Education						
High school (ref)	7.11	-	1.000	-	-	-
College	69.24	0.9536	2.595	1.611	4.179	<.0001
Postgraduate	23.64	1.7123	5.541	2.947	10.609	<.0001
Political						
Democrat (ref)	53.25	-	1.000	-	-	-
Republican	18.43	0.0552	1.057	0.660	1.702	0.8191
Other	28.32	-0.4065	0.666	0.439	1.013	0.0563
Know COVID Death						
Yes	43.82	0.3564	1.428	1.009	2.030	0.0453
Primary Care						
Yes	82.13	1.1017	3.009	2.057	4.416	<.0001
Perfect Score						
Yes	50.04	0.3466	1.141	0.852	2.376	0.0937
CNN News						
Yes	36.98	-0.0341	0.966	0.653	1.434	0.8649
Fox News						
Yes	19.82	0.0854	1.089	0.728	1.639	0.0200
Knowledge Score	-	0.3336	1.396	1.305	1.497	<.0001
Trust Score	-	1.0109	2.748	2.147	3.547	<.0001
Media Self-efficacy	-	-0.3449	0.708	0.539	0.927	0.0124

*Intercept = -7.5389 AUC=0.9017
OR= Odds Ratio CI=Confidence Interval ref=reference group

Some variables were excluded such as gender, race, employment and previous COVID diagnosis were excluded as they were not statistically significant. The area under the curve (AUC) or c-statistic for this final model presented in Table 3.7 was 0.9017. The SAS output from this proc logistic procedure is presented in Appendix C.

Living in a small city (OR: 1.452 p-value 0.1258), suburb of a large city (OR: 1.757 p-value 0.0161) or large city (OR: 1.252 p-value 0.4245) were all associated with higher likelihood of vaccination than those who lived in rural communities. When compared to those who had an education of high school or lower, having a college level education was statistically significant and meant they were nearly 2.5 times more likely to be vaccinated. A postgraduate education was associated with an even higher odds (OR: 5.541 CI: 2.947 – 10.609). Access to primary care was also statistically significant at a p-value <0.0001 and major predictor of vaccination with those who had access being thrice as likely to be vaccinated (OR: 3.009).

Beyond these socio-demographic and health variables of importance, we assessed COVID knowledge, and those who had a perfect score (positive deviants) with an OR: 0.3466 and p-value 0.0937. For each unit increase in the total score the likelihood of vaccination increased by 39.6% and was statistically significant with a p-value <0.0001. Another critical predictor was trust across various shareholders, and when measured as a consolidated score, for each unit change the likelihood of vaccination nearly increased three-fold (OR: 2.748 p-value <0.0001).

The wide difference in vaccination rates between Democrats and Republicans, did not appear significant in the final model when other confounders were adjusted for. However, when compared to Democrats, those who declared ‘other’ as their political affiliation were 40% less likely to vaccinate (OR: 0.666 p-value 0.0563). While other media literacy variables of media mindfulness and media locus of control did not remain in the final model, media self-efficacy was identified as a predictor. For each unit

increase in media self-efficacy score there was a 35% decline in likelihood of vaccination (OR: 0.708 p-value 0.0124).

3.3 Discussion

The quantitative analysis of this survey data has yielded some interesting insights into the factors that increase vaccine acceptance. Based on research in this area (Hudson & Montelpare, 2021) we anticipated socio-demographic variables to be important predicting vaccination. The differences in age groups were shown as significant based on the bivariate analysis, with vaccination rates being higher in older age groups in comparison to those relatively younger with an up to 87.39% vaccination among those 85+. Gender and race did not appear to have a significant relationship to vaccination in the bivariate analysis.

Community type, higher education, access to primary care, higher level of COVID knowledge, and trust in healthcare stakeholders were the main determinants of higher odds of vaccination. Individuals that could wade through the flood of misinformation through better health literacy skills were more likely to improve their COVID knowledge and receive vaccination.

Although Republicans appeared to have lower rates of vaccination in general, when other factors such as access to care, education, community were accounted for, there were no significant differences between Democrats and Republicans. The wide difference in vaccination rates between these groups in the preliminary findings did not remain statistically significant when other factors like income, education and community type were accounted for. Evidently these factors are critical determinants of vaccine

acceptance regardless of conservative or liberal political values. However, those who mentioned their political affiliation was either moderate, independent, or other were found to have lower odds of vaccination when compared to Democrats.

An important determinant of better health literacy was not over-estimating media self-efficacy. While survey participants in general rated their ability as high to judge and discriminate good information from news and social media, the results suggest this was a drawback. Rural vs. urban communities

While none of the other sociodemographic factors such as age, gender, race, income, or employment were identified predictors, the community that an individual resided in, and their level of education were important predictors of vaccination. Those from small cities, suburbs or large cities were all more likely to vaccinate showing there are obstacles to vaccination in rural communities. Studies show that there were higher rates of COVID-19 cases and mortality in our rural communities (Saelee et al., 2022). Disparities in access to health education and care among rural communities must be addressed in our public health efforts. These populations are known to be older, uninsured, and many individuals are dealing with health conditions that make them vulnerable. Access to care and differences in views regarding seriousness of COVID, combined with high vaccine hesitancy even for routine vaccinations affect vaccine acceptance of those living in rural communities.

Lack of economic opportunity, local culture and risk perception and geographic location of rural communities are disadvantages that compound and increase health disparity (Thomas, DiClemente, & Snell, 2013). Individuals are often unemployed, living in poverty and have difficulty overcoming their circumstances. Research suggests that

they rely on intimate relationships that are often bound by cultural and religious beliefs and often unable to avoid mass transit or practice social distancing at work. Access to tertiary care health facilities is limited by geography and economic adversity. Public health efforts should aim at collaborative pursuits to overcome these issues.

3.3.1 Higher Education

As seen in the results, those with college education were twice as likely to vaccinate as those with a lower level of education. Postgraduates showed a much higher odds being more than 5 times as likely to vaccinate. This is probably because higher levels of educational attainment are not associated with the level of science denial as those with lower levels of education (Albrecht, 2022). The rampant misinformation that circulated regarding COVID, through political division and conspiracy theorists resulted in high level of mistrust among people about the science (Albrecht, 2022) .

Studies discuss the concept of “knowledge gap hypothesis”, which suggests that as the amount of (mis)information grows in the news, online and social media, so does the complexity of information those with higher levels of education can bridge these knowledge-gaps (Gerosa, Gui, Hargittai, & Nguyen, 2021). Higher education enables them to decipher, comprehend complex information and assimilate new knowledge. They are also capable of discriminating against misinformation that is propagated through various communication channels such as television, news media, online websites, and social media. Less educated people are on the other hand unlikely to be careful and critical of fake news and are therefore more susceptible to misinformation (Gerosa et al., 2021) .

3.3.2 Knowledge and Misinformation

During the pandemic an extraordinary amount of scientific information was generated in a short period by healthcare researchers. New evidence about the disease process, spread of infection, management and prevention of illness was produced and disseminated by the scientific community at a rapid pace. However, this knowledge was often distorted by misinformation and people struggled to understand the information shared by the scientists.

Conventional media practices of fully vetting information before news broadcasts were sometimes not feasible, especially during the early days of the pandemic (Rochwerg et al., 2020). The explosion of research and scientific information was concurrent with the unfortunate propagation of misinformation. This created barriers to acquiring good knowledge to help in healthcare decision-making. Individuals who were able to access and understand trustworthy data produced by healthcare researchers were more likely to believe in the ability of vaccines in preventing spread of COVID and early adopters of vaccines.

It is evident from the findings of this final predictive model that those who were able to build strong knowledge and understanding of the disease transmissions and had the ability to differentiate myths and rumors from evidence-based information were at an advantage. To further understand the beliefs and practices of these individuals who had a high level of knowledge, we interviewed a subset of these positive deviants in the next phase of this study. Regardless of how these individuals acquired their knowledge, or

help combat misinformation, they demonstrated correspondingly high odds of vaccination.

3.3.3 Access to Primary Care

Primary care physicians have been very critical in debunking vaccine myths and have been shown to have the greatest chance to encourage vaccination among their patients (Katzman & Katzman, 2021). Considered among the most trusted source of vaccine information, they have been instrumental to counteracting vaccine myths and misinformation during the COVID-19 pandemic. Patients consider them to be credible and trustworthy and are helpful in addressing the anxieties and concerns of patients with vaccine hesitancy.

As many individuals worried about safety and efficacy of vaccines, concern for side effects and long-term impacts, primary care providers have been able to bridge the knowledge gap for patients. COVID hindered access to primary care as many clinics focused on reducing spread with social distancing and evolved their telemedicine practices (Rawaf et al., 2020). When the vaccine became available, people were unsure of the vaccine and access to primary care became a key determinant of overcoming vaccine hesitance. One cross-sectional study of primary care providers per capita and associated COVID vaccination rates shows that there was strong association. Primary care providers have been successful in building community trust and counseling to improve vaccination rates (Lo et al., 2022).

3.3.4 Trust and Misinformation

The study showed that there was a strong correlation between trust and knowledge, as well as vaccination. Trust was measured across multiple stakeholders: doctor, pharmacist, CDC, national and state government as well as pharmaceutical companies. The consolidated trust score was associated with an increase in odds of 2.7 times for each unit increase in the trust score. Research has been consistent in showing trust in healthcare was a major factor that influence vaccine hesitance (Fan et al., 2022).

With the rapid research and development cycle that the COVID vaccines underwent there was great deal of concern about the vaccine safety and efficacy. But despite the widespread misinformation about vaccines, those individuals with high inherent trust in healthcare professionals and government agencies were more likely to vaccinate. Another key characteristic of high level of trust was higher level of education, (Fan et al., 2022; Szilagyi et al., 2021) One other area of focus to improve trust has been the transfer and effective communication about the vaccine approval process. Outreach efforts by public health and primary care doctors are also shown to help improve trust and consequently increase vaccination.

3.3.5 Media Self-efficacy

In general media self-efficacy is a component of media literacy, that is self-reported measure of one's ability to judge fake news and assess the veracity of information. Our results suggest that as the media self-efficacy score increased, vaccination odds decrease. This is possibly because with so many vaccine myths and indiscriminate misinformation that became available to individuals, the media consumption also increased exponentially. As per the research of (Gerosa et al., 2021), they suggest that when information is

overabundant people's ability to comprehend does not increase with consumption. It is believed to be the opposite, with more confusion and lack of clarity. If this is indeed the case, it follows that individuals may overestimate their ability to assess and acquire accurate healthcare knowledge and make unsuitable healthcare decisions.

3.4 Limitations of the Quantitative Analysis

As this was a limited sample, the predictive model for vaccination cannot be generalized to the general population. There is disproportionately high vaccination rate in this study population and application of this model requires population-based adjustments to correctly predict and score vaccine acceptance. The analysis approach also split the data into training and validation data sets to make an honest assessment of this model. Another approach to consider includes the entire data to develop a model with other techniques such as lasso regression to account for validation.

4. ANALYSIS OF INTERVIEW DATA

4.1 Introduction

Given the complexity of the misinformation landscape that shrouded the COVID pandemic several public health entities advocated for strategies to detect and prevent the spread of misinformation (Bin Naeem & Kamel Boulos, 2021). With the WHO declaring that the infodemic impeded the ability to find and discern reliable information, it made this a public health priority to address and combat misinformation (Eysenbach, 2020). As the quantity of information from science; policy and practice; news media and social media grew exponentially causing a crisis, the WHO suggested a framework that first started with facilitating accurate knowledge translation. They encourage knowledge refinement through filtering and fact-checking and suggested we build eHealth literacy.

Considering the average vaccine development requires a 10.7 year timeline,(Pronker, Weenen, Commandeur, Claassen, & Osterhaus, 2013) the efforts to rush vaccine production caused a sense of mistrust in the global population (Hotez et al., 2021). Even as the world health leaders struggled to tackle the infodemic, some individuals have demonstrated the ability to peruse, and assimilate good knowledge on COVID and navigated the milieu of myths, fake news and conspiracy theories with impressive clarity and acumen.

The positive deviance framework suggests that by understanding how these outliers navigate healthcare decision making, we may be able to build effective public health strategies (Bradley et al., 2009; Toscos et al., 2018). In order to apply this approach to improve COVID knowledge, as a follow-up on the initial survey the study team identified and interviewed a selected subset of the survey participants. These efforts were focused

on these positive deviants (PDs), to understand what set these individuals apart in their approach acquiring and sharing knowledge on COVID-19.

There were 603 individuals (40.25%) participants of the original 1,498 that scored a perfect score on the initial survey. As shown in the quantitative data those with a perfect score had a vaccination rate (94.62%) when compared to those that scored less than 18 (63.22) on the knowledge questions. This difference was significant on chi-square testing with a p-value <0.0001. Descriptive statistics of the participants with a perfect score suggest that 60% of PDs lived in suburbs or large cities compared to 50% of those with scores less than 18. Democrats formed 68.57% of this population when compared to only 28.9% of those with lower scores. These individuals also displayed higher mean trust scores (M:3.56 SD: 0.63) in comparison to the others (M: 2.83 SD: 0.87). When comparing media literacy scores under the three component categories of media locus of control, media mindfulness and media self-efficacy, they did not demonstrate a significant difference. The pursuit of this mixed methods approach is to further drill down the characteristics and behaviors of these PDs.

4.2 Methods

4.2.1 Secondary Interview design

A semi-structured interview guide was developed with two COVID-19 experts from the ASU COVID Translational Team. This guide is presented in Table 4.1. After identifying individuals with perfect and near-perfect scores on the COVID-19 vaccine knowledge questions, we identified a diverse sample of individuals who also reported sharing reliable COVID-19 vaccine information with their in-person and online sources.

We deemed these individuals as true positive deviants given that they not only had accurate information, but they also served as advocates of reliable COVID-19 information. The research team conducted a total of 25 interviews, using the semi-structured interview guide that was reviewed and piloted.

Table 4.1 Semi-structured Interview Guide

Thank you for taking the time to take part in this interview. You have been identified as an individual who is very well-informed on COVID-19 information based on your responses to our previous survey research. These interviews will be used to get a better understanding of how people have found and made sense of reliable health information about COVID-19 prevention. We expect to use the findings from this research to develop approaches to spread the best practices we find here to improve public health and prevention.
• *Since the beginning of the pandemic, what sources of information have you used to find reliable COVID-19 information?* • *How did you know that this reference was a reliable source to trust?* • *What has been your process of finding and interpreting information about COVID-19 vaccines?* • *How has your process for finding reliable information about COVID-19 vaccines or COVID-19 been any different than finding other health information in the past?* • *What do you do when you find health misinformation?* • *How have you shared reliable health information with people in your social networks (in-person and/or online)?* • *During this time of rampant misinformation, what would you recommend to others – to find and analyze reliable health information?* • *Is there anything else you would like to share about your beliefs about finding information about COVID-19?*
Thank you for taking the time to speak with me about your practices in identifying reliable COVID-19 vaccine information. I certainly appreciate your valuable input. This ends our interview.

4.2.2 Interview Recruitment

For the interview portion of the study, MTurk survey participants were asked to provide their email address if they were willing to participate in a one-time follow-up interview. The research team reviewed individuals with a perfect (18/18) or near-perfect

(17/18) knowledge score on COVID-19 knowledge questions from the survey research. We messaged participants within one month of their survey completion and included a Doodle Poll to assess their availability for a one-time phone interview. Using Google Voice, potential participants were sent text messages and reminded of the upcoming interview. On the day of the interview, a study team member called the participants, obtained their informed consent, and conducted the interview. All interview participants received a $30 Amazon e-gift card after completing the interview. All interviews were recorded, and a professional transcription service transcribed the audio files.

4.3 Data Analysis

4.3.1 Interview Data:

To analyze the qualitative data, an inductive reasoning approach was used (Saldana, 2013). Study team member, Dr. Koskan reviewed all the transcripts and was the primary codebook creator and editor. To enhance the rigor of the qualitative analysis, a team-based thematic analysis to code the interview data was performed. PhD candidate, Sivanandam was trained to co-conduct thematic analysis. One transcript was coded together to test the coding guide (Appendix D) and coding similarities were ensured. Subsequently, three transcripts were coded separately, and the team met afterwards to resolve coding discrepancies and further clarifications. After an additional two transcripts that were coded separately a consensus was reached and the remaining transcripts were split between the two study team members and hand coded. The resulting codes were uploaded in ATLAS ti software by tagging the participant specific transcripts and the codes updated with the segments of the interview that correlated with the code. This

approach to qualitative data coding and thematic analysis is consistent with the inductive reasoning approach widely accepted in qualitative research (Ando, Cousins, & Young, 2014; Miles & Huberman, 1994; Saldana, 2013). Then the output from ATLAS ti was aggregated, findings synthesized and summarized by code. This generated a comprehensive summary of findings and quotes were highlighted to best illustrate the emerging themes and subthemes.

4.4 Results

A diverse sample of 25 participants of the initial survey were chosen to include a distribution across various age, race, community, and political subgroups. All selected individuals were vaccinated against COVID demonstrating that their perfect knowledge scores translated to meaningful health behaviors. A breakdown of their socio-demographic characteristics is presented in Table 4.2.

Participants were probed on various predetermined areas outlined in the interview guide. They described what they considered their trusted sources of information for COVID-19, sources they did not trust, how they determined credibility of their information sources and shared their reactions to misinformation. They also addressed their information sharing approaches.

4.4.1 Trusted Information Sources

Participants identified various sources of information that they trusted, ranging for healthcare organizations such as the CDC or WHO or other private medical entities, media platforms such as local /national news, social media, and individuals such as

family and friends (3), experts (6) or their clinical provider (12). 6 participants identified data-driven sources as their trusted source of information.

Table 4.2 Socio-demographic Characteristics of the Interview Participants

Characteristic	N	%	Characteristic	N	%
Sex			Political affiliation		
Female	10	40.0	Democrat	14	56.0
Male	15	60.0	Republican	3	12.0
			Moderate	8	32.0
Race/Ethnicity			Community		
White	17	68.0	Rural	5	20.0
Hispanic	3	12.0	Small city	4	16.0
Black	2	8.0	Suburb	8	32.0
Asian	3	12.0	Large City	8	32.0
Education			Health Insurance	24	96.0
High school	1	4.0			
College level	16	64.0	Primary Care	24	96.0
Postgraduate	9	36.0			
Employment			Previous COVID	8	32
Full-time	12	48.0			
Part-time	3	12.0	COVID vaccine		
Retired	3	12.0	Booster	21	84
Not employed	7	28.0	Initial only	4	16
Income					
Under $52,000	10	40.0		*	**
$52- $74,999	8	32.0	Age (mean)	M: 46.1	SD:13.4
Above $75,000	7	28.0			

*M=Mean **SD=Standard deviation

Participants identified various sources of information that they trusted, ranging for healthcare organizations such as the CDC (17) or WHO (6) or other private medical

entities (5), media platforms such as local (9)/national (9) news, social media (8), and individuals such as family and friends (3), experts (6) or their clinical provider (12). 6 participants identified data-driven sources as their trusted source of information.

Individuals that preferred local news as they found national news misleading or political. They were interested in local mandates for social distancing and masks or were personally dealing with clinical conditions that put them at risk for COVID or had a loved one that they were caring for. In contrast interviewees who followed national news, were more interested in the global and national scope of the pandemic, and preferred to assess how other communities were handling it. They generally identified news outlets that they perceived as less polarized or politically unaffiliated. Such individuals were especially concerned with the political divide and how it impacted the pandemic response from state to state. One participant mentioned:

> *"I look at state-by-state statistics of mortality, especially. And see that there appears to be a pretty significant dichotomy on the basis of whether you categorize a state red or blue." -Participant 7*

Among healthcare entities the CDC was a popular choice that individuals trusted that they were the source of reputable, unbiased source for scientific information. They were often proactive about staying updated on the current state of the pandemic and routinely sought information from the organization's website. They also found it to be a good resource for vaccine information as well as prevention behaviors. Some participants relied on the WHO but generally preferred US based sources such as CDC or other private medical entities such as WebMD, Mayo clinic, Cleveland clinic etc. These

sources were believed to be more research and data-based and were more likely to address specific questions reliably.

Clinicians and experts were strongly preferred over friends and family, with many believing healthcare providers not only delivered accurate information but also trusted them because of their first-hand experience in managing COVID-19. Participants also trusted those they deemed experts based on their serious credentials as epidemiologist, public health leaders and further believed that individuals whose livelihood was based in science were more likely to share reliable information.

> *"That's what they spent their whole life doing. That's what they've spent their life, blood, sweat, and tears to do what they do, because for whatever reason they find it interesting, stimulating, and that's what they do. They're there to protect the public health or the individual person's health."-Participant 2*

Individuals who trusted social media sources were confident in their self-efficacy to differentiate good information from bad. They preferred to follow the social media accounts of healthcare professionals or followed Reddit pages where vaccine manufactures shared clinical trial data directly to the consumer. These individuals evidently self-aware and participant noted,

> "*So, there's a lot of information out there. There's some bad information. There's some good information." – Participant 24*

4.4.2 Untrusted Sources

Interview participants were less focused on untrusted sources, but as many as six individuals mentioned their mistrust of social media. They felt that there was a lot of misinformation circulating in social media, and specifically wary of Facebook posts. Fox news was mentioned by 1 individual, while another found CNN, MSNBC and Fox to all be biased one way or the other. President Trump was identified by 3 participants as unreliable and objected to him sharing misinformation. Some participants mentioned non-experts who appealed to people's vulnerable emotional state and found their sharing news from unverified sources without scientific basis to be reproachful.

> *"All these platforms that provide information, such as social media, do a very poor job of giving you proper information. And they're so fantastic at throwing you bad information without any censorship or warning"- Participant 20*

4.4.3 Assessing Information Accuracy and Reliability

As many as 14 participants relied on sources that explained the science behind the information. Particularly with respect to vaccines they trusted the science and medical experts and could appreciate the transparency of vaccine research and development data. Information from sources such as the Mayo clinic or CDC that were research focused and data-based were perceived as being credible sources of information. They believed when different scientific entities concurred on the information being shared, they were likely to be accurate. One participant suggested,

"Go with what you know. Anytime the network is agreeing with major leading scientists and doctors are agreeing with them, you should listen to that information, in spite of your political leanings."-Participant 21.

Many participants emphasized the importance of identifying and following reputable sources of information. 15 individuals that were interviewed mentioned knowing the sources of information being shared about COVID-19 as being critical. To them, it was important to know that the source was credible and reliable and used facts to inform their reporting, not opinion or hearsay. Some of them described examining the source to make sure they are not biased or have a hidden agenda, giving examples such as politicians who may benefit from sharing misinformation.

Eight instances were counted for when participants cautioned against source of information with hidden agenda or potential for bias. Some participants described how, upon hearing certain types of claims, they would search to see if there was a political agenda for the information - or a way (e.g., financial) that an individual or company may gain from sharing that information.

"*Lots of times misinformation will be tied to some third-party websites, or certain websites funded by certain think tanks or certain groups that are very political leaning one way. So, usually there I can get an indication of where this information comes from and what kind of political agenda it has."-Participant 20*

Verifying information across multiple sources was deemed essential by most participants. They recommended that it was useful to verify information by cross-

referencing it to other sources of information. They described critically appraising information that did not align with what other sources were saying. Other times, they described verifying the information using fact-checking software. They believed that by being informed of different viewpoints and perspectives one may be able to discern what was sound scientific evidence as opposed to spurious information without any reliability.

> *Check multiple sources because if it's out there in one source doesn't mean it's true. So, I would just tell them to check. Like if you're unsure, check and then if you find it, check again because that first one could be an off* shoot and then just maybe three or four. And think after three or four you *probably have a good idea that it's well reported and probably legitimate."- (Participant 22)*

Some participants mentioned the importance of using critical thinking to evaluate the pros and cons of vaccinating with critical thinking. They described estimating potential short-term and long-term side effects of the vaccine and comparing with the reduced risk of hospitalization and death. A key attribute of this group of participants is that all of them have received at least one dose of a COVID-19 vaccine dose.

4.4.4 Countering Misinformation

A predominant proportion of the participants mentioned that their reaction to being exposed to misinformation was to ignore it. While they typically don't elaborate on the reasons for this passive behavior, those who specifically address their approach of ignoring misinformation argue that it can be distracting and confusing. They champion their preference to focus on reliable and trustworthy sources. A participant living in a

rural community worried about getting caught up in the spiral of misinformation in their social setting and said,

> *"And it was you just you kind of grabbed onto the good in the world while trying to ignore the bad and not getting sucked in, and because it needed to be scared, it was easy to get sucked into conspiracy theory."- Participant18*

A couple of participants mentioned their efforts to flag misinformation and redirect to the correct information or report it as misinformation. Even so there are reservations on the usefulness of this approach. Individuals discussing their discomfort in addressing misinformation mentioned that they tend to avoid conflict. in correcting misinformation. They described how usually they assess how extreme the other person's view is and how far it differs from their own. If they determine it would lead to unpleasant arguments, then they choose to avoid conflict.

> "Yes, I don't let it go. But I'm also not going to get into a full-blown argument on it." -Participant 10

4.4.5 Sharing Reliable Health Information

A central behavior that was quite prevalent (18) among PDs was they were highly likely to share reliable health information via in-person discussions with people they knew. They also found countering misinformation to be easier in person than having an online debate. Some noted that non-verbal communication influenced the amount of information they would share, whether they provided any clarification, and the extent to which they would discuss the pandemic. Participants described how the relationship to

the person they were discussing COVID-19 with impacted the extent to which they would discuss COVID-19.

The significance of the relationship one shares to their ability to share information suggests that when you have an intimate and trusting connection, one is more likely to either give or receive advice. When it came to sharing information and correcting misinformation, it was evident from the interview responses that the type and closeness of the relationship to the other person mattered. Some participants talk about how they are only socially active and engaged in COVID related discussions with people who hold the same views and beliefs as them. It was apparent that some individuals felt more comfortable sharing COVID-19 information or correcting misinformation with people with whom they shared a closer relationship or who shared similar beliefs as they did.

> *"And I don't know whether there's a lot of people like me, that just kind of like back away, I don't want to deal with this. Or, I don't want to potentially ruin a friendship, or alienate a family member."- (Participant 11)*

Posting or sharing information on social media was not uncommon, and participants admitted to sharing reliable or interesting COVID-19 information via social media posts. Others participated in online groups, individuals who self-selected to be in a forum due to similar interests (e.g., gaming), health conditions (e.g., immunocompromised), or geographic community. Some individuals acknowledged resharing (including retweeting) reliable health information that they found online. They

also described vetting the information to make sure it was correct and coming from a reliable source before they shared it with people in their online social networks.

> *"Things would have to meet a certain criterion for me to retweet it or post it on Facebook. But I feel like some of the people that I talked to aren't as savvy when it comes to scientific literacy. And I don't want to accidentally push them in the wrong way. So, I must have a level of care when I try to promote (information). When I promote something, I put my weight and my intelligence behind it, and I don't want to accidentally send things out."- (Participant 18)*

4.4.6 Vaccine Decision-making

When specifically asked about their approach to vaccination, most participants verified that they relied on health authorities and state agencies as well as news media for their knowledge. Some participants reviewed several resources and assessed controversies and invariably trusted the science behind vaccine development. The transparency of the data available on vaccine efficacy (not cure but reduce symptoms) and trials was also helpful to some. Knowing what to expect after receiving the vaccine and preparing for it was also mentioned.

Other participants who had some hesitancy, either spoke with healthcare professionals or reflected on the vaccine experience of those in their social circle, until they felt comfortable with taking the vaccine. Having a loved one diagnosed or passing away of COVID was also mentioned as a determinant.

Availability of vaccine from one manufacturer vs. another, as well as personal preference about a certain manufacturer also played a role. The number of doses required for adequate protection was also a determinant for some in choosing between manufacturers.

4.5 Discussion

The thematic analysis of the interview data, built on the findings of the quantitative data which demonstrated that their rural communities had lower vaccination rates and deserved a collaborative community-based approach to COVID-19 vaccine messaging. Survey data also showed that individuals with higher educational attainment had correspondingly higher rate of vaccination as did those with higher knowledge and trust scores. These parameters appear to enable strong health literacy and foster the ability to withstand misinformation through critical thinking and responsiveness to reliable public health messaging.

Specific to the positive deviants studied in this portion of the study; trust scores were relatively higher than those with lower knowledge scores. They were also more likely to share credible information or act against misinformation. Beyond that, the interview recruitment process strived to sample a population that was diverse and representative of both rural and urban communities, as well as with different political affiliations. With these characteristics in consideration, a discussion of the key findings from the analysis of the interview data is presented.

4.5.1 Geographic Differences and Relevance of News Consumption

In discussing trusted sources of information, the PDs show that they relied significantly on credible public health resources such as the CDC and WHO. They further demonstrate a reliance on clinical and scientific experts when looking for information regarding COVID.

They were self-aware of their personal health needs as well as their loved ones and sought appropriate information proactively. Choosing local news as it applied to day to day lives, while absorbing the scope and magnitude of the pandemic from the perspective of national news was apparent in their discussion. There were many differences between COVID-19 spread and infection risk based on geography and public health mandates varied depending on where one lived. An understanding of the distinction that local practices may not reflect the significant risk that other communities with more exposure were experiencing was evident. Evidence from research suggests that knowledge of geographic and state specific health risk can guide health planning and disease control policy.(Deb Nath, Khan, Schmidt, Njau, & Odoi, 2023)

4.5.2 Impact of Political Divide

Apparent differences in the state-by-state health policies because of the political divide was also identified as a factor in choosing an information resource. Participants demonstrated an awareness of how to assess if an information source had a political or financial agenda. The importance of countering the politicization of public health has been expounded in literature (Sharfstein et al., 2021), as misinformation was propagated by anti-vaccine groups with right-leaning media programs.

Although our quantitative analysis did not reveal any significant differences between Fox news vs. CNN news resources, differences in vaccination outcomes for these audiences has been presented in research. In discussing these news sources, PDs believed these news channels had political leanings one way or the other and were indifferent to those distinctions.

Research suggests that diversification of communication among trusted speakers with diverse perspectives could help reduce this divide and corresponding misinformation (Sharfstein et al., 2021). Drawing from a broad range of expertise, that includes social, behavioral and communication sciences beyond public health messaging is impactful according to researchers.

4.5.3 Trust in Science

Interviews demonstrated a strong level of trust in science and relied on clinical and scientific experts as well as credible public health and private medical entities for information. They considered the significance of getting firsthand information from those who were dealing with either managing or researching COVID as their form of livelihood. The high level of trust in science among PDs has been a protective factor in resisting misinformation and participants reference this in their interviews. This impacts the kind of resources and websites that they rely on for fact-checking their knowledge, and often had a preferred scientific expert or information resource such as the CDC. Some individuals also discuss their ability to discern and acquire their COVID knowledge as well as their vaccine acceptance because they trust the science.

Trust in science has been consistently shown in research to help combat COVID misinformation and vaccine hesitance (Capasso et al., 2022; Szilagyi et al., 2021). Public

health efforts have to systematically improve the societal consensus on trust in science, as demonstrated by the PDs. Efforts to build trust are not effective when there is an ongoing epidemic with vast misinformation complicating the situation.

Communities that have high trust in science were more likely to receive vaccination and trust infrastructure in our society has to an ongoing effort (Sturgis, Brunton-Smith, & Jackson, 2021). To create a climate of mutual trust between science and society a collaborative dialogue from a wide range of experts can be employed. By investing in this scientific citizenship strategy instead of highlighting political or ideological differences the positive deviance approach can be taken further to combat misinformation (Palamenghi, Barello, Boccia, & Graffigna, 2020).

4.5.4 Health Literacy Skills

Interview participants were especially confident in the critical thinking and health literacy skills. They shared views on assessing bias, cross-checking information across multiple sources behaviors that allowed them to gain accurate and reliable information. They discussed identifying scientifically sound sources of health information and following social media accounts of respected and credible public health experts. By ensuring if different scientific entities concurred on a health guideline, they were able to be confident in their knowledge.

Approaches to enhance health literacy in the population include machine learning based approaches to combat fake news, such a fact-checkers, as well as educating the public on various components of health literacy (Bin Naeem & Kamel Boulos, 2021). Basics of health literacy such checking the source, checking the author, seeking the supporting information, verifying with efforts are all well documented health literacy

behaviors. These positive deviants could serve as health ambassadors that can influence their communities by sharing their skills and championing behaviors to overcome misinformation. Education and communication campaigns to improve health literacy and vaccine communication strategies that help individuals identify fake news are a vital public health agenda against COVID misinformation (Montagni et al., 2021).

4.5.5 Disputing Misinformation

When asked about their efforts to counter misinformation, PDs mostly ignored it and were reluctant to engage in confrontation. Some said they may correct misinformation if they felt their opinion would be valued, but rarely went against blatant misinformation with strangers. They also reference the role of their relationship with the individuals as being relevant. Few individuals mentioned correcting or reporting misinformation, especially on social media.

With the COVID-19 infodemic causing a public health crisis, there is a growing body of research that advocates actively correcting false or misleading information (L. Bode & Vraga, 2018; Hotez et al., 2021). PDs that engage in correction behaviors, possibly do so as this is becoming increasingly acceptable to correct misinformation especially on social media. Younger individuals with higher educational attainment were generally most likely to confront misinformation (Leticia Bode & Vraga, 2021). Witnessing or experiencing correction, in addition to engaging in correction behaviors and encouraged the social acceptability of correction. Fostering the culture of correction behaviors in both public health and clinical professionals, and individuals with high levels of media literacy can be effective against misinformation.

4.6 Limitations of the Qualitative Analysis

There are some limitations to this study that must be considered. Since the survey data was collected via river sampling from a crowdsourcing platform, there is an increased risk for coverage bias, when there is disproportionate representation of certain subpopulations (Lehdonvirta, Oksanen, Räsänen, & Blank, 2021). Another limitation is that MTurk while affording a diverse sample of the U.S. population may be skewed towards younger, white, liberal individuals with higher education (Boas, Christenson, & Glick, 2020). Additionally, some known threats to data quality such as masking of geolocation, non-human (bots) responses and low attention spans may be constraints to the data. Efforts to counteract some of these issues through cross-verification of rurality with geolocation, screening VPN use for international standards, and reCAPTCHA to control for bots were incorporated in the data collection. An attention check was also incorporated into the survey instrument.

The positive deviant framework focused on assessing the media literacy behaviors of only those with a perfect score on the COVID-19 knowledge quiz and did not compare or assess these behaviors in the population with lower knowledge levels. The smaller sample size and inherent characteristics of these positive deviant individuals did not allow much diversity in political affiliation or trust scores.

5. STRATEGIES AGAINST MISINFORMATION

5.1 Conclusions

The planning of this research by a multi-disciplinary study team have broad applications in various domains to potentially combat misinformation. Let us consider the strategies that can be employed to ameliorate the negative impact of misinformation in the context of improving COVID-19 knowledge and vaccine acceptance. We will also discuss the potential implications for education and media practices regarding curation and validation of new health information.

In the public health domain, one focus area is the outreach to rural communities to improve both public health education, and primary care access with sensitivity to local culture and norms. The findings of this study point to the need for a collaborative public-health campaign that includes health providers, schools, faith-based organizations, as well as local employers. To overcome inherent social norms in rural communities and bridge the gap in education and healthcare access, further investment in the healthcare infrastructure and training of professionals is needed. The COVID-19 pandemic exposed the vulnerabilities of our healthcare system, but has also revealed opportunities to build better communication and public health campaign opportunities (Thomas et al., 2013).

Although Republicans had lower rates of COVID-19 vaccination in general, when other factors such as access to care, education, community type were accounted for, we found no significant differences in vaccination between Democrats and Republicans. This suggests that political beliefs and other similar values are outweighed by fundamental socio-economic factors.

Positive deviants (those with high knowledge of COVID-19) demonstrate that regardless of their political affiliation or community type, they were able to evaluate and discriminate credible health information from misinformation. We suggest this may have been due to systematic use of exceptional media literacy and information validation skills. The quantitative analysis shows education, income and community of residence providing better vaccine outcomes, and we can speculate that the PDs share these attributes. They can then be identified in the community to champion their health literacy skills. By working within vulnerable communities to identify PDs, such as thought leaders, providers, business owners, large employers in the community etc. our efforts to combat misinformation could engage these individuals to educate and outreach to enclaves of misinformation.

The role of Community Based Organizations (CBOs) as an integral component of health communication has been shown to be effective, especially in public health emergencies (Korin, Araya, Idris, Brown, & Claudio, 2022). CBOs are well positioned to combat misinformation through a nuanced understanding of the constituents they serve with a preexisting relationship built on trust. CBOs may be particularly effective in leveraging community engagement that extends beyond the reach of traditional public health outreach (Korin et al., 2022).

Such CBOs can also be expanded to enhance trust in science as this is an extension of the values that are demonstrated by PDs. Furthermore, working on improving trust in science is imperative as a public health focus. Improving the credibility of government and health care institutions in their ability to share public health messages in a timely and transparent manner is critical (Fan et al., 2022). Official media

sources that provide public health education should establish a presence in social media and other mainstream information platforms to improve trust. It is crucial to understand the public needs and respond in a timely manner to improve public awareness on key health issues. Information must be shared in an objective, fair, accurate and comprehensive manner to enhance public trust (Fan et al., 2022). Trust must be established as a baseline through consistent and proactive contact with the community on an ongoing basis. Successfully enriching the trust relationship between the population and the scientific community will allow us to derive from it in the contingency of another public health need such as during COVID-19.

Combined with the pursuit of trust in science, another avenue for public health intervention against misinformation, is the proactive and preemptive correction of myths, and conspiracy theories. Evidence suggests that by forewarning public about false information they may encounter proffers immunity against misinformation (Pilditch et al., 2022). This concept of cognitive inoculation could be encapsulated in public health education and intervention campaigns that teach people how to search for and use information with pro-active skepticism. Computational research into deploying this type of intervention using games that simulate social media environments has shown improvements in people's ability to recognize misinformation (Pilditch et al., 2022). By incorporating in public health practice, the findings from emerging research in the area of information science and information literacy we can further combat misinformation (Lloyd, 2017).

The health informatics environment has also seen some innovative changes to health care delivery with the rapid deployment of eHealth services and telemedicine with

exponential growth and novel clinical and population health developments. In the effort to leverage evidence-based public health informatics in the COVID -19 response, the International Medical Informatics Association (IMIA) has identified may key areas that health informatics can contribute to, ranging from telehealth, clinical informatics technology, language and meaning in biomedicine, education of informatics professionals, to social media infoveillance (Fernandez-Luque et al., 2020). Many experts operating in working groups identified these focus areas. Two main recommendations of these IMIA working groups are 1) training and capacity building and 2) evaluation through consolidation of evidence and assessment of COVID-19 impact through interdisciplinary collaboration. IMIA also encourages better information-sharing practices among the scientific community with a collaborative mindset (Soualmia, Hollis, Mougin, & Séroussi, 2021).

The ensuing developments in health informatics incorporate public health dashboards as commonplace in our daily lives, as tools to communicate health data and the public has come to rely on credible health information from their healthcare providers. Future possibilities include targeted healthcare campaigns, especially if it can be combined with AI driven outreach based of public data to customize public health messages based on the audience. When sharing complex health information to individuals, it is important to deliver knowledge in a manner that will affect a positive response. Collaboration with health behaviorists and communication professionals that account for individual beliefs and health literacy levels is imperative.

Targeted outreach of individuals that is customized to their individual susceptibilities is widely employed in artificial intelligence (AI) driven marketing in our

day to day lives. Similarly, personalized health messages for individuals based on individual preference and needs based on their health risk data can be delivered to help influence health behaviors using AI (Jungwirth & Haluza, 2023). Applications of big data analytics and related digital technologies offering solutions to address the challenges of COVID-19 and population level public health responses are gaining momentum in public health research (Gunasekeran, Tseng, Tham, & Wong, 2021). Micro-targeting individuals susceptible to misinformation with dissemination of positive and credible knowledge must be further developed.

With the increase of digital and social media platform use, social responsibility on these online providers to curate and combat misinformation is critical. AI technology can be applied by platform companies to monitor and correct misinformation, as well as promote accessibility of good and reliable health information (Muric et al., 2021). There is an emerging need to score the reliability of a website for accurate and current information. Indeed, this may be needed for all sources of information, news, and public statements by elected officials.

Media platforms must also be held accountable to minimum standards of accurate and credible information sharing practices and discouraged from presenting biased and distorted views when sharing healthcare knowledge. Both content and source of information must be authenticated by news organizations, and the public should be encouraged to do the same to discern relevant health information (Bin Naeem & Kamel Boulos, 2021). Several important aspects to health literacy can be factored systematically in media practices, encouraging consumers to assess the source of information, evaluate bias and cross-verify across multiple sources for consistency and scientific basis.

The lessons from this research underscore the need to invest in our public health infrastructure and a multi-faceted approach to combat misinformation. Investments in community and higher education, healthcare access, health literacy and building trust in science must be combined with targeted outreach and leveraging PDs as health literacy and information validation experts and champions.

REFERENCES

Albrecht, D. (2022). Vaccination, politics and COVID-19 impacts. *BMC Public Health, 22*(1), 96. doi:10.1186/s12889-021-12432-x

Ando, H., Cousins, R., & Young, C. (2014). Achieving Saturation in Thematic Analysis: Development and Refinement of a Codebook. *Comprehensive Psychology, 3*, 03.CP.03.04. doi:10.2466/03.CP.3.4

Balkányi, L., Lukács, L., & Cornet, R. (2021). Investigating the Scientific 'Infodemic' Phenomenon Related to the COVID-19 Pandemic. *Yearb Med Inform, 30*(1), 245-256. doi:10.1055/s-0041-1726483

Barometer, E. T. (2021). 2021 Edelman Trust Barometer: Executive Summary. Retrieved from https://www.edelman.com/sites/g/files/aatuss191/files/2021-03/2021%20Edelman%20Trust%20Barometer.pdf

Biasio, L. R., Bonaccorsi, G., Lorini, C., & Pecorelli, S. (2021). Assessing COVID-19 vaccine literacy: a preliminary online survey. *Hum Vaccin Immunother, 17*(5), 1304-1312. doi:10.1080/21645515.2020.1829315

Bin Naeem, S., & Kamel Boulos, M. N. (2021). COVID-19 Misinformation Online and Health Literacy: A Brief Overview. *Int J Environ Res Public Health, 18*(15). doi:10.3390/ijerph18158091

Blakeslee, S. (2004). The CRAAP test. *Loex Quarterly, 31*(3), 4.

Blizzard, K. (2021). Cut the CRAAP: Teaching Information Evaluation in the Misinformation Age.

Boas, T. C., Christenson, D. P., & Glick, D. M. (2020). Recruiting large online samples in the United States and India: Facebook, mechanical turk, and qualtrics. *Political Science Research and Methods, 8*(2), 232-250.

Bode, L., & Vraga, E. K. (2018). See Something, Say Something: Correction of Global Health Misinformation on Social Media. *Health Commun, 33*(9), 1131-1140. doi:10.1080/10410236.2017.1331312

Bode, L., & Vraga, E. K. (2021). Correction experiences on social media during COVID-19. *Social Media+ Society, 7*(2), 20563051211008829.

Bradley, E. H., Curry, L. A., Ramanadhan, S., Rowe, L., Nembhard, I. M., & Krumholz, H. M. (2009). Research in action: using positive deviance to improve quality of health care. *Implement Sci, 4*, 25. doi:10.1186/1748-5908-4-25

Bunker, D. (2020). Who do you trust? The digital destruction of shared situational awareness and the COVID-19 infodemic. *International Journal of Information Management, 55*, 102201. doi:https://doi.org/10.1016/j.ijinfomgt.2020.102201

Calleja, N., AbdAllah, A., Abad, N., Ahmed, N., Albarracin, D., Altieri, E., . . . Purnat, T. D. (2021). A Public Health Research Agenda for Managing Infodemics: Methods and Results of the First WHO Infodemiology Conference. *JMIR Infodemiology, 1*(1), e30979. doi:10.2196/30979

Capasso, M., Caso, D., & Zimet, G. D. (2022). The Mediating Roles of Attitude Toward COVID-19 Vaccination, Trust in Science and Trust in Government in the Relationship Between Anti-vaccine Conspiracy Beliefs and Vaccination Intention. *Front Psychol, 13*, 936917. doi:10.3389/fpsyg.2022.936917

Choukou, M. A., Sanchez-Ramirez, D. C., Pol, M., Uddin, M., Monnin, C., & Syed-Abdul, S. (2022). COVID-19 infodemic and digital health literacy in vulnerable populations: A scoping review. *Digit Health, 8*, 20552076221076927. doi:10.1177/20552076221076927

Cole, J., Tulloch, O., Schmidt-Sane, M., Hrynick, T., & Ripoll, S. (2022). Social science approaches to infodemiology: understanding the social, political, and economic context of information. *Global Health Promotion, 29*(3), 140-144. doi:10.1177/17579759211073174

Corinti, F., Pontillo, D., & Giansanti, D. (2022). COVID-19 and the Infodemic: An Overview of the Role and Impact of Social Media, the Evolution of Medical Knowledge, and Emerging Problems. *Healthcare (Basel), 10*(4). doi:10.3390/healthcare10040732

Deb Nath, N., Khan, M. M., Schmidt, M., Njau, G., & Odoi, A. (2023). Geographic disparities and temporal changes of COVID-19 incidence risks in North Dakota, United States. *BMC Public Health, 23*(1), 720. doi:10.1186/s12889-023-15571-5

Dib, F., Mayaud, P., Chauvin, P., & Launay, O. (2022). Online mis/disinformation and vaccine hesitancy in the era of COVID-19: Why we need an eHealth literacy revolution. *Hum Vaccin Immunother, 18*(1), 1-3. doi:10.1080/21645515.2021.1874218

Eysenbach, G. (2009). Infodemiology and infoveillance: framework for an emerging set of public health informatics methods to analyze search, communication and publication behavior on the Internet. *J Med Internet Res, 11*(1), e11. doi:10.2196/jmir.1157

Eysenbach, G. (2020). How to Fight an Infodemic: The Four Pillars of Infodemic Management. *J Med Internet Res, 22*(6), e21820. doi:10.2196/21820

Fan, J., Wang, X., Du, S., Mao, A., Du, H., & Qiu, W. (2022). Discussion of the Trust in Vaccination against COVID-19. *Vaccines, 10*(8), 1214. Retrieved from https://www.mdpi.com/2076-393X/10/8/1214

Fernandez-Luque, L., Kushniruk, A. W., Georgiou, A., Basu, A., Petersen, C., Ronquillo, C., . . . Zhu, X. (2020). Evidence-Based Health Informatics as the Foundation for the COVID-19 Response: A Joint Call for Action. *Methods Inf Med, 59*(6), 183-192. doi:10.1055/s-0041-1726414

Gerosa, T., Gui, M., Hargittai, E., & Nguyen, M. H. (2021). (Mis)informed During COVID-19: How Education Level and Information Sources Contribute to Knowledge Gaps. *International Journal of Communication, 15*, 21.

Gisondi, M. A., Barber, R., Faust, J. S., Raja, A., Strehlow, M. C., Westafer, L. M., & Gottlieb, M. (2022). A Deadly Infodemic: Social Media and the Power of COVID-19 Misinformation. *J Med Internet Res, 24*(2), e35552. doi:10.2196/35552

Gisondi, M. A., Chambers, D., La, T. M., Ryan, A., Shankar, A., Xue, A., & Barber, R. A. (2022). A Stanford Conference on Social Media, Ethics, and COVID-19 Misinformation (INFODEMIC): Qualitative Thematic Analysis. *J Med Internet Res, 24*(2), e35707. doi:10.2196/35707

Gunasekeran, D. V., Tseng, R. M. W. W., Tham, Y.-C., & Wong, T. Y. (2021). Applications of digital health for public health responses to COVID-19: a systematic scoping review of artificial intelligence, telehealth and related technologies. *npj Digital Medicine, 4*(1), 40. doi:10.1038/s41746-021-00412-9

Hamel L, K. A., Sparks G, Stokes M, Brodie M. (2021). KFF COVID-19 Vaccine Monitor: Media and misinformation. .

Hamel, L., Lopes, L., Kirzinger, A., Sparks, G., Stokes, M., & Brodie, M. KFF COVID-19 Vaccine Monitor: Media and Misinformation. Retrieved from https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-media-and-misinformation/

Himelein-Wachowiak, M., Giorgi, S., Devoto, A., Rahman, M., Ungar, L., Schwartz, H. A., . . . Curtis, B. (2021). Bots and Misinformation Spread on Social Media: Implications for COVID-19. *J Med Internet Res, 23*(5), e26933. doi:10.2196/26933

Hotez, P., Batista, C., Ergonul, O., Figueroa, J. P., Gilbert, S., Gursel, M., . . . Bottazzi, M. E. (2021). Correcting COVID-19 vaccine misinformation: Lancet Commission on COVID-19 Vaccines and Therapeutics Task Force Members. *EClinicalMedicine, 33*, 100780. doi:10.1016/j.eclinm.2021.100780

Hudson, A., & Montelpare, W. J. (2021). Predictors of Vaccine Hesitancy: Implications for COVID-19 Public Health Messaging. *Int J Environ Res Public Health, 18*(15). doi:10.3390/ijerph18158054

Inoue, M., Shimoura, K., Nagai-Tanima, M., & Aoyama, T. (2022). The Relationship Between Information Sources, Health Literacy, and COVID-19 Knowledge in the COVID-19 Infodemic: Cross-sectional Online Study in Japan. *J Med Internet Res, 24*(7), e38332. doi:10.2196/38332

The International Federation of Library Associations and Institutions (IFLA). How to Spot Fake News – COVID-19 Edition. Retrieved from https://www.ifla.org/skills-for-a-digital-world/how-to-spot-fake-news-covid-19-edition/

Islam, M. S., Kamal, A. M., Kabir, A., Southern, D. L., Khan, S. H., Hasan, S. M. M., . . . Seale, H. (2021). COVID-19 vaccine rumors and conspiracy theories: The need for cognitive inoculation against misinformation to improve vaccine adherence. *PLoS One, 16*(5), e0251605. doi:10.1371/journal.pone.0251605

Jungwirth, D., & Haluza, D. (2023). Artificial Intelligence and Public Health: An Exploratory Study. *International Journal of Environmental Research and Public Health, 20*(5), 4541. Retrieved from https://www.mdpi.com/1660-4601/20/5/4541

Kaiser Family Foundation. (2021). KFF COVID-19 Vaccine Monitor: Media and Misinformation. Retrieved from https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-media-and-misinformation/

Katzman, J. G., & Katzman, J. W. (2021). Primary care clinicians as COVID-19 vaccine ambassadors. *Journal of primary care & community health, 12*, 21501327211007026.

Korin, M. R., Araya, F., Idris, M. Y., Brown, H., & Claudio, L. (2022). Community-Based Organizations as Effective Partners in the Battle Against Misinformation. *Front Public Health, 10*, 853736. doi:10.3389/fpubh.2022.853736

Kožuh, I., & Čakš, P. (2021). Explaining News Trust in Social Media News during the COVID-19 Pandemic-The Role of a Need for Cognition and News Engagement. *Int J Environ Res Public Health, 18*(24). doi:10.3390/ijerph182412986

Kumari, A., Ranjan, P., Chopra, S., Kaur, D., Kaur, T., Upadhyay, A. D., . . . Vikram, N. K. (2021). Knowledge, barriers and facilitators regarding COVID-19 vaccine and vaccination programme among the general population: A cross-sectional survey from one thousand two hundred and forty-nine participants. *Diabetes Metab Syndr, 15*(3), 987-992. doi:10.1016/j.dsx.2021.04.015

Lee, J. J., Kang, K. A., Wang, M. P., Zhao, S. Z., Wong, J. Y. H., O'Connor, S., . . . Shin, S. (2020). Associations Between COVID-19 Misinformation Exposure and Belief

With COVID-19 Knowledge and Preventive Behaviors: Cross-Sectional Online Study. *J Med Internet Res, 22*(11), e22205. doi:10.2196/22205

Lehdonvirta, V., Oksanen, A., Räsänen, P., & Blank, G. (2021). Social media, web, and panel surveys: using non-probability samples in social and policy research. *Policy & internet, 13*(1), 134-155.

Liew, T. M., & Lee, C. S. (2021). Examining the Utility of Social Media in COVID-19 Vaccination: Unsupervised Learning of 672,133 Twitter Posts. *JMIR Public Health Surveill, 7*(11), e29789. doi:10.2196/29789

Litman, L., & Robinson, J. (2020). *Conducting online research on Amazon Mechanical Turk and beyond*: Sage Publications.

Liu, T., & Xiao, X. (2021). A Framework of AI-Based Approaches to Improving eHealth Literacy and Combating Infodemic. *Front Public Health, 9*, 755808. doi:10.3389/fpubh.2021.755808

Lloyd, A. (2017). Information literacy and literacies of information: A mid-range theory and model. *Journal of Information Literacy, 11*(1).

Lo, C.-H., Chiu, L., Qian, A., Khan, M. Z., Alhassan, H. A., Duval, A. J., & Chan, A. T. (2022). Association of primary care physicians per capita with COVID-19 vaccination rates among US counties. *JAMA Network Open, 5*(2), e2147920-e2147920.

Loomba, S., de Figueiredo, A., Piatek, S. J., de Graaf, K., & Larson, H. J. (2021). Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. *Nat Hum Behav, 5*(3), 337-348. doi:10.1038/s41562-021-01056-1

Lurie, P., Adams, J., Lynas, M., Stockert, K., Carlyle, R. C., Pisani, A., & Evanega, S. D. (2022). COVID-19 vaccine misinformation in English-language news media: retrospective cohort study. *BMJ Open, 12*(6), e058956. doi:10.1136/bmjopen-2021-058956

Lyu, J. C., Han, E. L., & Luli, G. K. (2021). COVID-19 Vaccine-Related Discussion on Twitter: Topic Modeling and Sentiment Analysis. *J Med Internet Res, 23*(6), e24435. doi:10.2196/24435

Marsh, D. R., Schroeder, D. G., Dearden, K. A., Sternin, J., & Sternin, M. (2004). The power of positive deviance. *Bmj, 329*(7475), 1177-1179. doi:10.1136/bmj.329.7475.1177

Miles, M., & Huberman, A. (1994). *Qualitative data analysis: An expanded sourcebook, 2nd ed*. Thousand Oaks, CA, US: Sage Publications, Inc.

Monselise, M., Chang, C. H., Ferreira, G., Yang, R., & Yang, C. C. (2021). Topics and Sentiments of Public Concerns Regarding COVID-19 Vaccines: Social Media Trend Analysis. *J Med Internet Res, 23*(10), e30765. doi:10.2196/30765

Montagni, I., Ouazzani-Touhami, K., Mebarki, A., Texier, N., Schück, S., Tzourio, C., & group, t. C. (2021). Acceptance of a Covid-19 vaccine is associated with ability to detect fake news and health literacy. *Journal of Public Health, 43*(4), 695-702. doi:10.1093/pubmed/fdab028

Muric, G., Wu, Y., & Ferrara, E. (2021). COVID-19 Vaccine Hesitancy on Social Media: Building a Public Twitter Data Set of Antivaccine Content, Vaccine Misinformation, and Conspiracies. *JMIR Public Health Surveill, 7*(11), e30642. doi:10.2196/30642

NAMLE. (2023). The National Association for Media Literacy Education. Retrieved from https://namle.net/resources/

Ngai, C. S. B., Singh, R. G., & Yao, L. (2022). Impact of COVID-19 Vaccine Misinformation on Social Media Virality: Content Analysis of Message Themes and Writing Strategies. *J Med Internet Res, 24*(7), e37806. doi:10.2196/37806

Office of the Surgeon, G. (2021). Publications and Reports of the Surgeon General. In *Confronting Health Misinformation: The U.S. Surgeon General's Advisory on Building a Healthy Information Environment*. Washington (DC): US Department of Health and Human Services.

Omboni, S., Padwal, R. S., Alessa, T., Benczúr, B., Green, B. B., Hubbard, I., . . . Wang, J. (2022). The worldwide impact of telemedicine during COVID-19: current evidence and recommendations for the future. *Connect Health, 1*, 7-35. doi:10.20517/ch.2021.03

Palamenghi, L., Barello, S., Boccia, S., & Graffigna, G. (2020). Mistrust in biomedical research and vaccine hesitancy: the forefront challenge in the battle against COVID-19 in Italy. *European Journal of Epidemiology, 35*(8), 785-788. doi:10.1007/s10654-020-00675-8

Pew Research Center. (2020). Local news is playing an important role for Americans during COVID-19 outbreak. Retrieved from https://pewrsr.ch/3eSZzTz

Pilditch, T. D., Roozenbeek, J., Madsen, J. K., & van der Linden, S. (2022). Psychological inoculation can reduce susceptibility to misinformation in large rational agent networks. *R Soc Open Sci, 9*(8), 211953. doi:10.1098/rsos.211953

Pool, J., Fatehi, F., & Akhlaghpour, S. (2021). Infodemic, Misinformation and Disinformation in Pandemics: Scientific Landscape and the Road Ahead for Public Health Informatics Research. *Stud Health Technol Inform, 281*, 764-768. doi:10.3233/shti210278

Pronker, E. S., Weenen, T. C., Commandeur, H., Claassen, E. H., & Osterhaus, A. D. (2013). Risk in vaccine research and development quantified. *PLoS One, 8*(3), e57755. doi:10.1371/journal.pone.0057755

Purnat, T. D., Vacca, P., Burzo, S., Zecchin, T., Wright, A., Briand, S., & Nguyen, T. (2021). WHO Digital Intelligence Analysis for Tracking Narratives and Information Voids in the COVID-19 Infodemic. *Stud Health Technol Inform, 281*, 989-993. doi:10.3233/shti210326

Purnat, T. D., Vacca, P., Czerniak, C., Ball, S., Burzo, S., Zecchin, T., . . . Nguyen, T. (2021). Infodemic Signal Detection During the COVID-19 Pandemic: Development of a Methodology for Identifying Potential Information Voids in Online Conversations. *JMIR Infodemiology, 1*(1), e30971. doi:10.2196/30971

Rawaf, S., Allen, L. N., Stigler, F. L., Kringos, D., Quezada Yamamoto, H., & van Weel, C. (2020). Lessons on the COVID-19 pandemic, for and by primary care professionals worldwide. *European Journal of General Practice, 26*(1), 129-133. doi:10.1080/13814788.2020.1820479

Rochwerg, B., Parke, R., Murthy, S., Fernando, S. M., Leigh, J. P., Marshall, J., . . . Sevransky, J. E. (2020). Misinformation During the Coronavirus Disease 2019 Outbreak: How Knowledge Emerges From Noise. *Crit Care Explor, 2*(4), e0098. doi:10.1097/cce.0000000000000098

Roozenbeek, J., Schneider, C. R., Dryhurst, S., Kerr, J., Freeman, A. L. J., Recchia, G., . . . van der Linden, S. (2020). Susceptibility to misinformation about COVID-19 around the world. *R Soc Open Sci, 7*(10), 201199. doi:10.1098/rsos.201199

Ruiz, J. B., & Bell, R. A. (2021). Predictors of intention to vaccinate against COVID-19: Results of a nationwide survey. *Vaccine, 39*(7), 1080-1086. doi:10.1016/j.vaccine.2021.01.010

Saelee, R., Zell, E., Murthy, B. P., Castro-Roman, P., Fast, H., Meng, L., . . . Murthy, N. (2022). Disparities in COVID-19 Vaccination Coverage Between Urban and Rural Counties - United States, December 14, 2020-January 31, 2022. *MMWR Morb Mortal Wkly Rep, 71*(9), 335-340. doi:10.15585/mmwr.mm7109a2

Saldana, J. (2013). *The Coding Manual for Qualitative Researchers.* Thousand Oaks, CA: Sage.

Sharfstein, J. M., Callaghan, T., Carpiano, R. M., Sgaier, S. K., Brewer, N. T., Galvani, A. P., . . . Salmon, D. A. (2021). Uncoupling vaccination from politics: a call to action. *The Lancet, 398*(10307), 1211-1212.

Skafle, I., Nordahl-Hansen, A., Quintana, D. S., Wynn, R., & Gabarron, E. (2022). Misinformation About COVID-19 Vaccines on Social Media: Rapid Review. *J Med Internet Res, 24*(8), e37367. doi:10.2196/37367

Soualmia, L. F., Hollis, K. F., Mougin, F., & Séroussi, B. (2021). Health Data, Information, and Knowledge Sharing for Addressing the COVID-19. *Yearb Med Inform, 30*(1), 4-7. doi:10.1055/s-0041-1726541

Sreeramoju, P., Dura, L., Fernandez, M. E., Minhajuddin, A., Simacek, K., Fomby, T. B., & Doebbeling, B. N. (2018). Using a Positive Deviance Approach to Influence the Culture of Patient Safety Related to Infection Prevention. *Open Forum Infect Dis, 5*(10), ofy231. doi:10.1093/ofid/ofy231

Stokes-Parish, J. (2022). Navigating the Credibility of Web-Based Information During the COVID-19 Pandemic: Using Mnemonics to Empower the Public to Spot Red Flags in Health Information on the Internet. *J Med Internet Res, 24*(6), e38269. doi:10.2196/38269

Sturgis, P., Brunton-Smith, I., & Jackson, J. (2021). Trust in science, social consensus and vaccine confidence. *Nature Human Behaviour, 5*(11), 1528-1534. doi:10.1038/s41562-021-01115-7

Su, Y., Borah, P., & Xiao, X. (2022). Understanding the "infodemic": social media news use, homogeneous online discussion, self-perceived media literacy and misperceptions about COVID-19. *Online Information Review, 46*(7), 1353-1372. doi:10.1108/OIR-06-2021-0305

Suarez-Lledo, V., & Alvarez-Galvez, J. (2021). Prevalence of health misinformation on social media: systematic review. *Journal of medical Internet research, 23*(1), e17187.

Szilagyi, P. G., Thomas, K., Shah, M. D., Vizueta, N., Cui, Y., Vangala, S., . . . Kapteyn, A. (2021). The role of trust in the likelihood of receiving a COVID-19 vaccine: Results from a national survey. *Preventive Medicine, 153*, 106727. doi:https://doi.org/10.1016/j.ypmed.2021.106727

Tangcharoensathien, V., Calleja, N., Nguyen, T., Purnat, T., D'Agostino, M., Garcia-Saiso, S., . . . Briand, S. (2020). Framework for Managing the COVID-19 Infodemic: Methods and Results of an Online, Crowdsourced WHO Technical Consultation. *J Med Internet Res, 22*(6), e19659. doi:10.2196/19659

Thomas, T. L., DiClemente, R., & Snell, S. (2013). Overcoming the triad of rural health disparities: How local culture, lack of economic opportunity, and geographic location instigate health disparities. *Health Education Journal, 73*(3), 285-294. doi:10.1177/0017896912471049

Ting, D. S. W., Carin, L., Dzau, V., & Wong, T. Y. (2020). Digital technology and COVID-19. *Nat Med, 26*(4), 459-461. doi:10.1038/s41591-020-0824-5

Toscos, T., Carpenter, M., Flanagan, M., Kunjan, K., & Doebbeling, B. N. (2018). Identifying Successful Practices to Overcome Access to Care Challenges in

Community Health Centers: A "Positive Deviance" Approach. *Health Serv Res Manag Epidemiol, 5*, 2333392817743406. doi:10.1177/2333392817743406

Viswanath, K., Bekalu, M., Dhawan, D., Pinnamaneni, R., Lang, J., & McLoud, R. (2021). Individual and social determinants of COVID-19 vaccine uptake. *BMC Public Health, 21*(1), 818. doi:10.1186/s12889-021-10862-1

WHO Definition of eHealth. Retrieved from https://www.emro.who.int/health-topics/ehealth/

WHO Director General, Tedros Adhanom Ghebreyesus at the Munich Security Conference, (Feb, 2020).

Zhao, S., Hu, S., Zhou, X., Song, S., Wang, Q., Zheng, H., . . . Hou, Z. (2023). The Prevalence, Features, Influencing Factors, and Solutions for COVID-19 Vaccine Misinformation: Systematic Review. *JMIR Public Health Surveill, 9*, e40201. doi:10.2196/40201

APPENDIX A

SURVEY QUESTIONS WITH CODEBOOK

Demographics:

U Gender

1-male

2-female

3- other fill in

V Age

open

W Languages spoken at home

1-English

2- Spanish

3- other fill in

AA Community you live in

1- rural

2- small city or town

3- suburb near large city

4- large city

AB Which of the following best describes you?

1-Hispanic or Latino

2- American Indian or Alaska Native

3- Asian

4- Black or African American

5- Native Hawaiian or other Pacific Islander

6- Caucasian or White

7- Multiracial

8- Prefer not to say

9 - other fill in

AD Are you Hispanic or Latino

1- yes

2- no

AE Highest level of education

1- some high school

2- high school graduate

3- some college

4 - trade/technical/vocational training

5- college graduate

6- some postgraduate work

7 - post-graduate degree

AF Current employment status

1- full-time

2- part-time

3- not employed

4- retired

5- unable to work

6- other fill in

AH Household income

1- 0-$25,999

2- 26,000-51,999

3- 52,000-74,999

4- 75,000-99,999

5- 100,000-200,000

6- more than 200,000

7- prefer not to say

AI Political affiliation

1- democrat

2- moderate

3- republican

4- independent

5- prefer not to say

6- other fill in

AK level of trust in COVID info from national government

1- very low

2- low

3- moderate

4- high

5- very high

AL level of trust in COVID info from state/territorial government

1- very low

2- low

3- moderate

4- high

5- very high

AM level of trust in COVID info from CDC?

1- very low

2- low

3- moderate

4- high

5- very high

AN level of trust in COVID info from pharmaceutical companies?

1- very low

2- low

3- moderate

4- high

5- very high

AO level of trust in COVID info from your doctor?

1- very low

2- low

3- moderate

4- high

5- very high

AP level of trust in COVID info from your pharmacist?

1- very low

2- low

3- moderate

4- high

5- very high

AQ Are you covered by health care?

1- yes

2- no

AR Do you currently have a primary care provider?

1- yes

2- no

AS Have you previously been diagnosed with covid-19?

1- yes

2 - no

AT have you known someone who has died due to complications with covid-19?

1- yes

2- no

AU have you or someone you know been hospitalized with covid-19?

1- yes

2- no

AV Have you vaccinated against covid-19?

1- Yes, I received all doses and 1 or more booster doses (1 shot for J&J, 2 for Pfizer & Moderna)

2 - Yes, I received the original doses but no booster dose (1 shot for J&J, 2 for Pfizer/Moderna)

3- No, but I plan on vaccinating

4- No, and I do not plan on vaccinating

COVID-19 knowledge questions- 18 total

AW The COVID-19 vaccines (Pfizer, Moderna) are safe ~~in~~ FOR MOST ? ~~large numbers of~~ recipients. T

1

AXThe COVID-19 vaccines (Pfizer, Moderna) are effective in preventing hospitalization. T

1

AY The COVID-19 vaccines (Pfizer, Moderna) are effective in preventing death. T

1

AZ Regular use of masks in high-risk settings will lessen ~~your~~ SOMEONE'S risk of developing or spreading COVID-19. T

1

BA Avoiding close contact with others who have been exposed to or are sick with COVID is a key strategy in preventing COVID-19. T.

1

BB Those who are fully vaccinated cannot transmit COVID-19. F

2

BC The use of masks in schools has not shown to reduce the risk of COVID-19 infection in children. F

2

BD COVID-19 can only be spread by those who are exhibiting symptoms. F

2

BE Those who have had COVID-19 cannot contract the disease again. F

2

BF Social distancing (staying 6 feet away from others) can help prevent the spread of COVID. T

1

BG The government is exaggerating the number of COVID-19 deaths. F (KFF question)

2

BH Pregnant women should not get the COVID-19 vaccine. F (KFF question)

2

BI The COVID-19 vaccines have been shown to cause infertility. F (KFF question)

2

BJ You can get COVID-19 from the vaccine. F

2

BK The COVID-19 vaccines can change your DNA. F (KFF question)

2

BL People of all ages can become infected with COVID-19. T

1

BM People of all racial and ethnic groups can become infected with COVID-19. T

1

BN Most people who are infected with the COVID-19 virus recover from it. T

1

From Reuters Institute Digital News Report 2021

News Media Literacy Scale

25. On a scale of 1 to 5 , please tell me how much you agree or disagree with this statement.

1 - strongly disagree

2- disagree

3- neutral

4- agree

5 - strongly agree

BO I do not like to have to do a lot of thinking (reverse-coded).

BP I try to avoid situations that require thinking in-depth about something (reverse-coded).

BQ I prefer complex to simple problems.

26. On a scale of 1 to 5, please tell me how much you agree or disagree with this statement.

1 - strongly disagree

2- disagree

3- neutral

4- agree

5 - strongly agree

BR I am in control of the information I get from the news media.

BS When I am misinformed by the news media, I am to blame.

BT If I pay attention to different sources of news, I can avoid being misinformed.

BU If I take the right actions, I can stay informed.

BV Most people think the news has (CHOOSE ONLY ONE ANSWER)

1- a greater effect on themselves than other people,

2- a greater effect on other people than themselves,

3- the same effect on themselves as others,

4- does not have any effects on anyone,

5- do not know.

News Literacy, Social Media & Misinformation

1 - strongly disagree

2- disagree

3- neutral

4- agree

5 - strongly agree

BW I have the skills to interpret media messages

BX I am confident in my ability to judge the quality ACCURACY? of news

BY People should accept information from the news on face value [reversed]

BZ It is the role of the press to represent diverse viewpoints

CA It is the job of citizens to overcome their biases when consuming news

CB People need to review news content critically

News/Media Consumption questions

CC. Typically, how often do you access news? By news, we mean

national, international, regional/local news and other topical events accessed via any platform (radio, TV, newspaper or online)

1- More than 5 times a day

2- Between 2 and 5 times a day

3- Once a day

4 - 4-6 days a week

5 - 2-3 days a week

6- Once a week

7 - Less often than once a week

8 - Never

9 - Don't know

CD. How interested would you say you are in politics?

1- Extremely interested

2- Very interested

3- Somewhat interested

4- Not very interested

5 - Not at all interested

6 - Don't know

CE How often do you eat cement?

1- daily

2- weekly

3- monthly

4- yearly

5- never

38. Which of the following television news programs have you watched in the last week as a source of news? Please select all that apply.

CF NBC Nightly News

CG The Today Show

CH Meet the Press

CI PBS Newshour

CJ Fox News

CK CNN

CL MSNBC

CM None of these

CN Other fill in

39. Which of the following newspapers/digital newspapers have you used in the last week as a source of news?

Please select all that apply.

CO The New York Times

CP USA Today

CQ Washington Post

CR Wall Street Journal

CS Huffington Post

CT BuzzFeed

CU CNN.com

CV Foxnews.com

CW none of these

CX other fill in

As a source of news, which of the apps/websites that include news from multiples sources have you read in the last week (all that apply)?

CY apple news

CZ google news

DA MSN

DB yahoo

DC flipboard

DD social media such as facebook, twitter, youtube, reddit

DE none of these

DF other fill in

DG Which would you say is your MAIN source of news?

1 Television

2- Newspapers

3- News websites

4- Radio

5 - Podcasts

6 - Social Media

7- apps that feature articles from multiple sources (e.g., apple news, flipboard)

9 - conversations with others

DH Please indicate your level of agreement with the following statement.

"Thinking about online news, I am concerned about what is real and what is fake on the internet."

1- Strongly disagree

2- disagree

3- Neither agree nor disagree

4- agree

5- Strongly agree

DI Thinking specifically about coronavirus (COVID-19) and its effects, which of the following sources, if any, are you **most** concerned about online? Please select ONLY one ANSWER.

False or misleading information from...

1 - The government, politicians or political parties in my country

2 - Foreign governments, politicians or political parties

3- Ordinary people

4- Activists or activist groups

5- Celebrities (e.g. actors, musicians, sports stars)

6- Journalists or news organizations

7- I am not concerned about any of these

8 - Don’t know

DJ Thinking specifically about Coronavirus (COVID-19) and its effects, which of the following, if any, are you most concerned about online? Please select one.

False or misleading information via...

1- News websites or apps

2- Search engines (e.g. Google, Bing)

3- Facebook

4 - Twitter

5- YouTube

6 - Messaging applications (e.g. WhatsApp, Facebook Messenger)

7- I am not concerned about any of these

8 - Don’t know

DK Thinking specifically about Coronavirus (COVID-19) and its effects, which of the following, do you trust most? Please select one.

False or misleading information via...

1- News websites or apps

2- Search engines (e.g. Google, Bing)

3- Facebook

4 - Twitter

5- YouTube

6 - Messaging applications (e.g. WhatsApp, Facebook Messenger)

7- I am not concerned about any of these

8 - Don't know

Which of the following have you used for sharing or discussing news in the last week? Please select all that apply.

DL Facebook

DM Twitter

DN Instagram

DO YouTube

DP TikTok

DQ- Reddit

DR - WhatsApp

DS - Snapchat

DT- LinkedIn

DU - Telegram

DV - None (Did not share news online)

47. During an average week ~~in~~ which of the following ways do you share or participate in news coverage? Please select all that apply.

DW - Rate, like, or favorite a news story

DX - Comment on a news story

DY - Share a news story

DZ- Vote in an online poll via a news site or social network

EA - Talk online with friends and colleagues about a news story (e.g. by email, social media, messaging app)

EB - Talk with friends and colleagues about a news story (face to face)

EC - None of these (SINCE YOU HAVE THIS ANSWER YOU DON'T HAVE TO HAVE "IF ANY" IN THE STEM QUESTION

ED What is the best way to locate ACCURATE information about health and disease prevention?

_____

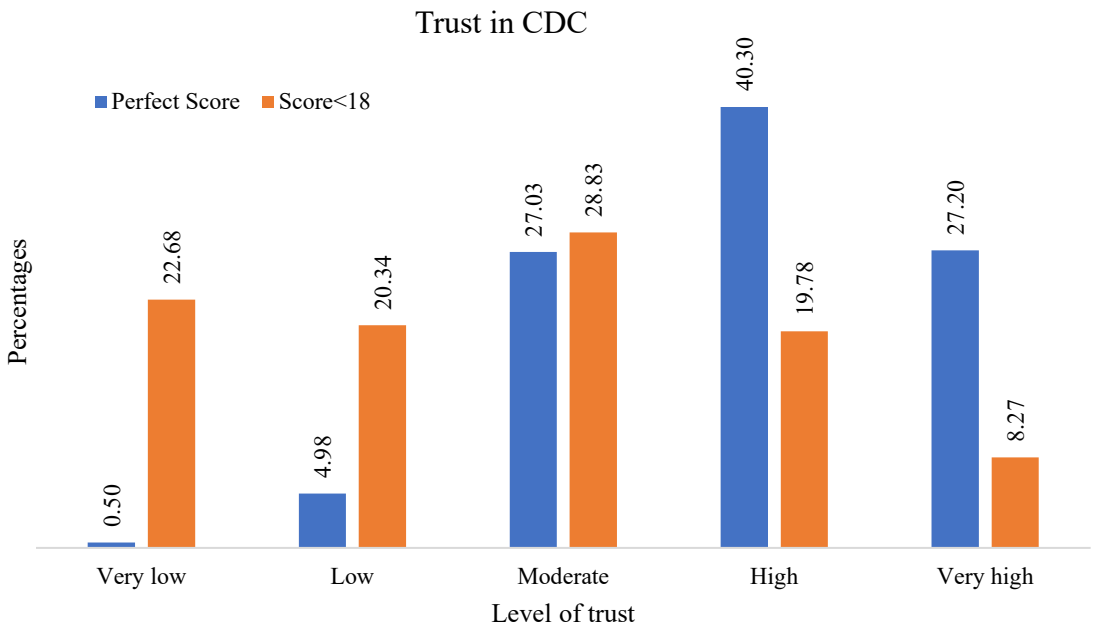
_____

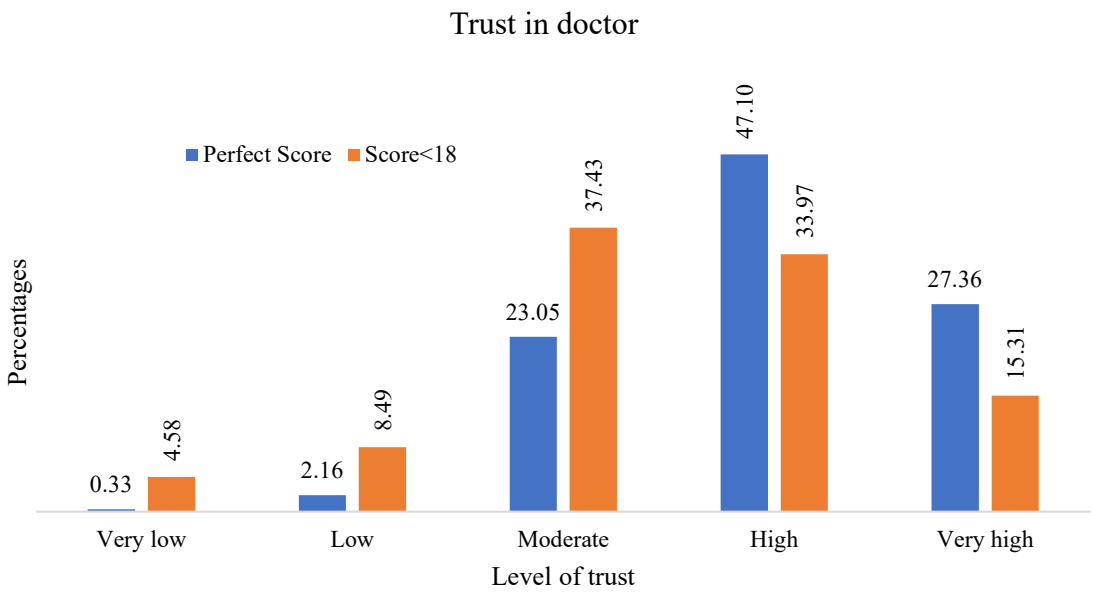
_____

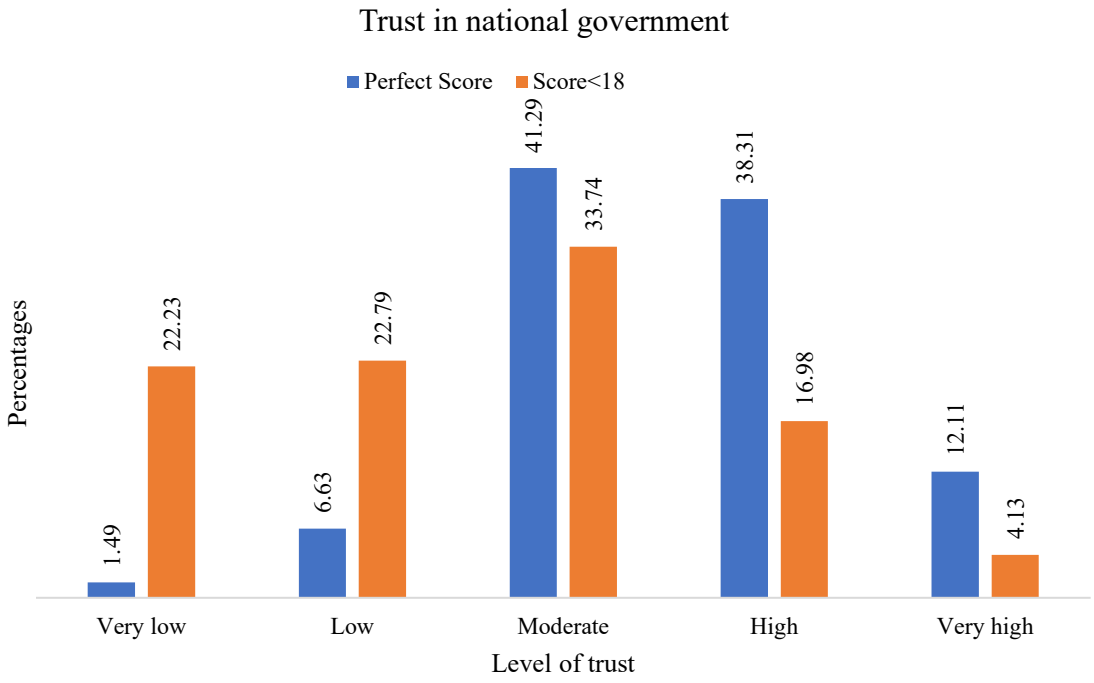
_____

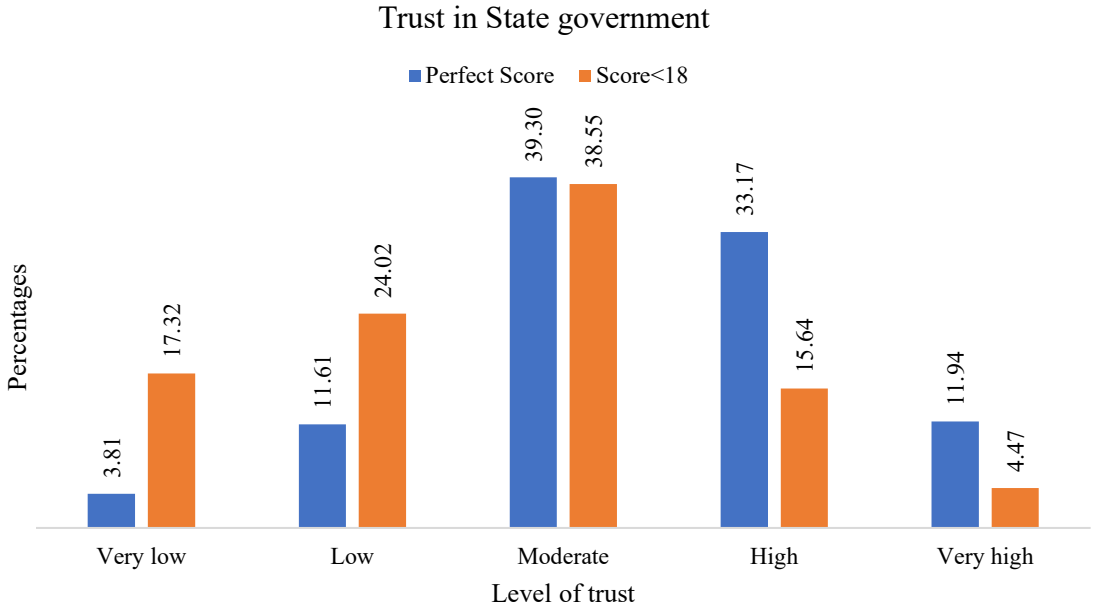
APPENDIX B

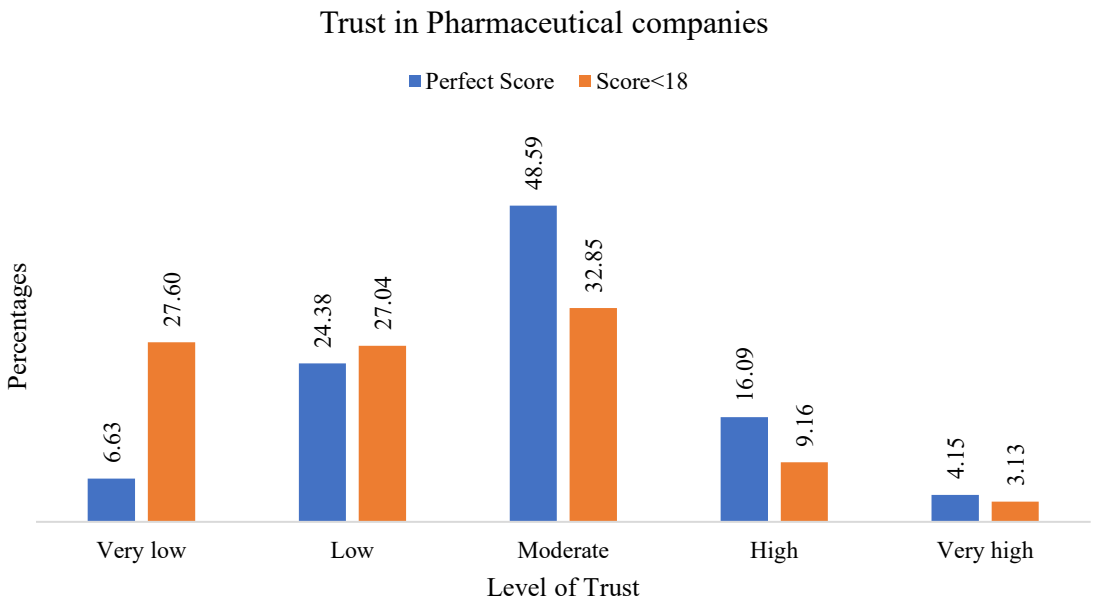
TRUST ACROSS MULTIPLE STAKEHOLDERS

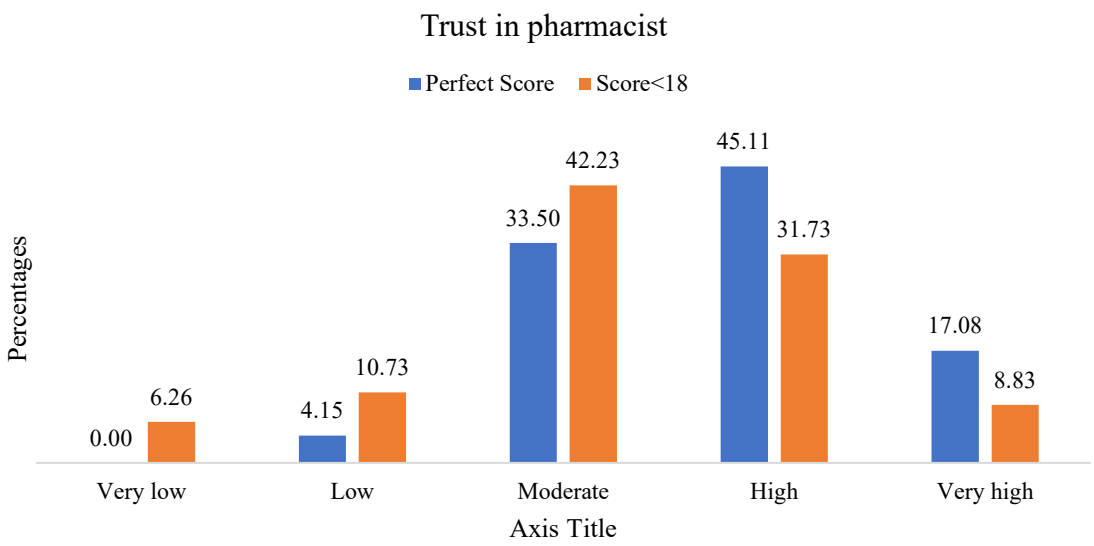

Trust in CDC
Perfect Score
Score<18
Percentages
0.50
22.68
4.98
20.34
27.03
28.83
40.30
19.78
27.20
8.27
Very low
Low
Moderate
High
Very high
Level of trust


Trust in doctor
Perfect Score
Score<18
Percentages
0.33
4.58
2.16
8.49
23.05
37.43
47.10
33.97
27.36
15.31
Very low
Low
Moderate
High
Very high
Level of trust


Trust in national government
Perfect Score
Score<18
Percentages
1.49
22.23
6.63
22.79
41.29
33.74
38.31
16.98
12.11
4.13
Very low
Low
Moderate
High
Very high
Level of trust


Trust in State government
Perfect Score
Score<18
Percentages
3.81
17.32
11.61
24.02
39.30
38.55
33.17
15.64
11.94
4.47
Very low
Low
Moderate
High
Very high
Level of trust


Trust in Pharmaceutical companies
Perfect Score
Score<18
Percentages
6.63
27.60
24.38
27.04
48.59
32.85
16.09
9.16
4.15
3.13
Very low
Low
Moderate
High
Very high
Level of Trust


Trust in pharmacist
Perfect Score
Score<18
Percentages
0.00
6.26
4.15
10.73
33.50
42.23
45.11
31.73
17.08
8.83
Very low
Low
Moderate
High
Very high
Axis Title

APPENDIX C

SAS OUTPUT FOR FINAL LOGISTIC REGRESSION MODEL

Final Logistic Model

The LOGISTIC Procedure

Model Information	
Data Set	WORK.CRONK_PREDICT
Response Variable	Vaccinated
Number of Response Levels	2
Model	binary logit
Optimization Technique	Fisher's scoring

Number of Observations Read	1484
Number of Observations Used	1484

Response Profile		
Ordered Value	Vaccinated	Total Frequency
1	0	359
2	1	1125

Probability modeled is Vaccinated=1.

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	1644.123	974.071
SC	1649.425	1058.911
-2 Log L	1642.123	942.071

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	700.0518	15	<.0001
Score	656.4919	15	<.0001
Wald	343.7377	15	<.0001

Final Logistic Model

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates						
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq	Standardized Estimate
Intercept	1	-7.5389	0.7854	92.1370	<.0001	
Know_COVID_Death	1	0.3564	0.1781	4.0056	0.0453	0.0965
CNN_d	1	-0.0341	0.2004	0.0290	0.8649	-0.00888
FoxNews_d	1	0.0854	0.2068	0.1704	0.6797	0.0200
community_SC	1	0.3728	0.2435	2.3441	0.1258	0.0925
community_SU	1	0.5636	0.2343	5.7877	0.0161	0.1504
community_LC	1	0.2246	0.2812	0.6378	0.4245	0.0481
Perfect_Score	1	0.3466	0.2610	1.7630	0.1842	0.0937
Political_R	1	0.0552	0.2414	0.0523	0.8191	0.0128
Political_O	1	-0.4065	0.2130	3.6418	0.0563	-0.0972
PrimaryCare	1	1.1017	0.1947	32.0288	<.0001	0.2510
education_C	1	0.9536	0.2429	15.4135	<.0001	0.2431
education_PG	1	1.7123	0.3262	27.5484	<.0001	0.3811
Media_Selfefficacy	1	-0.3449	0.1380	6.2469	0.0124	-0.1164
TotalScore	1	0.3336	0.0350	90.8433	<.0001	0.6153
Trust_Score	1	1.0109	0.1279	62.4542	<.0001	0.4833

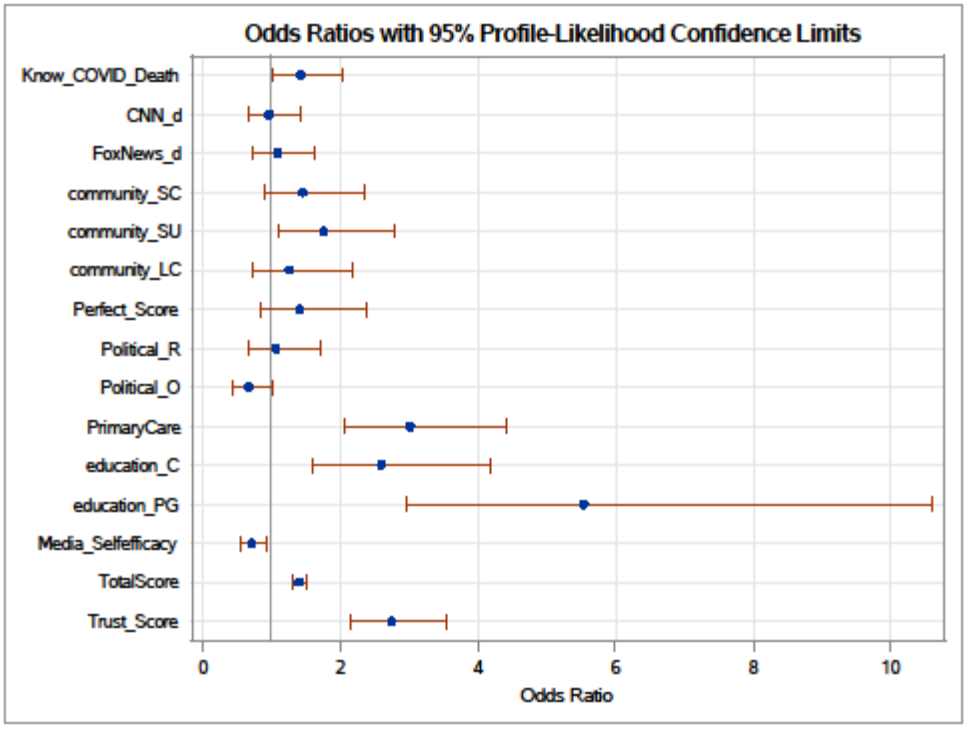
Association of Predicted Probabilities and Observed Responses			
Percent Concordant	90.2	Somers' D	0.803
Percent Discordant	9.8	Gamma	0.804
Percent Tied	0.0	Tau-a	0.295
Pairs	403875	c	0.902

Odds Ratio Estimates and Profile-Likelihood Confidence Intervals				
Effect	Unit	Estimate	95% Confidence Limits	
Know_COVID_Death	1.0000	1.428	1.009	2.030
CNN_d	1.0000	0.966	0.653	1.434
FoxNews_d	1.0000	1.089	0.728	1.639
community_SC	1.0000	1.452	0.900	2.341
community_SU	1.0000	1.757	1.109	2.781
community_LC	1.0000	1.252	0.722	2.178
Perfect_Score	1.0000	1.414	0.852	2.376

Final Logistic Model

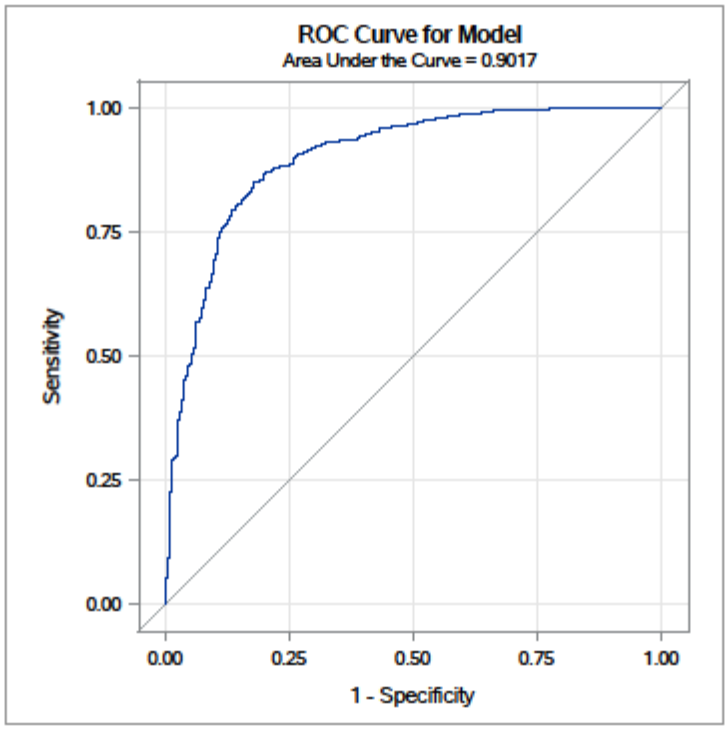
The LOGISTIC Procedure

Odds Ratio Estimates and Profile-Likelihood Confidence Intervals				
Effect	Unit	Estimate	95% Confidence Limits	
Political_R	1.0000	1.057	0.660	1.702
Political_O	1.0000	0.666	0.439	1.013
PrimaryCare	1.0000	3.009	2.057	4.416
education_C	1.0000	2.595	1.611	4.179
education_PG	1.0000	5.541	2.947	10.609
Media_Selfefficacy	1.0000	0.708	0.539	0.927
TotalScore	1.0000	1.396	1.305	1.497
Trust_Score	1.0000	2.748	2.147	3.547



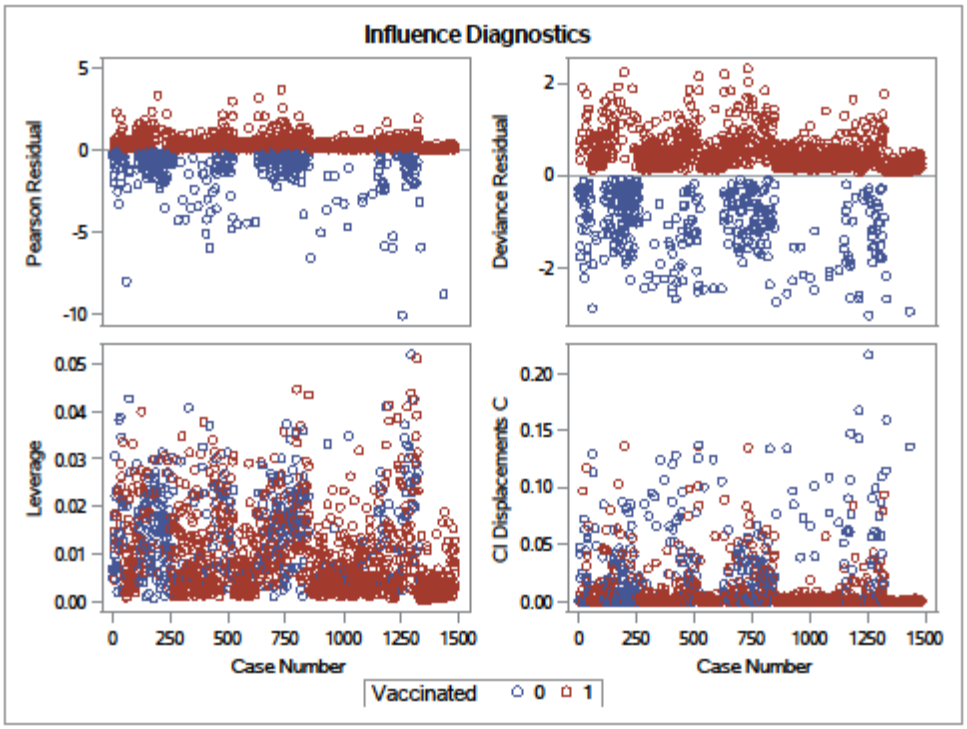
Final Logistic Model

The LOGISTIC Procedure



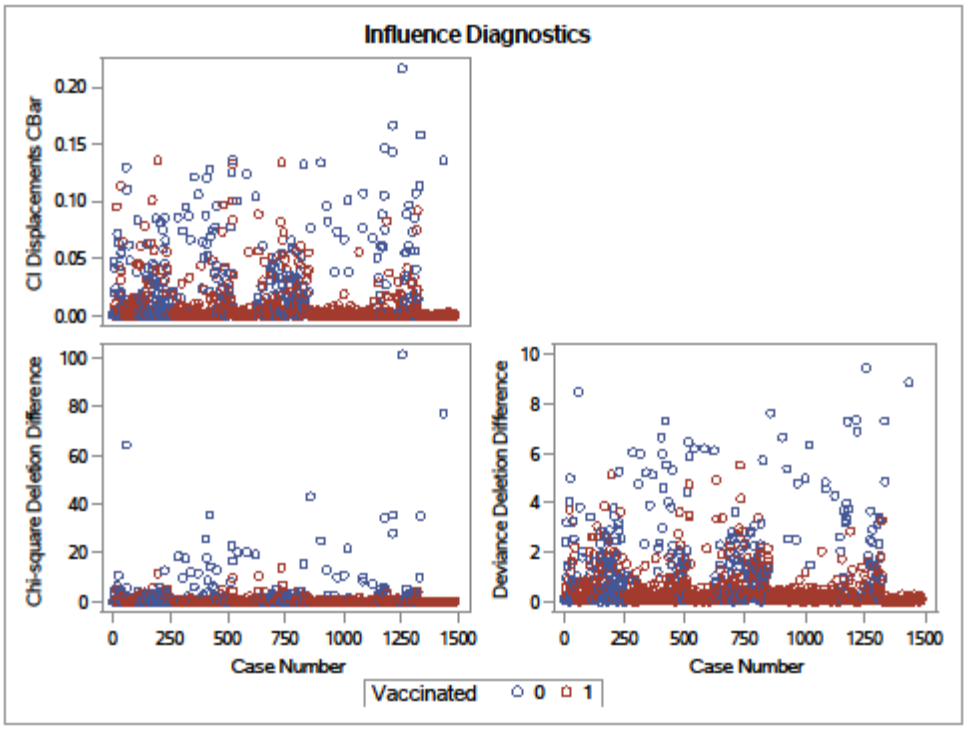
Final Logistic Model

The LOGISTIC Procedure



Final Logistic Model

The LOGISTIC Procedure



APPENDIX D

INTERVIEW CODING GUIDE

Trusted Sources

- **TS: Local news:** city, county – level news sources; generally, this refers to tv news – but sometimes refers to city/county-level data presented on websites
- **TS: National news:** Describe watching national-level news sources; PBS (when presenting national-level information)
- **TS: Private Medical Entity**: Mayo clinic, Cleveland clinic, WebMD
- **TS: CDC** – Any mention of trusting the CDC for reliable health information;
- **TS: WHO –** Any mention of trusting the WHO for data –
- **TS: Academic sources** – Johns Hopkins, University presentation of data, Harvard
- **TS: Data-driven sources:** More likely to trust sources that share data, statistics, information that feels more concrete than opinion, alone
- **TS: Social media**: Specific social media platforms that individuals trusted for COVID-19 information (sometimes Twitter and Reddit – usually not Facebook) – This may be co-coded with experts
- **TS: Experts**: Experts such as Anthony Fauci and Rochelle Walensky (referred to as the woman from the CDC) – or epidemiologists, researchers, and physicians – not interpersonal sources, more mainstream recognized experts
- **TS: Clinicians:** the role of trusted healthcare professionals in obtaining accurate COVID-19 information – more interpersonal sources; like a personal physician, pharmacist
- **TS: Family and friends:** Trusting family and friends who share similar views about COVID-19; hearing from others about their experiences receiving COVID-19 vaccines;

Untrusted Sources

- **US: Facebook**: Sharing of opinions by non-experts on Facebook; rampant spread of misinformation on this social media platform
- **US: Social media**: More general than Facebook, specifically – the role of social media for individuals to spread misinformation to a larger audience
- **US: TV news media**: Biased news sources that spread misinformation; sometimes participants name specific media groups (e.g., Fox News); discussion of bias in the news media – and their affiliated websites
- **US: Trump**: Role of former President Trump in spreading misinformation about COVID-19
- **US: Non-experts**: Individuals who are not health or medical experts spreading misinformation, largely on social media, general public – this can also include holistic health websites (aka woo woo - reference in interview) - also fake news websites created recently

Trust and Ideology

- **Trust in science/medicine:** The participant describes trusting science, medicine, and healthcare researchers to provide reliable, accurate information. Often participants will use this to describe trusting the vaccine – because, generally, they

trust science and medicine. This can also describe how anti-vaxxers do not trust science or medicine. – This also includes the FDA and CDC

- **Trust in government**: Whether the participant trusts the local, state, federal governments to provide accurate information to the public
- **Mistrust in Politicians**

Analysis Behavior

- **AB: Identify reputable sources –** Use this code any time a participant describes questioning WHO is posting health information. What are their credentials? How do you know this source is considered an expert source? Participants have also described verifying sources
- **AB: Hidden Agenda:** When assessing the source of information, examine the source to see if there are any hidden agendas to share misinformation (Do you have a stake in the outcome or a reason to purposely share information). What could motivate individuals to post information, especially if it is controversial?
- **AB: Bias:** Unconsciously sharing information – no real agenda for why they share information
- **AB: Verify information** – look at multiple sources, cross-reference and compare information; if you see something questionable, look at other sources to check the accuracy of information. This can include using fact-checking websites/resources (redundant information), this could include verifying information online
- **AB: Verify with a healthcare provider**: This is a form of verifying information; however, it focuses on talking to a doctor, pharmacist, or other healthcare providers to assess the accuracy of the information or to clarify unclear information
- **AB: Role of faith**: Role of religion/ faith and intuition to trust what information is accurate (uncommon response)
- **AB: Common sense**: Using common sense, does something sound correct, does it seem blatantly incorrect, uses intuition when evaluation information
- **AB: Critical thinking**- weighing the pros and cons (about vaccination)

Misinformation

- **M: Ignore**: ignore this; move on; don't pay attention to it; includes online and interpersonal
- **M: Listen/Read but do not correct**
- **M: Share opposing viewpoints:**
- **M: Flag/Report:** On Twitter or Facebook – alerting social media platforms that an individual is posting or sharing misinformation
- **M: Avoid Conflict**
- **M: Block -** Social media - blocking or unfollowing someone who spreads misinformation

Sharing information

- **SI: Interpersonal communication**: Describes sharing information in interpersonal settings (in-person/phone) conversations; preference for discussing information in person or over the phone
- **SI: Posting information–** Describes posting information on a personal account – this can be on Facebook, Twitter, Reddit, or on a gaming site; a form of information advocacy by sharing information
- **SI: Resharing/Retweeting information:** describes sharing information already seen online – retweets/reposts information
- **SI: Not Sharing information:** Generally described as not sharing via a mediated source – such as online, email, social media

Other codes:

- **Echo chambers-** This has been described in a few ways. This can include saying that people in an individual's network tend to all agree on COVID-19 information. This has also been used to describe how social media tends to reflect echo chambers
- **Conflict avoidance:** Role of the person another person feels comfortable either correcting misinformation or sharing reliable information; this varied; not discussing controversial topics in mixed company
- **Amount of time people spent online:** Participants described spending more time online during COVID-19 and the spreading of misinformation
- **Politicization of COVID-19/Vaccine:** Describes how politicians and biased media politicized COVID-19
- **Role of relationship** - someone who is close to me, do not talk to people who are not close to me, talk to friends/ family, do not bring this up in mixed company - in sharing information or in correcting/confronting misinformation
- **Scientific Literacy** - The ability to understand and apply science
- **Vaccine decision-making** - Any process used to decide whether or not to vaccinate - Probably near the same information about analytic behaviors and right after information-seeking practices for COVID-19 vaccines

Do Not Code This – Just keep this in mind for information processing

Processes for Finding/ Receiving Information

- **Active search for information:** Describe actively searching, seeking, and Googling COVID-19 health information;
- **Passively receive information:** Describes information coming to them from sources – this is different from actively seeking health information – you consume news that comes to you (podcast, email, app) instead of searching for the information

APPENDIX E

ASU IRB EXEMPTION FOR HUMAN SUBJECT TESTING

ASU Knowledge Enterprise Development

EXEMPTION GRANTED

Alexis Koskan
Public Health
480/884-2533
Alexis.Koskan@asu.edu

Dear Alexis Koskan:

On 6/8/2022 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Identifying Strategies for Combating Health Misinformation around COVID-19 Prevention and Control.
Investigator:	Alexis Koskan
IRB ID:	STUDY00015977
Funding:	Name: Arizona State University (ASU)
Grant Title:	
Grant ID:	
Documents Reviewed:	• CHS Cronkite Study Protocol, Category: IRB Protocol; • Description of Seed Funding, Category: Sponsor Attachment; • Informed Consent (interview), Category: Consent Form; • Informed Consent (Survey), Category: Consent Form; • Interview guide, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Participant demographic survey, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Recruitment Script (MTurk), Category: Recruitment Materials; • Survey (main), Category: Measures (Survey questions/Interview questions /interview

	guides/focus group questions);

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 5/28/2022.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

If any changes are made to the study, the IRB must be notified at research.integrity@asu.edu to determine if additional reviews/approvals are required. Changes may include but not limited to revisions to data collection, survey and/or interview questions, and vulnerable populations, etc.

REMINDER - - Effective January 12, 2022, in-person interactions with human subjects require adherence to all current policies for ASU faculty, staff, students and visitors. Up-to-date information regarding ASU's COVID-19 Management Strategy can be found here. IRB approval is related to the research activity involving human subjects, all other protocols related to COVID-19 management including face coverings, health checks, facility access, etc. are governed by current ASU policy.

Sincerely,

IRB Administrator